United States Avocado Production (Hass Avocado)

Final A United States Avocado Production, California, Florida, Texas, Hawaii, Puerto Rico

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Southern California Avocado Orchards

(https://californiaavocado.com/avocado101/the-history-of-california-avocados/) 53,702 total acres in 2024 (California Avocado Commission).

Florida Avocado Orchards (Bing.com) 6,000 bearing acres in 2020

(https://www.nass.usda.gov/Statistics_by_State/Florida/Publications/Annual_Statistical_Bulletin/2021/B1thru13Cit-2021.pdf)

Texas Avocado Orchards (Bing.com) Very small acreage. Less than 600 acres.

(https://galveston.agrilife.org/files/2012/03/Fruit-Nut-Production-Avocados.pdf)

Hawaii Avocado Orchards (Bing.com)

600 acres (https://aggie-horticulture.tamu.edu/fruit-nut/wp-content/uploads/sites/6/2015/04/avocados_2015.pdf)

Puerto Rican Avocado Orchards (Bing.com)

Minimal acreage. Less than 600.

Additional copies can be ordered from:

Robert J. McNeil, Publisher

Disclaimer: Information provided herein is for the benefit of the avocado grower and student. Techniques described are provided without guarantee as to their effectiveness. Utilization of such techniques is the sole decision and responsibility of the reader. Trade names have been used as a service. No recommendation of specific trade name products is implied.

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Foreward

This book has been written for use by my students of avocado culture so that they may have concise, complete, and up-to-date information with respect to avocado cultivars.

I hope it will also be useful to all others in the avocado industry, such as growers, nurserymen, home gardeners, etc.

This book is a compilation of information from many sources including my own. I have compiled it in a creative way.

Robert J. McNeil, Ph.D. Professor Emeritus, Fruit Science, CalPolySLO

Compilation explained.
https://www.law.cornell.edu/wex/compilation

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Chapter 1. Avocado Production in California

(https://apps1.cdfa.ca.gov/FertilizerResearch/docs/Avocado_Production_CA.pdf)

Avocados are native to Central America and the West Indies. While the Spanish were familiar with avocados, they did not include them in the mission gardens. The first recorded avocado tree in California was planted in 1856 by Thomas White of San Gabriel. The first commercial orchard was planted in 1908. In 1913 the variety 'Fuerte' was introduced. This became the first important commercial variety, due to its good taste and cold tolerance. Despite its short season and erratic bearing it remained the industry standard for several decades [3]. The black skinned 'Hass' avocado was selected from a seedling grown by Robert Hass of La Habra in 1926. 'Hass' was a better bearer and had a longer season, but was initially rejected by consumers already familiar with the green-skinned 'Fuerte'. However, by 1972 'Hass' surpassed 'Fuerte' as the dominant variety, and as of 2012 accounted for about 95% of avocados grown in California [3].

By the early 1930s, California had begun to export avocados to Europe. Research into avocados' nutritional benefits in the 1940s — and a shortage of fats and oils created by World War II contributed to an increased acceptance of the fruit [3]. However, acreage expansion from 1949 to 1965 depressed markets and led to slightly decreased plantings through the 1960s [2]. Due in large part to better marketing, the industry expanded rapidly in the 1970s and 1980s, reaching its peak in the mid-80s with 75,000 acres [2,5]. However, overplanting and new competition from Chile, combined with a growing consumer fear of high-fat foods, resulted in a glut, low prices and a market crash in the early 1990s [1,3]. The state's crop lost over half its value between 1990 and 1993 [5]. Aggressive marketing, combined with acreage reduction, revived the industry for the next decade [1,3]. Starting in the mid-2000s, however, drought and sharply increasing water prices, especially in San Diego County, have resulted in further acreage reductions [3]. San Diego County alone lost over 8,000 acres of avocado groves between 2007 and 2012 [4,5]. Foreign competition, especially from Mexico and Chile, pose another challenge for the industry [3].

Todays Production.

Avocados are frost-sensitive, and are grown mostly along the southern coast. In 2012 San Diego and Ventura counties grew 65% of California's avocados [4]. There is also important acreage in Santa Barbara, Riverside and San Luis Obispo counties. California has historically dominated the US avocado industry. Over the past decade, California has produced between 75% and 92% of the nation's avocados. The other major producer is Florida; Hawaii also has a small acreage. All California avocados are marketed fresh [4]. 'Hass', the major variety grown in California, can be harvested from spring through fall. Green-skinned winter varieties are also grown, but face strong competition from imported Chilean 'Hass' [3].

Yield.

Avocados have a strong alternate bearing habit, and yields are also greatly affected by drought and freeze events. Average yields are therefore in general lower than a typical heavy bearing (“on”) year and higher than a typical light-bearing (“off”) year and are not a good indicator of the yield potential of a particular grove in a given year. For example, in the 1970s, when the state average yield ranged from 2,000 and 9,000 lbs/ acre, a single ‘Hass’ grower reported a five-year high and low yield of 21,000 and 1,900 lbs/ acre, respectively [2]. However, despite fluctuations, average yields increased steadily from 1925 through the 1950s, and have remained fairly stable since the 1960s [4,5]. The increase during the first half of the century coincides with the industry’s adoption of the higher-yielding and more reliably bearing ‘Hass’ variety [3].

Fertilization

Based on USDA surveys since 1993, California avocado growers applied on average 115 lbs N/acre each year. The annual phosphate (P_2O_5) and potassium (K_2O) applications averaged 48 and 51 lbs/ acre, respectively. While 91% of growers reported applying nitrogen, phosphorus and potassium fertilizers were applied on 40 and 45% of the acreage, respectively. Growers applied N on average 3 to 4 times per year and P and K 2 to 3 times [4].

References

Avocado Production

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3. Shepherd, J.S., Bender, G.S., 2013. History of the Avocado Industry in California. In: Bender, G., (Ed.). Avocado production in California: A cultural handbook for growers, Book 1: Background Information. (2nd ed.).

The University of California Cooperative Extension, San Diego County and The California Avocado Society. pp. 1-18. Available online at: http://ucanr.edu/sites/alternativefruits/files/166823.pdf (Accessed September, 2015)
4. USDA NASS. Quickstats. Available online at: http://quickstats.nass.usda.gov/ (Accessed September, 2015)
5. USDA NASS. Historical Data. Available online at: http://www.nass.usda.gov/Statistics_by_State/California

Avocado Cultivation in California (Wikipedia.com)

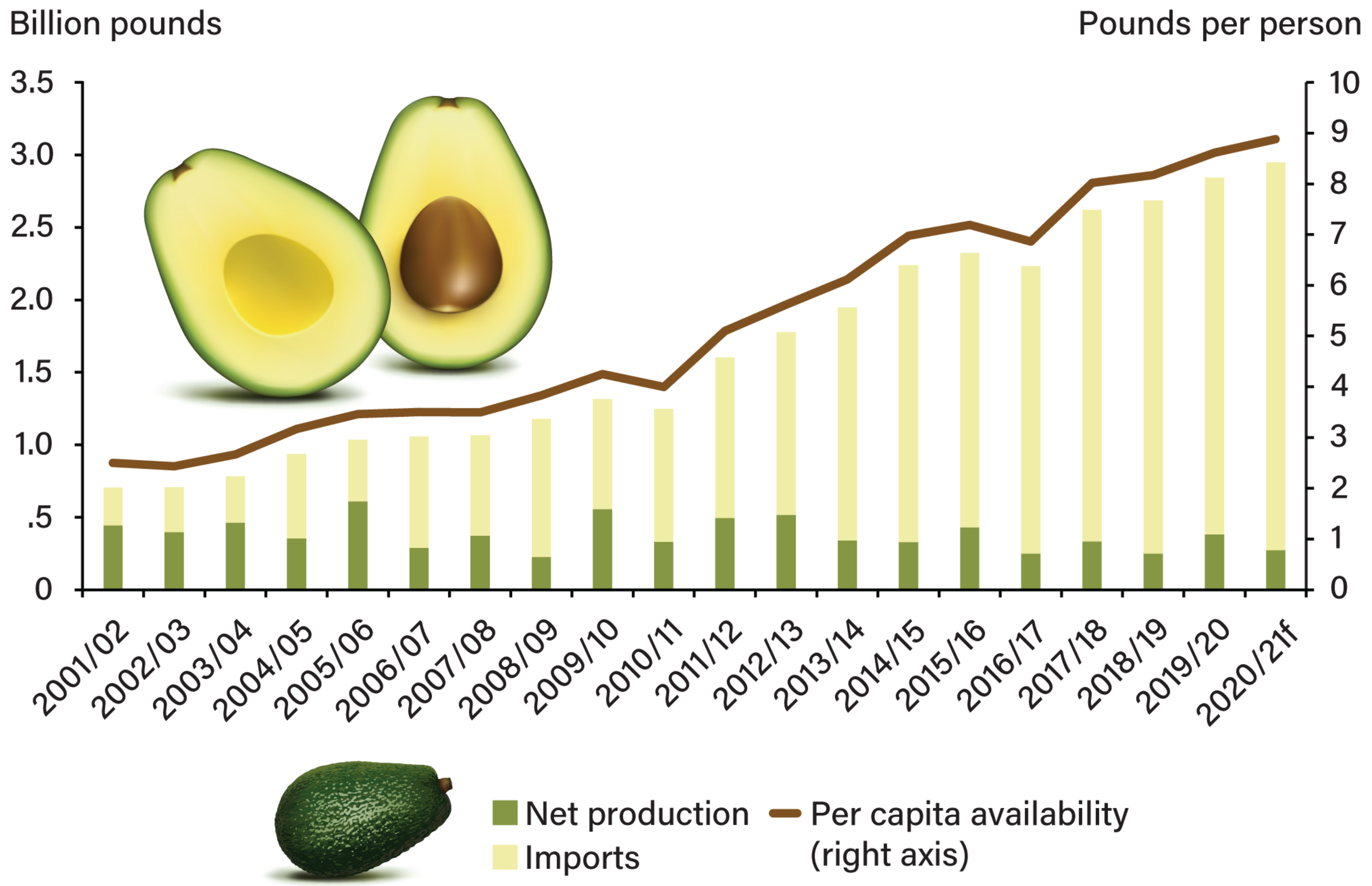
Avocados were introduced to California from Nicaragua in the early 1850s, when avocado trees imported from the Central American country were observed and reported growing near San Gabriel. The avocado has since become a successful cash crop. About 24,000 hectares (59,000 acres) – as of 2015, some 80% of United States avocado production – is located in Southern California.

Avocado is the official fruit of the state of California. Fallbrook, California, claims, without official recognition, the title of "Avocado Capital of the World" (also claimed by the town of Uruapan in Mexico), and both it and Carpinteria, California, host annual avocado festivals.

The California Avocado Commission and the California Avocado Society are the two major grower organizations and Calavo Growers is a major distributor, and 16 others.

U.S. avocado imports, production, and per capita availability, 2001/02–2020/21f

USDA Economic Research Service
U.S. DEPARTMENT OF AGRICULTURE



Notes: f = forecast. Net production = domestic production minus exports. Data are reported in marketing years. California (November–October) and Florida (June–March) have different marketing years, so production is aggregated based on the year of harvest.

Source: USDA, Economic Research Service.

Per capita consumption of avocados in the USA. See latter table from the Economic Research Service, USDA.

Per capita consumption has increased to almost 9 pounds per person in 2020/2021, in 20 years. It was only 3 pounds per person in 2001/2002.

Supply (imports plus US production) in the USA has increased from .7 billion pounds to 2.7 billion pounds in the last 20 years.

U.S. consumers' fondness for avocados has taken off since the early 2000s. From 2000 to 2021, the quantity of avocados available per person, a proxy for consumption, tripled to more than 8 pounds per person. The United States has produced an average of about 400 million pounds of avocados each year since 2000, but production has slowly declined since 2011 with a decline in U.S. avocado acreage. Imports have risen to support year-round demand. Imported avocados now account for 90 percent of the domestic supply compared with 40 percent in the early 2000s. In the 2020/21 marketing year, U.S. avocado imports reached a record high of 2.675 billion pounds. Mexico is the leading global producer of avocados, and the United States is the main destination for Mexico's avocado exports. The United States imported an annual average of 2.25 billion pounds from Mexico in 2019–21 compared with 55 million pounds in 2001–03. From 2019–21, 88 percent of all shipments came from Mexico, while 7 percent came from Peru, 3 percent from the Dominican Republic, and 1 percent from Chile. This chart appears in the USDA, Economic Research Service's Fruit and Tree Nuts Outlook, March 2022.

Top 71 Avocado Producing Countries (Tonnes) (Wikipedia)(FAO)

The following is a list of countries by avocado production from 2016 to 2022, based on data from the Food and Agriculture Organization Corporate Statistical Database. The estimated total world production for avocados in 2022 was 8,978,275 metric tonnes, up 4.8% from 8,570,284 tonnes in 2021. Mexico was the largest producer, accounting for over 28% of global production.

USA is number 13 in the world rankings. The world leaders in avocado production were Mexico, Colombia, Peru, Dominican Republic, and Kenya. Major exporters into the USA were Mexico(88%), Peru(7%), Dominican Republic(3%), and Chile(1%).

The U.S. has produced an average of about 400 million pounds of avocados each year since 2000.

Total U.S. production in 2018 was 364 million pounds, with California being the major producer.

U.S. acreage has declined over time.

The value of U.S. avocado production measured $341.9 million in 2021.

The United States produced 149,600 tons of avocados.

The total number of U.S. acres in production stabilized at 51,840.

Top 71 Avocado Producing Countries (Tonnes) (Wikipedia)(FAO)

	Country/region	2022	2021	2020	2019	2018	2017	2016
1	Mexico (Cultivation in)	2,592,581	2,442,945	2,393,849	2,300,889	2,184,663	2,029,886	1,889,354
2	Colombia	1,090,664	979,618	829,147	535,021	445,075	308,166	294,389
3	Peru	866,457	776,651	672,232	571,992	504,840	466,796	455,394
4	Dominican Republic	737,201	634,368	620,087	665,652	644,603	637,688	601,349
5	Kenya	458,439	416,803	322,556	264,032	233,933	217,688	176,045
6	Indonesia	389,000	526,000	669,000	461,613	410,084	363,157	304,983
7	Brazil	338,238	300,874	267,059	242,723	236,177	212,873	196,545
8	Vietnam	210,595	213,007	158,889	110,520	77,874		
9	Israel	189,667	165,000	147,000	138,766	131,720	110,000	101,500
10	Haiti	173,507	170,000	171,984	198,976	254,825	300,031	352,139
11	Chile	168,010	169,004	161,218	151,527	135,000	200,000	179,000
12	Ethiopia	167,884	193,400	245,336	104,492	84,794	81,432	64,982
13	United States	142,340	136,750	187,433	122,670	168,530	170,260	125,237
14	Guatemala	138,964	135,671	132,909	128,422	134,353	127,480	122,184
15	China	135,860	124,780	115,620	106,830	113,121	113,740	115,970

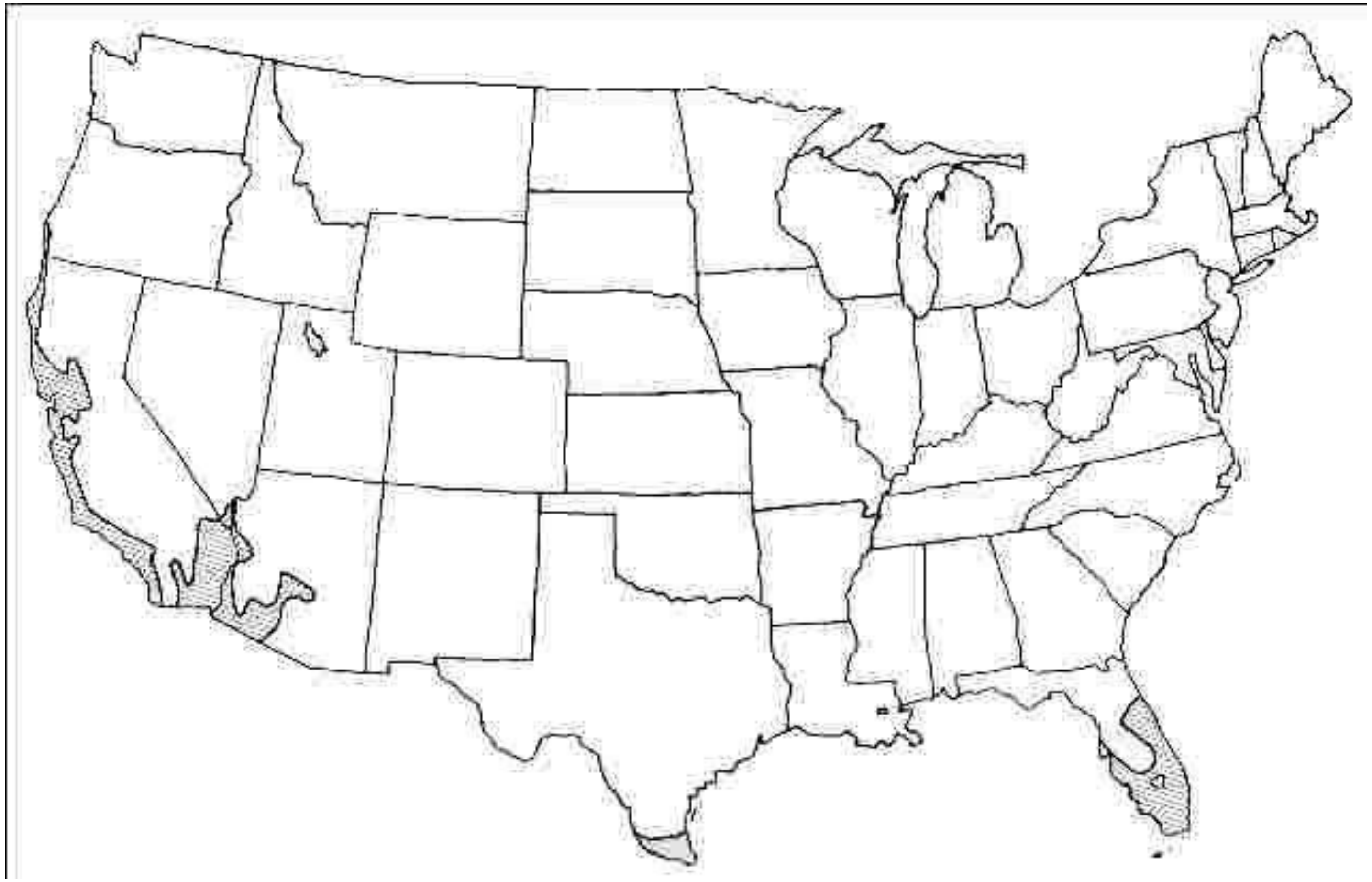
16	Venezuela	128,611	129,798	128,694	130,109	118,017	143,229	130,635
17	Spain	105,930	116,770	99,070	97,730	89,590	92,936	91,509
18	South Africa	103,602	82,677	84,775	83,623	127,568	63,045	89,546
19	Morocco	98,720	82,369	69,940	54,576	51,170	41,695	42,256
20	Malawi	94,096	93,839	93,543	93,286	92,239	97,358	86,769
21	Australia	86,171	85,986	77,295	79,533	63,486	56,501	67,600
22	Cameroon	74,325	74,480	74,393	74,101	74,946	74,134	73,222
23	Democratic Republic of the Congo	62,035	62,150	62,310	62,366	62,292	62,454	62,709
24	Angola	55,119	53,271	52,488	51,910	50,087	48,996	73,007
25	El Salvador	43,757	38,568	28,559	40,613	41,011	36,088	10,537
26	New Zealand	42,346	38,282	37,537	35,120	32,865	27,000	35,000
27	Turkey	40,181	9,081	5,923	4,209	3,164	2,765	1,950
28	Ivory Coast	36,648	36,775	36,697	36,472	37,157	36,460	35,800
29	Madagascar	27,352	27,197	27,044	26,993	26,744	26,545	26,369
30	Ecuador	26,440	42,492	20,352	26,408	18,232	20,995	16,118

31	Portugal	25,790	20,170	16,560	13,370			
32	Philippines	20,076	19,875	20,055	19,597	19,443	19,440	19,572
33	Lebanon	19,408	18,955	18,748	18,604	18,503	19,193	18,695
34	Paraguay	15,329	15,256	15,357	15,373	15,038	15,661	15,420
35	Sri Lanka	14,245	14,941	19,274	22,446	22,744	13,773	15,651
36	Greece	13,890	12,760	9,570	9,380	6,530	1,756	1,731
37	Bolivia	12,514	12,443	12,477	12,690	12,452	12,509	12,497
38	Costa Rica	12,378	12,997	13,286	17,354	11,376	12,368	12,368
39	Panama	10,297	10,593	13,000	10,781	8,358	8,276	8,195
40	Republic of the Congo	9,506	9,588	9,497	9,433	9,159	9,103	9,035
41	Ghana	9,288	9,269	9,327	9,269	9,212	9,091	8,950
42	Central African Republic	8,148	8,115	8,074	8,255	8,017	7,949	8,800
43	Zimbabwe	6,169	6,247	5,800	5,300	5,300	3,000	1,800
44	Rwanda	5,838	5,950	6,477	6,601	8,597	6,912	9,296
45	East Timor	4,334	4,345	4,335	4,321	4,379	4,305	4,281

46	Argentina	4,150	4,131	4,113	4,095	4,044	4,033	4,027
47	Cuba	3,540	3,531	3,537	3,553	3,504	3,553	3,602
48	Palestine	3,151	3,498	1,520	1,216	800	719	677
49	Jamaica	2,400	2,414	2,385	2,402	2,546	2,527	2,447
50	Honduras	2,199	2,183	2,099	2,314	2,136	1,847	2,960
51	Grenada	1,552	1,553	1,553	1,550	1,548	1,548	1,549
52	Samoa	1,408	1,414	1,410	1,399	1,432	1,399	1,366
53	Bahamas	1,403	1,409	1,405	1,395	1,426	1,395	1,363
54	Cyprus	1,370	1,210	1,163	910	950	717	810
55	Guyana	1,188	2,123	9,016	9,213	8,586	5,874	1,383
56	Dominica	1,081	1.070	1,060	1,046	1,035	1,048	1,070
57	France	1,080	1,100	1,080	2,080	2,460	2,568	1,926
58	Bosnia and Herzegovina	1,037	1,037	1,038	1,036	1,037	1,037	1,034
59	Eswatini	874	877	875	871	885	869	860
60	Barbados	755	753	760	753	747	738	725

61	Malaysia	458	269	210	122	223		
62	Saint Lucia	340	304	265	344	335	287	250
63	Tunisia	331	332	331	329	335	329	323
64	*Puerto Rico*	311	346	429	535	584	584	651
65	Fiji	263	251	160				
66	Bhutan	136	73	112	61	60	44	
67	*French Polynesia*	115	115	115	114	117	113	111
68	Suriname	99	100	111	57			
69	Trinidad and Tobago	53	55	56	57	58	59	61
70	*Cook Islands*	21	21	21	21	20	22	22
71	Seychelles	13	13	13	13	12	12	12

US Avocado Growing Areas. (https://edis.ifas.ufl.edu/publication/ST435) **United States Avocado Growing Areas. California, Florida, Texas. Also Hawaii and Puerto Rico.**



US Avocado Production (Bing.com)

156,900 metric tons. Number 13 in the world rankings.

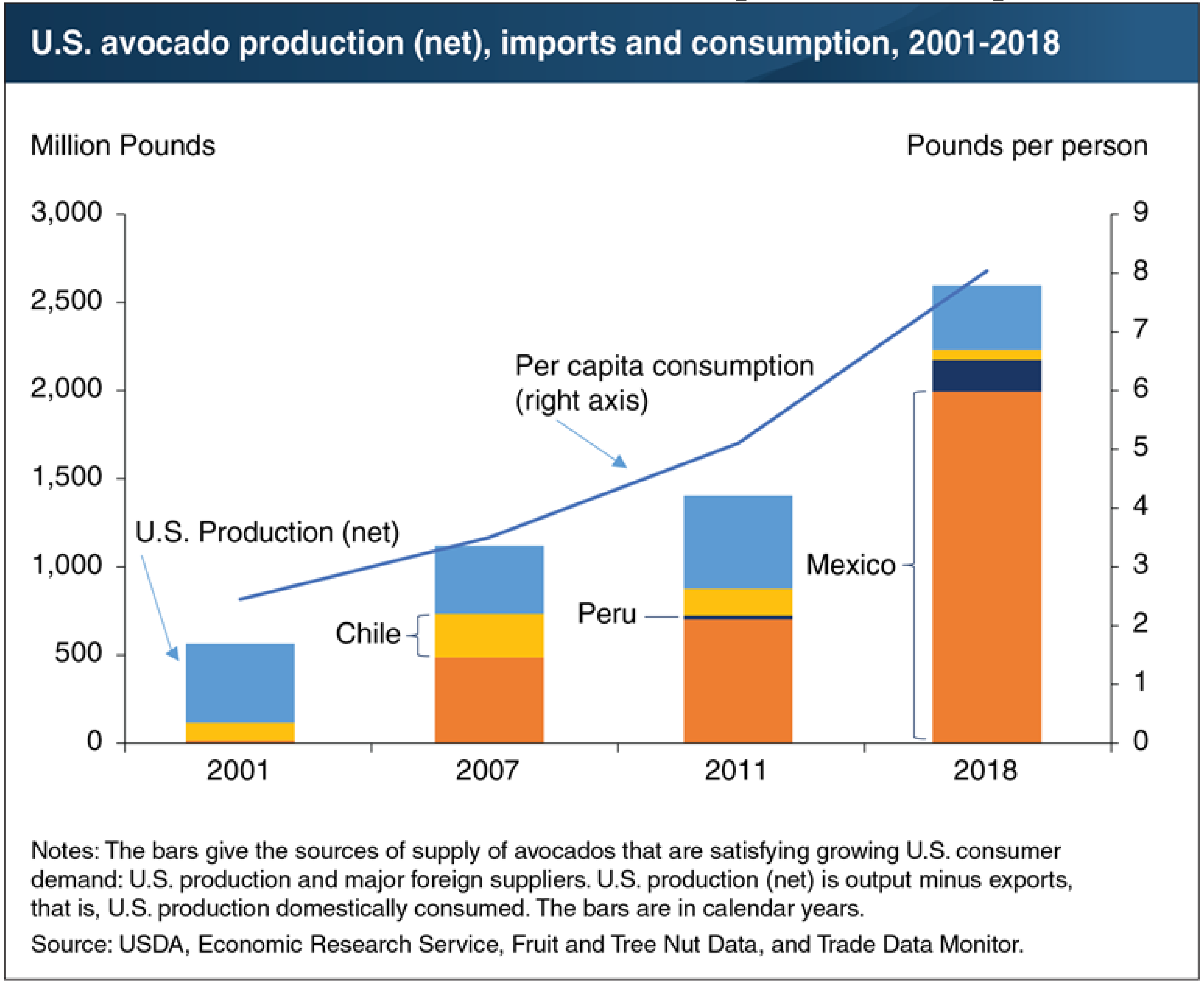
In 2022, U.S. avocado production reached 156,900 metric tons, marking a slight increase of 4.1% compared to 2021 but a significant drop of 24.1% from 2020 levels. Avocados are cultivated in just three states and one territory in the U.S.: California, Florida, Hawaii, and Puerto Rico. California accounted for the majority of production at 88.3% in 2022, while Florida and Hawaii contributed 11.5% and 0.2%, respectively, according to data from the National Agricultural Statistics Service (NASS).

Industry Statistics (USDA)

Avocados, native to Central and South America, have long been produced in California. In 1989, California supplied 90 percent of fresh avocados produced in the United States. As of 2008, approximately 6,500 growers produced avocados on 60,000 bearing acres of land (less than 100 square miles). Price and production levels vary from season to season, and from year to year, due to weather and incidents such as fires. In a typical year production averages 350 million pounds at a wholesale price of $1 per pound, although 2008 was an exceptionally low yield year. Most avocados are grown from San Luis Obispo south, with San Diego County the largest producer, now Ventura county (Wikipedia, 2024)..

U.S. demand for avocados has increased steadily over the past two decades. Per capita consumption of avocados has tripled since 2001 to 8 pounds per person in 2018. Total U.S. production in 2018 was 364 million pounds, with California the major producer, accounting for 93 percent of U.S. avocado output in that year. U.S. acreage has declined over time, and production volume can vary between years. To support year-round demand, the United States imports avocados. In 2007, Mexico overtook Chile as the dominant supplier, and by 2018 accounted for 89 percent of fresh avocado imports. While Mexico sells avocados to the United States every month of the year, shipments are lower during the summer. In 2018, Peru was the second largest source of imports, and shipments increase during the summer. Although U.S. avocado production has dropped since 2001, growing demand has benefited domestic producers through higher prices. For example, the price received by California growers in 2018 is up 22 percent from 2011. Since avocados can mature on the tree for an extended period, U.S. growers look for opportunities when fruit quality is at its peak and market conditions are optimal to harvest and ship to domestic and export markets. This chart is based on Fruit and Tree Nut Yearbook Data released in October 2019. (USDA, 2019)

US Avocado Production (USDA)



In 2021, the total planted avocado acreage in California was 51,988 acres. 53,702 in 2024, up by 1,704 acres since 2021. The majority of growing acreage is located in Ventura, San Diego, Santa Barbara, Riverside, and San Luis Obispo Counties. The top-producing counties include Riverside, Santa Barbara, San Diego, San Luis Obispo, and Ventura.

To ensure the California Avocado Commission can make informed marketing and budgeting decisions, it has partnered with LandIQ to conduct statewide spatial land use surveys via digital satellite imagery, aerial photography and analytical tools. This data is compiled in a comprehensive land use database and an annual summary is prepared. The 2024 Statewide Avocado Acreage and Conditional Analysis is now available online. Highlights from this year's survey are as follows: Planted avocado acreage in the state totaled 53,702 in 2024. 49,244 bearing acres.

About Land IQ (https://www.landiq.com/our-team)

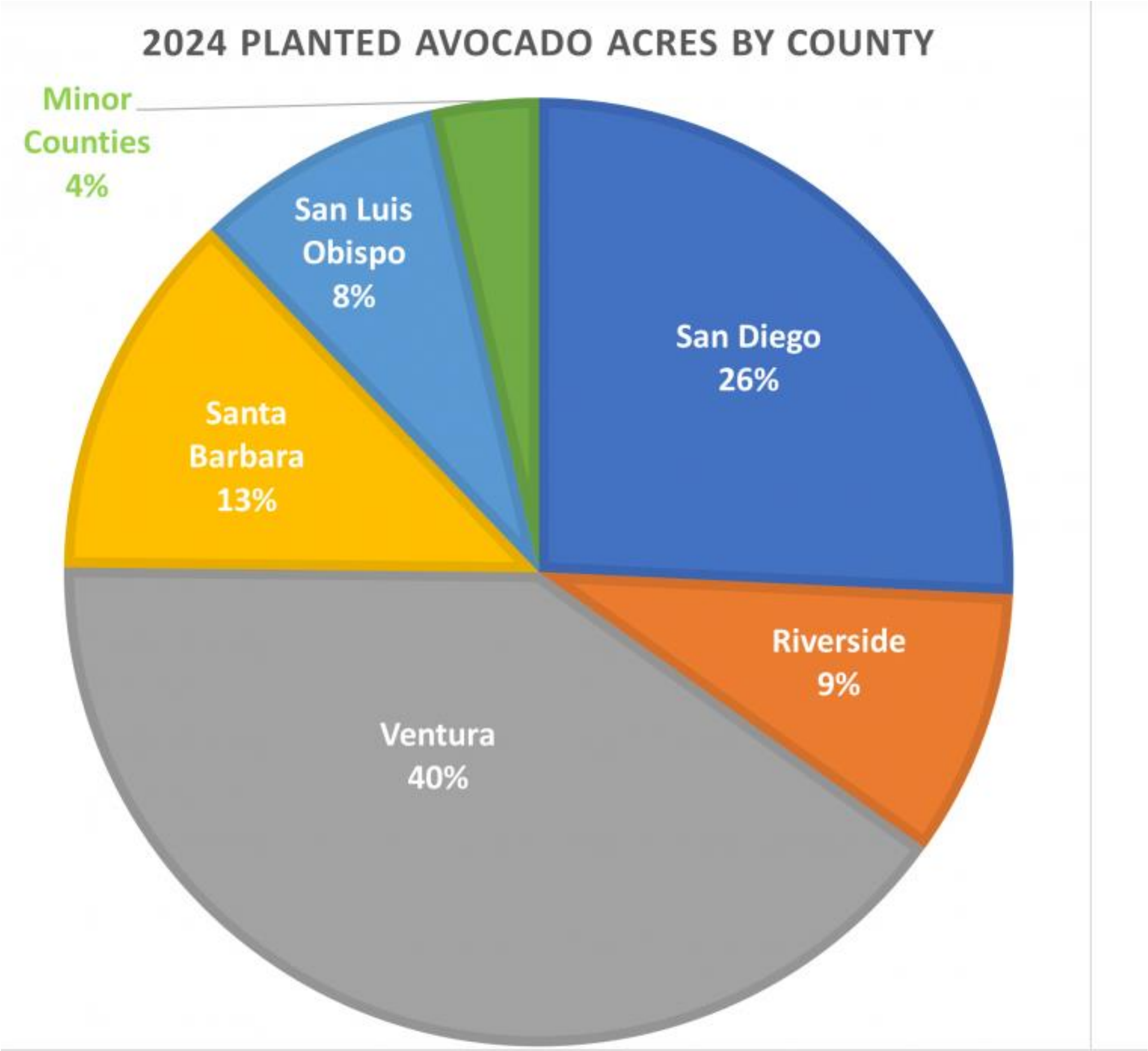
Land IQ maintains a staff of soil scientists, agronomists, ecologists, remote sensing and GIS specialists. Our experienced staff hold professional certifications including Certified Professional Soil Scientists and Agronomists, Certified Crop Adviser, Biologists, Ecologists and Certified Professionals in Erosion and Sediment Control. We have offices in Sacramento and Los Angeles.

Https://www.californiaavocadogrowers.com/industry/industry-statistical-data

Year	Bearing Acres	Volume (millions of pounds)	Crop Value ($)	Price Per Pound (¢)	Average Dollars Per Bearing Acre ($)	Average Pounds Per Bearing Acre
13/14	57,219	297.5	$333,216,563	112.00	$5,823	5,199
14/15	51,478	279.0	$303,160,400	108.60	$5,889	5,420
15/16	51,902	401.4	$412,332,493	102.70	$7,944	7,733
16/17	50,856	215.9	$345,875,896	160.20	$6,801	4,245
17/18	49,986	337.8	$383,129,253	113.4	$7,665	6,758
18/19	47,158	216.6	$372,285,783	171.8	$7,894	4,594
19/20	46,078	375.5	$411,490,578	109.6	$8,930	8,149
20/21	47,334	269.7	$327,605,005	121.5	$6,921	5,698
21/22	46,727	276.1	$486,549,026	176.2	$10,412	5,909
22/23	47,505	233.1	$237,007,667	101.7	$4,989	4,907

The California Avocado Commission's crop estimating team in conjunction with Land IQ uses the latest in remote sensing techniques to assess avocado acreage in production. As technology continues to advance refinements in our fourth generation of remote sensing techniques were applied to satellite imagery collected during spring and summer months. The imagery processing techniques include; segmentation into homogenous polygons, retention of tree crop polygons, calculation of average crop canopy moisture and vegetation indices, analysis of change maps from previous inventories, and classification of avocado groves into four categories; producing, topped/stumped, new/young, and abandoned. Aerial imagery (for a real-world view), and satellite imagery (for spectral and temporal data) are integrated into previously classified avocado acreage and analyzed for current condition of California avocado acreage statewide.

2024 Avocado Acreage Classification Summary				
County	**Producing Acres**	**New/Young Acres**	**Topped/Stumped Acres**	**Planted Acres**
San Diego	13,053	461	316	13,830
Riverside	4,303	530	69	4,902
Ventura	19,282	2,028	325	21,635
Santa Barbara	6,436	352	34	6,822
San Luis Obispo	4,395	118	35	4,548
Five County Total	**47,469**	**3,489**	**779**	**51,737**
Minor Counties				
Orange	*830*	*84*		*914*
San Bernardino	*510*	*28*		*538*
Monterey	*292*	*78*		*370*
Tulare	*99*			*99*
Los Angeles	*20*			*20*
Fresno	*10*			*10*
Kern	*3*			*3*
Sacramento	*11*			*11*
Minor Counties Total	**1,775**	**190**		**1,965**
GRAND TOTAL	**49,244**	**3,679**	**779**	**53,702**


2024 PLANTED AVOCADO ACRES BY COUNTY
Minor Counties 4%
San Luis Obispo 8%
San Diego 26%
Santa Barbara 13%
Riverside 9%
Ventura 40%

EXECUTIVE SUMMARY (CAC)

Spatial land use information is essential for the California Avocado Commission to make informed decisions for budgeting and marketing of crops. Accurate and timely land use information is the foundation of these analyses and is vital to the decision-making process. Increased availability of digital satellite imagery, aerial photography and new analytical tools make remote sensing land use surveys possible at the grove scale. These technologies allow accurate, large-scale crop and land use identification to be performed at time increments as desired and make highly accurate and comprehensive statewide avocado mapping possible. Growers, industry, regulators, government agencies, and commodity groups also benefit from spatial data related to crop type, location, condition, and density. These data are key components for management of environmental resources and proximity to sensitive areas including water quality, air quality, and disease or pest vectors. For 2023, the total planted avocado acreage in California was 52,534 acres. 53,702 in 2024, up by 1168 acres.

Table 3. Summary of 2023 Statewide Avocado Acreage by County

Five County	Acres	Number of Fields	Minor County	Acres	Number of Fields
San Diego	13,774	5,712	Orange	839	348
Riverside	4,778	2,384	San Bernardino	452	126
Ventura	21,118	6,683	Monterey	281	52
Santa Barbara	6,593	1,858	Tulare	104	36
San Luis Obispo	4,555	907	Los Angeles	16	14
			Fresno	10	4
			Kern	3	1
			Sacramento	11	5
Five County Total	**50,818**	**17,544**	**Minor County Total**	**1,716**	**586**
Overall Total: 52,534 Classified Acres / 18,130 Fields					

Table 4. Summary of 2023 Statewide Avocado Acreage by Condition

County	Producing Acres	Top/Stump Acres	New/Young Acres	Planted Acres
San Diego	12,892	594	288	13,774
Riverside	4,072	594	111	4,778
Ventura	18,882	1,676	561	21,118
Santa Barbara	6,325	219	50	6,593
San Luis Obispo	4,190	316	49	4,555
Five County Total	**46,360**	**3,399**	**1,059**	**50,818**
Minor Counties	1,628	51	37	1,716
Total	**47,988**	**3,451**	**1,096**	**52,534**

Table 6. 2023 Planted Avocado Acreage by Year Planted or Stumped

Year Planted	Planted Acres	Year Planted	Planted Acres	Year Planted	Planted Acres	Year Planted	Planted Acres
1984	14,114	1994	499	2004	2,112	2014	1,796
1985	4	1995	104	2005	1,225	2015	1,580
1986	45	1996	130	2006	978	2016	3,092
1987	133	1997	184	2007	1,426	2017	1,153
1988	20	1998	238	2008	889	2018	1,654
1989	38	1999	803	2009	1,102	2019	1,607
1990	523	2000	348	2010	926	2020	1,495
1991	189	2001	988	2011	1,083	2021	2,039
1992	146	2002	2,509	2012	1,100	2022	1,347
1993	135	2003	1,514	2013	2,371	2023	895

Acreage by Planting Density

In addition to age, a density analysis was conducted. Table 9 shows the number of acres by condition and density. Groves were classified according to the following standards:

High Density: 15x15 or closer and 20x10

Standard Density: 15x20 or greater, 20x20.

Sparse Density: Standard density grove that has as many as 50% of the trees missing.

Table 9. 2023 Avocado Acreage by Planting Density

County	Condition	High Density	Standard Density	Sparse Density
San Diego	Producing	2,056	9,738	1,097
	Stumped	50	228	10
	Young*	259	324	11
	Abandon	488	3,132	17
Riverside	Producing	1,066	2,667	339
	Stumped	16	96	
	Young*	348	245	1
	Abandon	194	425	
Ventura	Producing	3,963	14,604	314
	Stumped	42	503	16
	Young*	1,064	611	1
	Abandon	120	272	26
Santa Barbara	Producing	1,209	4,851	265
	Stumped	9	40	
	Young*	126	93	
	Abandon	62	222	
San Luis Obispo	Producing	363	3,810	16
	Stumped	3	46	0
	Young*	51	264	1
	Abandon	1	4	
Orange	Producing	58	681	49
	Stumped	3	18	
	Young*	5	24	
	Abandon	10	69	
Monterey	Producing	3	258	3
	Stumped		16	
	Young*			
	Abandon			

County	Condition	High Density	Standard Density	Sparse Density
San Bernardino	Producing	44	403	2
	Stumped			
	Young*		3	
	Abandon		1	
Tulare	Producing	32	65	6
	Stumped			
	Young*			
	Abandon		10	
Los Angeles	Producing	1	15	
	Stumped			
	Young*			
	Abandon	10	16	
Fresno	Producing		1	
	Stumped			
	Young*	8		
	Abandon	2	1	
Kern	Producing		3	
	Stumped			
	Young*			
	Abandon		3	
Sacramento	Producing		1	
	Stumped			
	Young*	11		
	Abandon			

Table 12. Net Acreage Change from 2022 to 2023 by County

County	Producing	Young	Stumped	Abandoned	Total
San Diego	(533)	(19)	(221)	(209)	(983)
Riverside	(67)	196	(105)	(114)	(91)
Ventura	604	(203)	175	(206)	370
Santa Barbara	9	23	(15)	(371)	(354)
San Luis Obispo	351	113	(44)	0	420
Orange	(16)	29	21	(50)	(15)
San Bernardino	47	(35)	(63)	86	35
Monterey	57	(16)	16	(3)	54
Tulare	22	0	(19)	(10)	(7)
Los Angeles	4	(0)	(1)	(7)	(4)
Fresno	2	7	0	(2)	8
Kern	2	(0)	0	1	3
Sacramento	1	11	0	0	11
Total	**483**	**106**	**(257)**	**(886)**	**(554)**

2022/2023_california_agricultural_statistics_review.pdf

Commodity Rank, Acreage, Production, and Value, 2022							
Commodity	CA Rank in U.S. [1]	CA Share of U.S. Receipts [2]	Area Harvested	Total Production	Total Value [2]	Commodity Rank in CA [3]	
						2021	2022
	Ranking	*Percent*	*1,000 Acres*	*1,000 Tons*	*$1,000*	*Ranking*	
FRUIT AND NUT CROPS TOTAL VALUE							
Almond (Shelled)	1	100.0	1,350.0	1,282.5	3,515,400	2	5
Apples	6	1.7	9.8	88.3	52,850	54	51
Apricots	1	84.3	5.5	26.4	24,372	57	61
Avocados	1	97.0	46.9	138.5	487,734	28	21

(2022/2023_california_agricultural_statistics_review.pdf)

California lead the nation with 97% of US production of avocados in 2022.

Costs of Production in California

(https://coststudyfiles.ucdavis.edu/uploads/cs_public/b4/3d/b43d58d9-1e91-4a3e-80f9-a2edb14958b0/2020avocadohighdensitysandiegocounty.pdf)

The total cost to produce an acre of avocados in California in 2020 was $11,920/acre in San Diego county. Net returns were $10,573/acre in San Diego. For 16,220 lb/acre at $1.39 per lb. Better yields or prices will increase net return.

UC COOPERATIVE EXTENSION AND AGRICULTURAL ISSUES CENTER TABLE 4. COSTS AND RETURNS PER ACRE TO PRODUCE AVOCADOS
San Diego County - 2020
https://coststudyfiles.ucdavis.edu/uploads/cs_public/b4/3d/b43d58d9-1e91-4a3e-80f9-a2edb14958b0/2020avocadohighdensitysandiegocounty.pdf

Quantity/ 16,220 lbs
Acre Unit
Price or
Cost/Unit 1.39
Value or
Cost/Acre
Your
Cost
GROSS RETURNS
Avocado

TOTAL GROSS RETURNS 22,494
OPERATING COSTS
Water: 7,201
San Diego District Water 45.48 AcIn 158.33 7,201
Fertilizers: 397
CAN-17% 241.44 Gal 1.00 241
15-5-5 24.00 Quart 1.45 35
Zinc Sulfate 12% 1.00 Gal 4.60 5
21-7-14 140.00 Lbs. 0.83 116
Insecticide: 25
Abamectin 15.00 Oz 1.00 15
NR-415 Oil 1.00 Gal 10.00 10
Harvest: 1,750
Picking – Labor 16,220.00 Lbs. 0.09 1,460
Hauling 16,220.00 Lbs. 0.004 65
CAC Assessment Fee 22,494.00 P-Value 0.01 225
Herbicide: 3
Generic Glyphosate 30.00 Oz 0.11 3
Rodenticide: 14
Gopher Trap 1.00 Acre 5.00 5

Squirrel Bait Station 1.00 Acre 0.23 0
Squirrel Bait 2.64 Lbs. 3.00 8
Squirrel Trap 1.00 Acre 1.00 1
Custom: 421
Float/Grading 1.00 Acre 75.00 75
Seeding (erosion control) 1.00 Acre 35.00 35
Seed Mix (erosion control) 10.00 Lbs. 9.00 90
Pest Control Advisor 1.00 Acre 38.00 38
Helicopter Rental 1.00 Acre 145.00 145
Road Repair 1.00 Acre 38.00 38
Disease: Root Rot: 66
Potassium Phosphite (Fungicide) 2.00 Gal 33.00 66
Labor: 1,863
Equipment Operator Labor 4.40 Hrs. 26.70 117
Manual Labor 29.00 Hrs. 19.28 559
Irrigation Labor 13.00 Hrs. 19.28 251
Pruning Labor 48.56 Hrs. 19.28 936
Machinery: 27

Fuel-Gas 5.78 Gal 3.20 18
Fuel-Diesel 0.00 Gal 2.92 0
Lube 3
Machinery Repair 6
Interest on Operating Capital @ 5.25% 152
TOTAL OPERATING COSTS/ACRE 11,920
TOTAL OPERATING COSTS/LBS 0.73
NET RETURNS ABOVE OPERATING COSTS 10,573

(https://californiaavocado.com/avocado101/the-history-of-california-avocados/)

Avocado History

The avocado (Persea americana) originated in south-central Mexico, sometime between 7,000 and 5,000 B.C. But it was several millennia before this wild variety was cultivated. Archaeologists in Peru have found domesticated avocado seeds buried with Incan mummies dating back to 750 B.C. and there is evidence that avocados were cultivated in Mexico as early as 500 B.C.

From Aguacate to Avocado

Spanish conquistadores loved the fruit but couldn’t pronounce it and changed the Aztec word to a more manageable aguacate, which eventually became avocado in English. The first English-language mention of avocado was by Sir Henry Sloane in 1696.

California’s Cash Crop

Fast forward to 1871, when Judge R.B. Ord of Santa Barbara successfully introduced avocados to the U.S. with trees from Mexico. By the early 1900s, growers were seeing the avocado’s commercial potential and ever since growers, enthusiasts and researchers have been hunting for improved varieties. A search through the industry’s foremost annals, in particular the California Avocado Society Yearbook, reveals that many new selections of avocado were made in the industry’s infancy and over subsequent years but few had commercial significance. By the 1950s around 25 different varieties of avocados were being commercially packed and shipped in California, with ‘Fuerte’ accounting for more than two-thirds of the production. Even though ‘Hass’ was discovered in the late 1920s and patented by Rudolph Hass in 1935, it was not until large-scale industry expansion occurred in the late 1970s that ‘Hass’ replaced ‘Fuerte’ as the leading California variety.

Today, California is the leading producer of domestic avocados and home to about 90 percent of the nation's crop. Most California Avocados are harvested on approximately 50,000 acres from Monterey through San Diego by about 3,000 growers. Ventura and San Diego top the list of avocado producing counties in California.
California Avocados are grown year-round. A single California Avocado tree can produce up to 200 pounds (21,800 lbs/acre) of fresh fruit each year, approximately 500 pieces, although most average around 60 pounds (6,540 lbs/acre) or 150 pieces of fruit.

THE HASS AVOCADO – A CALIFORNIA NATIVE
1926-2002
In 2002, the tree to which every Hass Avocado in the world can trace its lineage finally succumbed to root rot at the ripe old age of 76. Her offspring account for 95 percent of the avocados grown in California, and the fruit of her labor resulted in one of the state's most important industries. Yet, despite speculation to the contrary, nobody knows what variety of seed produced the original Hass Mother Tree.

The tree began life as lucky-find; a simple seed planted by A.R. Rideout of Whittier. Rideout, an innovator and pioneer in avocados, was always searching for new varieties and tended to plant whatever seeds he could find, often along streets or in neighbors' yards.

In the late 1920s, Mr. Rudolph Hass, a postman, purchased a seed from Rideout, and planted it in his new orchard. He planned to graft another variety on it, but when repeated grafts didn't take he planned to cut the tree down. Fortunately for avocado lovers everywhere, Hass's children talked him out of it. They preferred the taste of the tree's fruit to that of the Fuerte, the predominant variety and industry standard in those days.
Since the quality was high and the tree gave a good yield, Hass named the variety after himself and took out a patent in 1935. That same year, he signed an agreement with Harold Brokaw, a Whittier nurseryman, to grow and promote the Hass Avocados. They would split the gross income: 25 percent for Hass and 75 percent for Brokaw.

Brokaw began to propagate the rough, black Hass exclusively and promote it in favor of the standard varieties of the day. It made sense. The Hass was a far better bearer than the Fuerte and it matured at a different time of year. Because of the seasonal advantage, Brokaw was successful to the point of yearly sellouts of his nursery crops.

The patent expired in 1952, the same year Rudolph Hass died. But by then, the bumpy black avocado that bore his name was rapidly gaining in popularity on the smooth green Fuerte. Consumers preferred its richer, nuttier taste, while grocers favored it for its durability and longer shelf life. Today, the Hass accounts for about 80 percent of all avocados eaten worldwide and generates more than $1 billion a year in revenues in the United States alone.

The tree that launched an avocado revolution lived out her days in suburban La Habra Heights. Harold Brokaw's nephew Hank nursed her through more than a decade, trying to save her from root fungus. Hank lost the fight in 2002, and the tree's wood is currently in storage in a Ventura nursery awaiting the decision on a fitting commemoration of the original Hass Mother Tree.

California Avocado Commission

Created in 1978, the California Avocado Commission strives to enhance the premium positioning of California Avocados through advertising, promotion and public relations, and engages in related industry activities. California Avocados are commercially cultivated with uncompromising dedication to quality and freshness, by about 3,000 growers in the Golden State. The California Avocado Commission serves as the official information source for California Avocados and the California Avocado industry.

CAC PUBLISHES 2023 CALIFORNIA CROP ESTIMATE AND PROJECTIONS

Dec 31, 2022

In December 2022, the California Avocado Commission surveyed industry handlers to develop the following 2023 California Avocado Pre-Season Crop Estimate*:

- **Hass: 243 million pounds**
- **Lamb-Hass: 7 million pounds**
- **GEM: 6 million pounds**
- **Other: 1 million pounds**
- **Total: 257 million pounds**

**Please note the California Avocado Commission's crop year is aligned with the calendar year (January 1st through December 31st) and therefore information provided is for the 2023 calendar year.*

Avocados Background (Britannica.com)

Avocado, (Persea americana), tree of the family Lauraceae and its edible fruit. Avocados are native to the Western Hemisphere from Mexico south to the Andean regions and are widely grown in warm climates. Avocado fruits have greenish or yellowish flesh with a buttery consistency and a rich nutty flavour. They are often eaten in salads, and in many parts of the world they are eaten as a dessert. Mashed avocado is the principal ingredient of guacamole, a characteristic saucelike condiment in Mexican cuisine. Avocados provide thiamin, riboflavin, and vitamin A, and in some varieties the flesh contains as much as 25 percent unsaturated oil.

Britannica.com

Physical description

Avocado trees can be tall or spreading, and they have elliptic to egg-shaped leaves that are 10–30 cm (4–12 inches) in length. The small greenish flowers are borne in dense inflorescences and lack true petals. The flowers have nine stamens, arranged in three series, and a one-celled ovary. Interestingly, there are two types of avocado flowers, A and B, depending on the cultivar. These flowers are dichogamous (male and female parts mature separately), and each flower opens only twice. Type A flowers are functionally female in the morning, close at midday, and then reopen as functionally male in the afternoon of the following day. Type B flowers are functionally female in the afternoon, close in the evening, and then reopen the following morning as functionally male. When the two flower types are grown together, this temporal overlap of mature male and female parts encourages cross-pollination and, thus, greater fruit production.

Britannica.com

The fruit is exceedingly variable in size, no larger than a hen’s egg in certain Mexican races and sometimes weighing 1–2 kg (2–4 pounds) in other races. The form varies from round to pear-shaped with a long slender neck, and the colour ranges from green to dark purple. Botanically, the fruit is a berry and features a single large round seed with two cotyledons. The fruit’s outer skin is sometimes no thicker than that of an apple and sometimes is coarse and woody in texture.

Britannica.com

History and production

Avocados were first domesticated in tropical America, where they were cultivated as individual seedling trees before the Spanish conquest. The plants did not receive serious horticultural attention until about 1900, when horticulturists found that production of grafted trees was simple and allowed perpetuation of superior seedlings and the establishment of orchards. Flourishing avocado industries have since developed around the world in suitable climates. Mexico, the Dominican Republic, Peru, Indonesia, and Colombia were the top producers worldwide in 2020. The fruits are also grown commercially in Florida, California, Hawaii, Puerto Rico, Kenya, Haiti, Chile, South Africa, Brazil, and Australia, as well as on some Pacific islands and in several Mediterranean countries, including Israel.

Britannica.com

Major types

Horticulturally, avocados are divided into the Mexican (Persea americana, variety drymifolia), West Indian (P. americana, variety americana), and Guatemalan (P. americana, variety guatemalensis) races, with more than 1,000 cultivars between them. The Mexican race is native to Mexico and is characterized by the anise-like odour of the leaves and by small (weighing 90–240 grams [3–8 ounces]), thin-skinned fruits of rich flavour and excellent quality. Mexican avocados are the hardiest, growing in regions too cold for other types. The Guatemalan race, native to the highlands of Central America, is slightly less frost-resistant than the Mexican and produces fruits of medium to large size (240–1,000 grams), characterized by thick woody skins and a ripening season different from that of the others. Cultivation of the West Indian race, the most tropical in character, is limited in the United States to southern Florida. Hass avocado, the most popular cultivar in the United States, is a Mexican-Guatemalan hybrid.

Avocado Races California Avocado Commission

TRAIT	MEXICAN	GUATEMALAN	WEST INDIAN
TREE			
Climatic adaptation:	"semitropical"[1]	subtropical	tropical
Cold tolerance:	most	intermediate	least
Salt tolerance:	least	intermediate	most
Hairiness:	most	less	less
Leaf anise:	present	absent	absent
Leaf color:	medium	often redder	paler
FRUIT			
Months to mature:	6	12 or more	5
Size:	small	variable	variable
Pedicel (stem):	small	variable	variable
Skin thickness:	very thin	thick	medium
Skin surface:	waxy bloom	rough	shiny
Seed size:	large	small	variable
Seed cavity:	loose	tight	variable
Seed surface:	smooth	smooth	rough
Oil content:	highest	high	low
Pulp flavor:	spicy	often nutty	mild
Some varieties:	Topa Topa, Mexicola, Duke, Mentone	Reed, Nabal	Waldin, Booth, Trapp

Britannica.com

Guacamole, a spread or dip made of avocados. Traditionally, guacamole is made with peeled and mashed ripe avocados and salt. Lime juice, cilantro, onion, and hot green peppers, such as serranos and jalapeños, are the most common inclusions. Some recipes call for tomatoes. While it originated in Mexico, where it remains a staple food, guacamole has become one the most popular dips or spreads in the world.

See recipe on last page.

Britannica.com

Etymology and history

The word guacamole originated in Latin American Spanish. It comes from the Nahuatl word ahuacamolli, which translates to "avocado sauce."

The avocado, technically a type of berry, is considered to be native to a wide swath of the Western Hemisphere, stretching from Mexico in the north to the Andean regions of South America in the south. Genetic testing suggests that avocados were originally domesticated by several Mesoamerican cultures from an ancestor species that grew from the eastern and central highlands of Mexico to the Central American Pacific coast. Archaeological sites in Tehuacán, Mexico, reveal human consumption beginning in 8,000–7,000 bce. As the fruit began to appear more regularly in the English lexicon during the 18th and 19th centuries, it was often referred to as the "alligator pear," probably because of its tough leathery exterior.

Britannica.com

Guacamole was an established part of Aztec cuisine by the time of the Spanish conquest in the 16th century. The first person to write an English-language recipe for guacamole was the British privateer William Dampier. The recipe would appear in his 1697 book A New Voyage Around the World, in which he notes a mash made from avocados, lime juice, and sugar.

Preparation and nutritional profile

Guacamole is traditionally made by grinding the ingredients with a mortar and pestle. It can also be made in a simple mixing bowl with a utensil like a fork. A less chunky version can be made in a blender or food processor. Modern recipes often call for a paste to be rendered out of herbs, peppers, salt, and lime before adding the avocado and then mashing by hand.

Britannica.com

Guacamole’s nutritional value derives largely from the raw avocado, a good source of fats and vitamins. About 100 grams of avocado contains roughly 160 calories, 14.7 grams of fat, 8.5 grams of carbohydrates, and 6.7 grams of fiber. It contains vitamins B6, C, E, and K, as well as folate, niacin, and riboflavin. The minerals potassium and magnesium are also present.

Britannica.com

There are a few dishes in the world made from processing avocados down, like guacamole's smoother, thinner, Venezuelan cousin guasacaca, though none are technically prepared with the same ingredients and mashing technique. Guacamole's ownership is a point of pride for many Mexicans. Marketers promoting avocados have declared September 16th as National Guacamole Day (September 16 is also the day that Mexico's independence from Spain is celebrated) to encourage consumption of the dip. The record for the largest serving of guacamole, according to the Guinness Book of World Records, was achieved in April of 2018, when the Junta Local de Sanidad Vegetal de Tancítaro, in Michoacán, Mexico, made 3,788 kg (8,351 pounds) of it.

Britannica.com

In the United States guacamole is a beloved product of the Mexican-American cultural exchange. It has become a near-ubiquitous presence in Mexican restaurants and appetizer spreads. It is primarily eaten as a dip (often with tortilla chips) and as a topping or condiment on a variety of Mexican dishes—depending on local preparation—like tacos and tostadas, as well as Americanized Mexican or Tex-Mex foods like burritos and nachos. While many Americans make guacamole at home, it can also be bought in most supermarkets. Store-bought guacamole is usually refrigerated in sealed containers to prevent the avocado flesh from oxidizing and turning brown. The use of lime juice in the recipe also helps prevent the browning caused by oxidation, as does adding a thin layer of water or milk to the surface of freshly made guacamole and then covering the container with plastic wrap; the liquid should be gently poured off before the guacamole is served.

https://daily.jstor.org/the-illustrious-history-of-the-avocado/

Scientists think that the fruit first originated in Africa, then made it to North America, then traveled down to Central America. Conditions for avocado cultivation may have existed as far back as 16,000 B.C.E., the team writes—and its long history among Caral, Mokaya, and Maya peoples points to its beloved status.

Avocado can be found as the name of the 14th month on the Maya calendar, on Pacal tombs in Chiapas, and in Aztec paintings. Linguistic clues point to avocados' significance, too. "The presence of a plant or animal in nature alone is not enough for it to be named," the authors note; "it is necessary for the society or human group to acknowledge the importance of the species before naming it."

https://daily.jstor.org/the-illustrious-history-of-the-avocado/

Many cultures did just that, and the regard with which they held avocados is demonstrated by the many words with which they referred to it.

As cultures blended and met in Mesoamerica, it is thought that avocado came along for the ride. By the time Spaniards came to the Americas, the team writes, “the avocado was consumed from Mesoamerica to Peru.” The Spanish were intrigued not just by the biological diversity of the lands they conquered, but its delicious foods. An early explorer who found avocado in what is now Colombia wrote that its flesh “is like butter and is of marvelous flavor, so good and pleasing to the palate that it is a marvelous thing.” Spanish invaders took note of avocados, learned about their flavor profiles and potential medicinal applications, and wrote back to royalty about the fruit.

https://daily.jstor.org/the-illustrious-history-of-the-avocado/

The authors document three circumstances in which avocado was "used as tribute," given by indigenous people to their rulers or used as money in commercial transactions. They note the use of avocados as animal feed, remedy for bruises and split ends, and even as stamps on fabric.

As the Spaniards traveled outward to other colonies, they brought the avocado with them. They've been in California since the 1850s and had made their way all over the world by 1998. And though the world is still sorting through its modern avocado supply problem—blame the shortage on weather, labor issues, and increased demand—the ascendance of the humble avocado makes even more sense when you recognize its old-school roots.

https://daily.jstor.org/the-illustrious-history-of-the-avocado/

Resources

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THE AVOCADO (PERSEA AMERICANA, LAURACEAE) CROP IN MESOAMERICA: 10,000 YEARS OF HISTORY

By: María Elena Galindo-Tovar, Amaury M. Arzate-Fernández, Nisao Ogata-Aguilar and Ivonne Landero-Torres

Harvard Papers in Botany, Vol. 12, No. 2 (December 2007), pp. 325-334

Harvard University Herbaria

Climatic Zones for California Avocados (Koch, 1983)

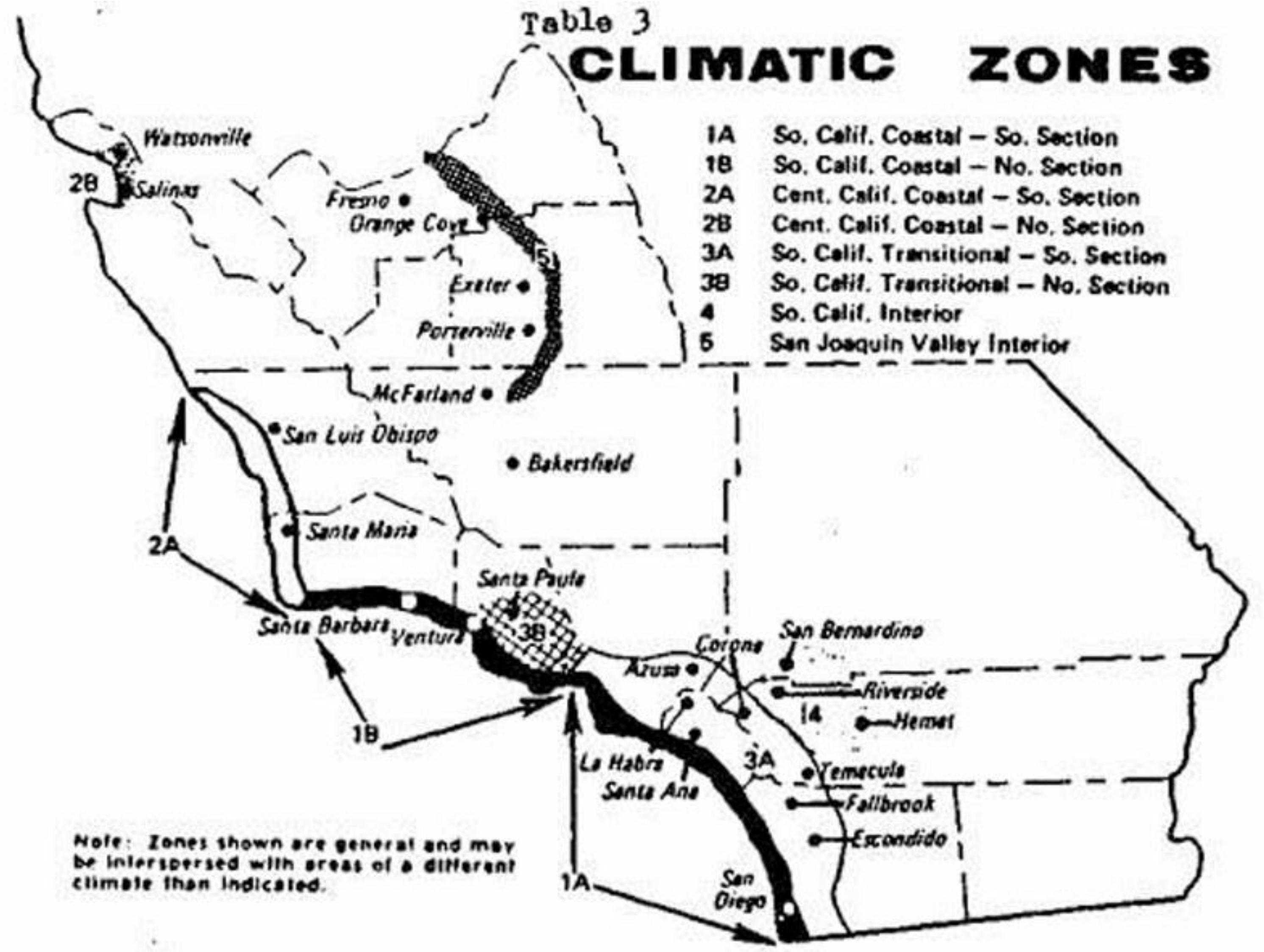


Table 3
CLIMATIC ZONES
1A So. Calif. Coastal – So. Section
1B So. Calif. Coastal – No. Section
2A Cent. Calif. Coastal – So. Section
2B Cent. Calif. Coastal – No. Section
3A So. Calif. Transitional – So. Section
3B So. Calif. Transitional – No. Section
4 So. Calif. Interior
5 San Joaquin Valley Interior
Watsonville
2B
Salinas
Fresno
Orange Cove
5
Exeter
Porterville
McFarland
San Luis Obispo
Bakersfield
Santa Maria
2A
Santa Paula
Santa Barbara
Ventura
3B
San Bernardino
Corona
Azusa
Riverside
4
Hemet
1B
La Habra
Santa Ana
3A
Temecula
Fallbrook
Escondido
San Diego
1A
Note: Zones shown are general and may be interspersed with areas of a different climate than indicated.

References Cited. Avocado Production in California. Chapter 1.

Wikipedia.com

FAO.com

https://coststudyfiles.ucdavis.edu/uploads/cs_public/b4/3d/b43d58d9-1e91-4a3e-80f9a2edb14958b0/2020avocadohighdensitysandiegocounty.pdf

https://www.californiaavocadogrowers.com/industry/industry-statistical-data

2022-2023_california_agricultural_statistics_review.pdf

Britannica.com

https://daily.jstor.org/the-illustrious-history-of-the-avocado/

Koch, F. D. 1983. California Avocado Growers Handbook. (https://openlibrary.org/books/OL11625561M/Avocado_Grower's_Handbook)

Chapter 2. Species and Cultivars

(https://californiaavocado.com/avocado101/avocado-varieties/)

Main California Avocado Varieties (Nine slides) (https://californiaavocado.com/avocado101/avocado-varieties/)

HASS

Distinctive for skin that turns from green to purplish-black when ripe, the Hass is the leading variety of California Avocado.

OVAL SHAPE

PEBBLY SKIN

SMALL/MEDIUM SEED

5 – 12 OUNCES

LAMB HASS

This variety is similar in appearance and taste to the Hass but a large robust size – the California summer sun variety.

OVAL SHAPE

PEBBLY SKIN

MEDIUM SEED

11.75 – 18.75 OUNCES

GEM®

A thick skinned and easily peeled avocado with rich, nutty flavor and similar ripening characteristics of the popular Hass Avocado; available spring through summer.

OVAL SHAPE

PEBBLY SKIN

MEDIUM SEED

7-11 OUNCES

GWEN

Gwen is similar in appearance, taste and texture to Hass, but slightly larger.

PLUMP OVAL

PEBBLY SKIN

SMALL/MEDIUM SEED

6 – 15 OUNCES

PINKERTON

Pinkerton avocados have small seeds, yield more fruit per tree and are available in a full range of sizes early winter through spring.

LONG PEAR SHAPE

SLIGHT PEBBLING

SMALL SEED

8 – 18 OUNCES

REED

A large, round fruit available in the summer months and early fall.

ROUND SHAPE

SLIGHT PEBBLING

MEDIUM SEED

8 – 18 OUNCES

FUERTE

Harvested late fall through spring, the Fuerte is the original high-quality California Avocado.

PEAR SHAPE

SMOOTH SKIN

MEDIUM SEED

5 – 14 OUNCES

BACON

A green-skinned variety of good quality, the Bacon is a medium-sized fruit available late fall into spring.

OVAL SHAPE

SMOOTH SKIN

MEDIUM/LARGE SEED

6 – 12 OUNCES

ZUTANO

Easily recognized by its shiny, yellow-green skin, the Zutano is one of the "season opener" varieties harvested when the season begins in September and is available through early winter.

PEAR SHAPE

SHINY SKIN

MEDIUM SEED

6 – 14 OUNCES

https://avocado.ucr.edu/unreleased-varieties

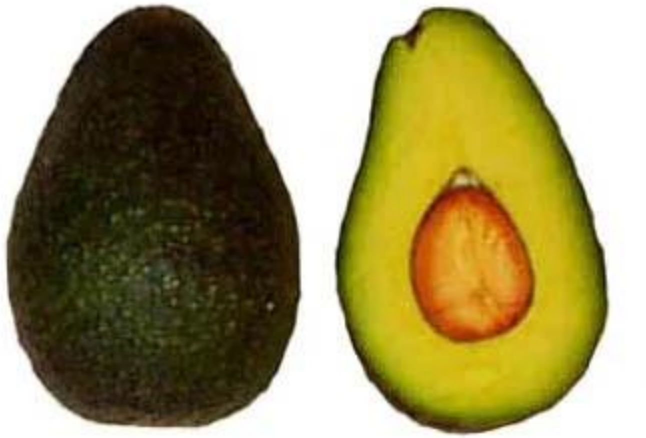
BL516 (Marvel)
(Released 2024)

BL667 (Nobel)

GEM
(Released 2005)

Harvest
(Released 2005)

UCR Unreleased Varieties (four slides) (https://avocado.ucr.edu/unreleased-varieties)



BL516 (Marvel)   Black. Now Luna. Released 2024.

Source: Open pollinated 'Gwen' seedling

Flower type: B

Average fruit weight: 6-9 oz

Average skin thickness: 1.2 mm

Additional Notes: Compact tree, hides fruit well.

Tree habit: upright.

BL516 Marvel. Now Luna. Released 2024.

(https://avocado.ucr.edu/avocado-variety-database)

Variety BL516

Flower Type B

Fruit Color Black

Ecotype Hybrid

(Hybrid) Previously referred to as "Marvel". Now Luna. Hass like variety, B flower type, 6-9 ozs, peels easily, pear to oval pear shaped, attractive flesh, green or green & black when hard, black when soft, seed is very small to medium in size, ripens much later than Hass. (J.R. Frink 1998) Narrow, upright growth habit with drooping branches that protect fruit from wind and sun (Focht 2023)

BL667 (Nobel)

Source: Open pollinated 'Gwen' seedling

Flower type: B. Black when soft.

Average fruit weight: 8-14 oz.

Average skin thickness: 1.4 mm

Additional Notes: This variety does not produce much budwood.

Tree habit: weeping but more or less compact and upright.

BL667 Nobel (https://avocado.ucr.edu/avocado-variety-database)

Variety BL667

Flower Type B

Fruit Color Black when soft

Ecotype Hybrid

(Hybrid) Occasionally referred to as "Nobel". B flower Hass like, 8-14 ozs, ave. 11 ozs, green when hard April-July, green & black hard Aug.-Dec., black when soft. Best taste test scores, May-Sept. in Irvine, immature Jan.-Mar, very attractive flesh, seed usually of medium size. Skin is less bumpy than Hass. This result of the UCR Avo. breeding program is a promising new variety. Dr. B. Bergh & Gray E. Martin submitted a declaration of invention form in 1997. For more information see p.39 CAS Yearbook 1993. (J.R. Frink 1998)

GEM Released 2005

Source: Open pollinated 'Gwen' seedling

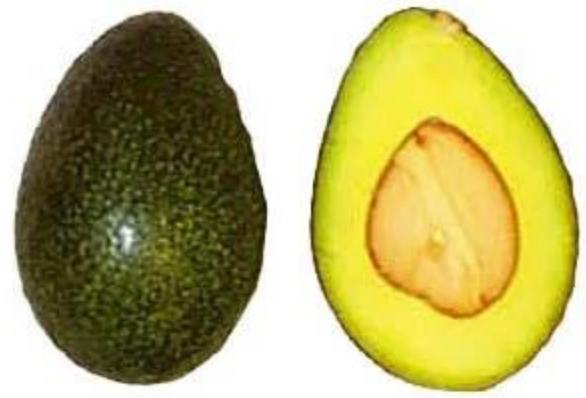
Flower type: A. Black. 7-11 oz.

Average fruit weight: 9.7 oz

Average skin thickness: 1.6 mm

Additional Notes: Seems to set fruit every year.

Tree habit: spreading but 'Gwen'-like.



Gem (https://avocado.ucr.edu/avocado-variety-database)

Variety GEM Released 2005.

Flower Type A

Fruit Color Black. 7-11 oz.

Ecotype Guatemalan

(Hybrid) Regist.1944 Originated by Wm.L.Troyer at 1544 N.Hill Ave.,Pasadena, CA, from Lyon seed. Fruit season,July-Sept.;color, green; weight,9 ozs.; shape, ovoid; skin,smooth,peels;flavor,fair plus;oil 19.33%.Seed,1.25 ozs.(CAS Yearbook 1950) Orig.in Fullerton,CA,by Lawrence W. Sherwood, Sherwood Specialty Nursery. Introd.in 1947. Plant patent 773; 30 Dec.1947.Chance seedling; discovered among a number of trees grown from seeds of a Mex. seedling of unknown parentage planted about 1907.Fruit:8-12 oz,averaging 4.50“ long & 2.50“ in diam.; pyriform; skin bright purple,attractive,smooth,glossy;seed small flesh pale yellow, flavor mild, buttery, oil content high, quality very good; ripens 15 Sept. in southern CA. Tree: upright spreading; bears well; blooms 1.50 to 2 months before Fuerte. Now obsolete. (B&O Register)

Gem. (https://avocado.ucr.edu/variety-list#gem)

Parentage: Guatemalan. Released 2005.

Peels: Yes

Seed Size: Medium

Skin Texture: Medium

Blossom Type: A

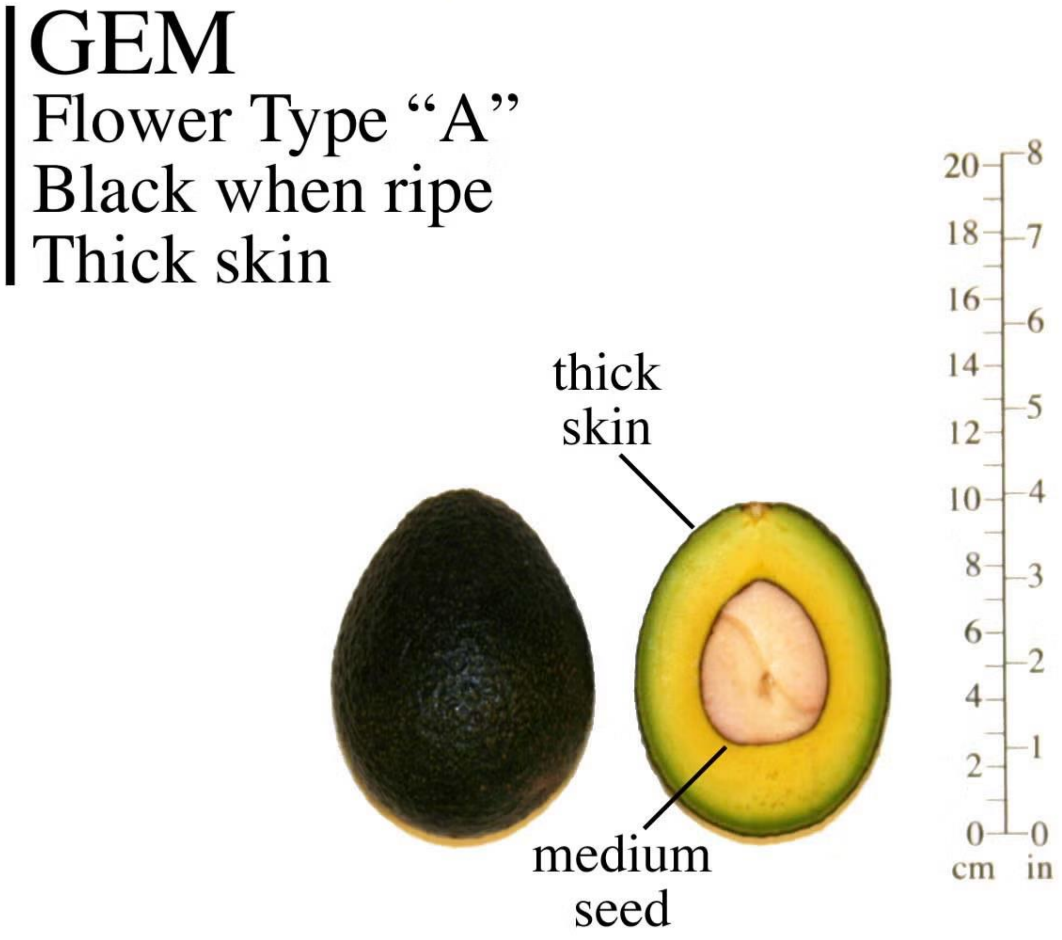
Fruit Shape: Ellipsoid

Skin Color Unripe: Green to Black

Skin Color Ripe: Black

Skin Thickness: Thick

Average Fruit Weight oz: 7 to 11



Harvest   Released 2005

Source: Open-pollinated 'Gwen' seedling

Flower type: A. Black. 7-10 oz.

Average fruit weight: 9.0 oz

Average skin thickness: 1.7 mm

Additional Notes: Has a strong tendency to alternate bear.

Tree habit: open tree.

Harvest. (https://avocado.ucr.edu/avocado-variety-database)

Variety HARVEST Released 2005.

Flower Type A

Fruit Color Black. 7-10 oz.

Ecotype Hybrid

(Hybrid) Very productive tree, black fruit, with excellent shelf life. Variety is very new, developed by UCR breeding program. Dr. Bob Bergh & Gray Martin submitted declaration of invention form for Harvest in 1997. Season is later than Hass. Fruit appearance is similar to Hass but more round oval than the pear oval of Hass. (J.R. Frink 1998)

Harvest. (https://avocado.ucr.edu/variety-list#harvest)

Parentage. Guatemalan. Released 2005.

Peels: Yes

Seed Size: Large

Skin Texture: Medium

Blossom Type: A

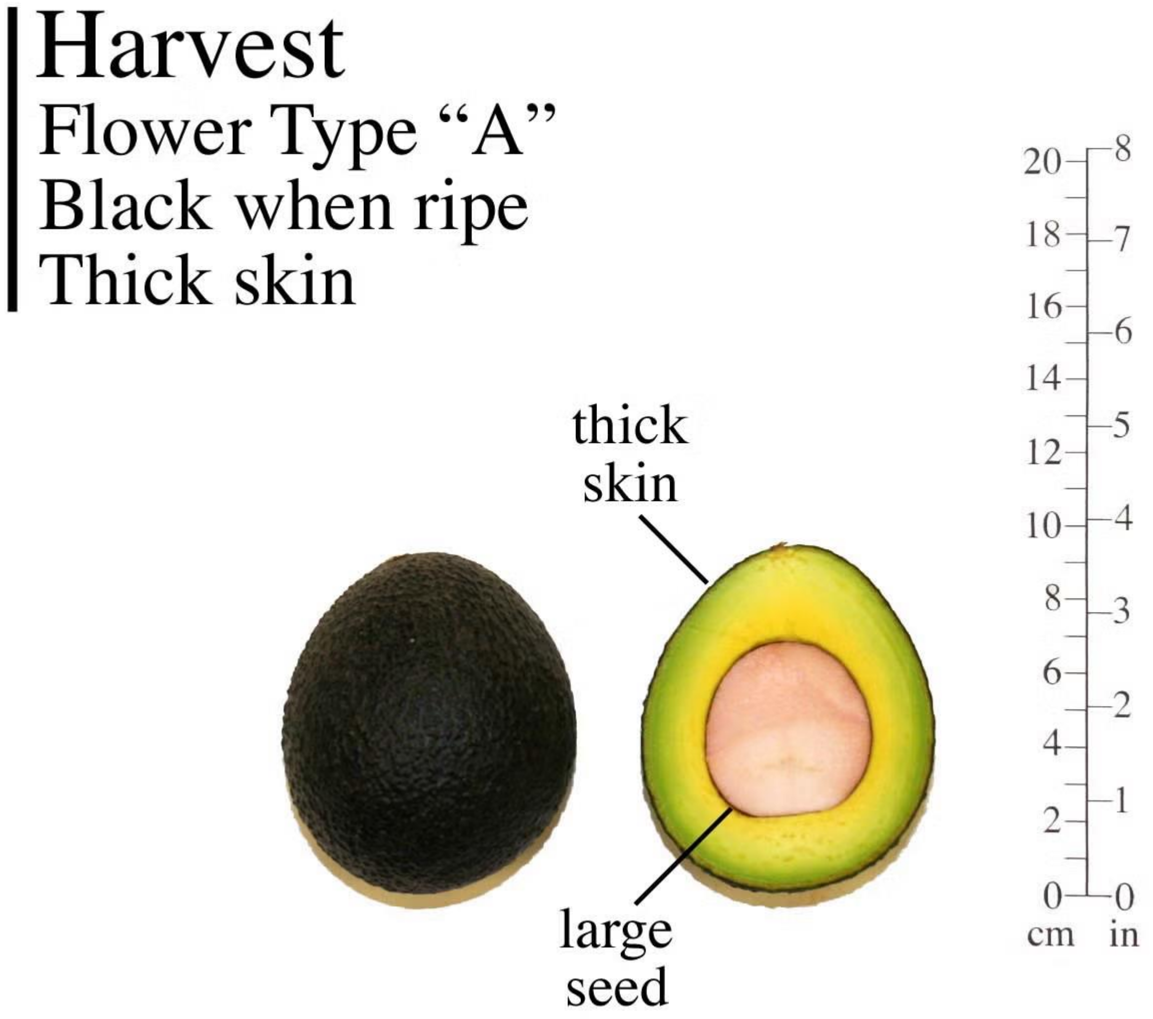
Fruit Shape: High spheroid

Skin Color Unripe: Dark Green

Skin Color Ripe: Black

Skin Thickness: Thick

Average Fruit Weight oz: 7 to 10



Taste Tests. 2011.

Table 2. Mean hedonic score (1-9 scale where 1 = dislike extremely; 5 = neither like or dislike; 9 = like extremely) for sensory evaluations conducted at the UC Kearney Agricultural Center in 2011.

	February Weeks @ 41^{0}F		**June** Weeks @ 41^{0}F			**August** Weeks @ 41^{0}F		
	0		0		4	0		4
Hass	4.8	bc	6.6	a	6.3	6.8	ab	6.9
Carmen Hass	5.6	ab	-		-	-		-
GEM	-		5.9	b	5.9	6.4	ab	5.9
Lamb Hass	-		-		-	5.6	c	6.0
464918-99	6.2	a	6.8	a	6.2	-		-
465202-99	4.8	bc	6.6	a	6.5	6.2	bc	6.5
465418-99	5.2	abc	6.4	ab	6.0	6.1	bc	6.2
465512-99	3.4	d	-		-	-		-
465518-99	4.2	cd	7.0	a	-	7.0	a	6.2
Probability	*0.0002*		*0.0240*		*0.7200*	*0.008*		*0.3250*

Mean separation at the 0.05 probability level using LSD.

Cultivars that are predominantly Mexican include Bacon, Zutano, Topa Topa, Mexicola, Duke. Cultivars that are equally Mexican-Guatemalan include Fuerte and Ryan. Cultivars that are predominantly Guatemalan include Hass, Lamb Hass, Gwen, Pinkerton, Reed, Gem, SirPrize, Luna.
Cultivars from hybrids (Guatemalan-West Indian) are generally not important to California, except for the Lula as a seedling rootstock. In years where there may be a shortage of seed, some nurserymen have purchased Lula seed from Florida for propagation. Lula is popular in the nursery because of its fast-growing qualities. Chlorosis symptoms have occasionally been noticed on trees grafted on this rootstock; more work needs to be done to determine which locations are more acceptable to use Lula as a rootstock in California. Lula (as a rootstock) does best in well-drained soils. It is the most used rootstock in Texas. (Adapted after Bender et al 2015)

The following tables show the trend in avocado production in California in the last ten years. Note the decline in the minor varieties for demand in the markets.
The leading varieties by volume are Hass, Lamb Hass, and Gem.

CAC PUBLISHES 2023 CALIFORNIA CROP ESTIMATE AND PROJECTIONS

The leading varieties now are Hass, Lamb Hass, and Gem.

Dec 31, 2022

In December 2022, the California Avocado Commission surveyed industry handlers to develop the following 2023 California Avocado Pre-Season Crop Estimate*:

- Hass: 243 million pounds
- Lamb-Hass: 7 million pounds
- GEM: 6 million pounds
- Other: 1 million pounds
- Total: 257 million pounds

**Please note the California Avocado Commission's crop year is aligned with the calendar year (January 1st through December 31st) and therefore information provided is for the 2023 calendar year.*

Table 1. Estimated acreage and yield for avocado cultivars in California 2001-2002 (California Avocado Commission}

Cultivar n	Bearing Acreage	Estimated Yield(lbs/acre}	Estimated Yield in California(million lbs}
Hass	51,575	7,044	363.3
Fuerte	1,452	4,125	6.0
Bacon	1,961	6,645	13.0
Zutano	706	3,144	2.2
Pinkerton	1,035	4,715	4.9
Reed	430	7,163	3.1
Gwen	260	5,633	1.5
Lamb Hass	420	5,143	2.2
Other	388	3,058	1.2
Total	58,227	6,825	397.4

Table 2. Decline in production for various avocado cultivars 2002-2012. Acreage from most of the minor cultivars is no longer determined, but AMRIC keeps track of yield (in pounds). Data is supplied by 13 of the major packers in the industry to AMRIC.

Season	Fuerte	Bacon	Zutano	Pinkerton	Gwen	Reed	Other greens
2002	3,476,645	9,734,690	888,980	3,230,570	1,746,815	3,185,455	465,340
2003	1,645,350	7,885,025	410,230	3,060,065	1,397,065	3,143,605	470,870
2004	2,743,590	7,399,135	346,795	5,226,390	1,603,630	1,715,270	668,140
2005	1,504,250	5,130,725	223,475	715,500	727,950	1,948,350	333,900
2006	2,321,050	3,747,775	160,425	4,186,900	908,475	2,331,925	486,150
2007	805,450	1,262,550	27,000	135,000	204,300	1,229,525	263,700
2008	619,825	1,823,700	58,500	1,288,400	470,250	1,334,750	190,800
2009	130,550	1,473,650	233,475	515,900	268,125	673,700	162,900
2010	708,650	1,372,700	229,925	638,200	267,300	583,800	519,300
2011	430,000	1,364,900	262,200	553,500	162,000	1,444,900	144,900
2012	655,900	1,068,700	133,200	399,100	184,500	817,900	132,300

Table 3. Estimated acreage and yield for avocado cultivars in California in 2011-2012 (California Avocado Commission)

Cultivar	Acreage (includes 7,800 acres of topped/stumped groves)	Yield in lbs/A in 2011-2012	Yield in California (million lbs) in 2011-2012
Hass	56,548	7,924	448.1
Lamb Hass	1,964	5,295	10.4
Other	1,117	3,312	3.7
Total	**59,629**	**7,753**	**462.3**

Table 4. Hass avocado acreage and production (estimated) by county in California in 2001-2002 (California Avocado Commission).

County:	Estimated acres	Lbs/acre	Total lbs (millions)
San Diego	22,862	7,410	169.9
Riverside	5,980	8,459	50.6
Orange	1,653	3,705	6.1
Los Angeles	220	6,486	1.5
Ventura	11,608	7,383	85.7
Santa Barbara	7,660	5,237	40.1
San Luis Obispo	1,303	6,687	8.7
San Joaquin Valley	57	3,837	0.2
Other	232	4,248	1.0

Cold Tolerance of California Avocado Varieties, an important characteristic (McNeil, 2024).

Hass 30 F (Bender et al, 2015)
Fuerte 27 F (Bender, et al, 2015)
Bacon 24-26 F (Homesteadandchill.com)
Reed 30 F (Arpaia)
Pinkerton 30 F (Bender, et al, 2015)
Lula 27 F
Gem 30 F
Zutano 26 F (Homesteadandchill.com
Lamb Hass 29-30 F (Bender, et al, 2015)
Gwen 30 F (Arpaia)
Sir Prize 32 F (Homesteadandchill.com)
Holiday 30 F (Homesteadandchill.com)
Duke 20 F (Silva et al, 2002)

Jim 24 F (Silva et al 2002)
Mexicola 20 F (Silva et al 2002)
Stewart 20-22 F (Silva et al 2002)
Wurtz 31-32 F (Silva et al 2002)
Mexicola Grande 20-22 F (Homestead andChill.com)

California Avocado Cultivars Websites

Cultivar descriptions are on the California Avocado Commission website: https://californiaavocado.com/avocado101/avocado-varieties/

And the UC Riverside website:

https://avocado.ucr.edu/variety-list

And in the avocado book at:

Avocado Production in California. (Bender, Gary, et al. 2015. A Cultural Handbook for Growers
Second Edition. Book One and Book Two-Background Information. Ca Avo Soc. Univ of Ca. Ca Avo Commission).

Website: Avocado%20Production%20in%20California.pdf%20Book%20One.pdf

Website: https://cesandiego.ucanr.edu/files/55062.pdf

Website Book 2: https://ucanr.edu/sites/alternativefruits/files/166825.pdf

Six New Black Fruit from California: Mexicola Grande, Gem, Sir Prize, Lamb Hass, Stewart, Luna. (McNeil, 2024)

Mexicola Grande (Bing.com). Cold hardy. 20-22 F. Black. Large.

Gem avocado. (etsy.com)
Less alternate bearing. Black. Slightly pebbly. 7-11 oz. Not Hardy. 30 F. A flower type.

Sir Prize avocado Light yield.
(etsy.com) 10-20 oz. Black. Rough Fuerte skin. Not Hardy. 30 F. B flower type.

Lamb Hass
Productive.
(etsy.com) 10-18 oz. Pebbly. Not Hardy. 30 F. Black. A flower type.

Stewart. (Walmart.com). Hardy to 20-22, or 25 F. Black. Smooth skin. Medium sized. Variable production. A flower type.

The new Luna UCR avocado. The results of avocado breeding for 86 years. Better than Hass. (https://news.ucr.edu/articles/)

And Gem **CACommission**

Table 5. AVOCADO CULTIVARS THAT ARE COMMERCIALLY AVAILABLE

	HASS	FUERTE	GWEN	PINKERTON	REED	BACON	LAMB/HASS	SIR PRIZE
MARKET ACCEPTANCE (Compared to Hass)	Excellent	Good/Fair	Good	Good	Good	Fair	Very Good	Good
FRUIT Skin Color	Black	Green	Green	Gram	Green	Green	Black	Black
Overall Quality	Excellent	Excellent	Very Good	Very Good	Very Good	Average	Very Good	Excellent
Taste	Excellent	Excellent	Very Good	Very Good	Very Good	Good	Very Good	Excellent
Appearance	Hass	Smooth Green	Green Hass	Necky Hass	Round	Smooth Green	Large Hass	Black Fuerte
Early Pick	January	November	April	January	May	October	May	November
Late Pick	August	March	September	May	November	February	November	March
Dominant Size	48	48	40	40	32	40	36	36
Size Range	40-60	40-60	32-48	32-48	32-40	40-48	32-48	32-48
Peel Thickness	Medium	Med. Thin	Med. Thick	Medium	Thick	Thin	Thick	Med. Thin
Peel Pliability	Very Good	Very Good	Good	Very Good	Good	Fair	Good	Good
Seed Size	Medium	Medium	Medium	Small	Medium	Large	Medium	Small
TREE Productivity	100**	75	125	125	150	100	150	100
Bearing Habit	Somewhat Alternating	Alternating	Consistent	Consistent	Highly Alternating	Somewhat Alternating	Somewhat Alternating	Somewhat Alternating
Wind Tolerance	Low	High	Low	High	Moderate	Moderate	High	Moderate
Persea Mite Tolerance	Low	Moderate	Very Low	Low	Moderate	High	High	Moderate
Cold Tolerance	Fair	Good	Fair	Fair	Fair	Good	Fair	Good*
Precociousness	2-3 Years	2-3 Years	1 Year	1-2 Years	2 Year	1 Year	1-2 Years	2-3 Years
Shape	Spreading	Spreading	Upright	Medium	Upright	Upright	Upright	Upright
Tree Per Acre	50-100	50-100	100-160	100-140	100-140	80-120	100-140	100-140
Flower Type	A	B	A	A	A	B	A	B
Bloom Months	Mar-May	Feb-Apr	Mar-May	Jan-Mar	Apr-June	Feb-Apr	Mar-May	Feb-Apr
POST HARVEST								
Storage Shelf life	Good+	Fair	Good-	Excellent	Good	Fair	Good-	Excellent
Shipping Quality	Good	Fair	Good-	Good	Good	Fair	Good-	Good
Response to Ethylene	Excellent	Poor	Unknown	Excellent	Poor	Poor	Unknown	Unknown
Ripeness Detection	Good	Good	Fair	Good	Fair	Good	Fair	Good
Peelability	Good	Good	Shell-Like	Good	Shell-Like	Fair	Shell-Like	Fair

FOOTNOTES

*University of California, Riverside Avocado Breeding Program

** Productivity estimates all relative to Hass

All weather related data based upon South Coast Field Station location in Irvine, CA

Hass. (https://californiaavocado.com/avocado101/avocado-varieties/) Oval shape. Black skin. Pebbly. 6-14 oz. Hass Avocado Ripeness indicators: Generally, the pebbly skin on a California Hass Avocado darkens a bit as it ripens (see our cards below for exceptions) and begins to yield to gentle pressure when squeezed gently in the palm of your hand. Note: Color alone is not always the best indicator of ripeness! Learn how to choose and use
The perfect avocado texture is silky smooth and the flavor is rich and nutty.

Hass Avocado

(Etsy.com) **6-14 oz. Black. Pebbly skin. Not Hardy. 30 F. Productive. A flower type.**

A short history of the Hass avocado.

(https://avocado.ucr.edu/variety-list)

Avocado Society Yearbook, 1973-1974 The origional tree was really a mistake - a lucky chance seedling. In the late 1920's, Mr. Rudolph Hass, who was a postman, purchased seedling trees from A. R. Rideout of Whittier, for the purpose of developing two acres of budded trees of the Lyon variety. It was Rideout's custom to plant very small seedlings at orchard spacing (12' x 12') at the grove site. The seedlings were grown in 2" x 2" x 8" tarpaper open-ended tubes of square cross sections. The seedlings were to grow in place for a year, or until well established, and be later budded in the field.

Hass' children first brought the tree to his attention. They preferred the fruit. Since the quality was high and the tree bore well, Hass patented it in 1935. The same year he ordered 300 trees propagated to this variety by H. H. Brokaw of Whittier. Hass never planted the ordered trees; however, he entered into an agreement that Brokaw grow and promote the variety in consideration of splitting gross tree income 25% for Hass and 75% for Brokaw.

That wasn't an easy decision in those days because the Hass fruit differed so dramatically from the Fuerte, which was the standard of the industry. Nonetheless, Brokaw began to propagate the rough, black Hass exclusively and promote it in favor of the then standard varieties. He and Hass felt justified inasmuch as the Hass was a far better bearer than the Fuerte and matured at a different time of the year. Because of the seasonal advantage Brokaw was successful to the point of yearly sellouts of his nursery crops of 3 to 10,000 trees. Selling price was $5.00 per tree and against (Fuerte tree) prices varying from $3.50 in good years down to $1.25 in poor ones.

Hass was at first thought to be an upright-growing variety since it was found crowded among other upright growing seedlings. Its season was advertised as being from May to November, even in the La Habra and Whittier areas. Brokaw maintains that this was so, just as the Fuerte commonly held until June in those days. He blames smog for earlier seasons in all varieties.

Despite speculation to the contrary, nobody knows what variety of seed produced the Hass. Rideout was an innovator and pioneer in avocados and used whatever seeds he could find - many times planting them along streets or in neighbor's yards in search for new varieties. Ironically, the Hass was one he hadn't intended to leave as a seedling.

Hass avocado (Homesteadandchill.com, https://avocado.ucr.edu/variety-list#hass, https://avocado.ucr.edu/avocado-variety-database)

Regist.1932 Plant Patent139 Aug. 27,1935 Origin.1926 from seed planted by R.G.Hass at 430 West Road, La Habra Hts.,CA. Originated in LaHabra, Heights, California, by Rudolph Hass. Introduced in 1936. Oval/pear shaped fruit. The leading commercial variety in California. One of the longest harvest seasons. 94.8% of the California acreage in 2012.

Guat x Mex. Flower/Pollination: Type A. Zones: 9-11. 6-14 oz. Medium seed. Tight in cavity. Medium skin thickness. Peels easily. Pebbly. Good shipper. Oil 18-23.7%. Up to 35% in Queensland. No fiber.

Growing Habits: Up to 35 feet, though can be kept pruned to be shorter (as with all avocado trees). Very productive. Some alternate bearing.

Cold-Hardy to: Frost-sensitive at 30 F. Also less heat tolerant than some avocado varieties, such as the more heat-hardy Mexicola, Lamb Hass, and Reed.

Fruit Characteristics: Creamy, nutty, high-fat flesh and medium-large fruit. Thick textured skin that turns black when ripe. Keeping quality excellent. Good shipper.

Bloom Time: February to May.

Ripens: April through November – from the previous years flowers.

Other Unique Facts: The Hass variety was first bred in a Southern California backyard in the 1930s. However, the Hass wasn’t grown and marketed on a large scale until the late 1970s. Both Hass and Reed avocado varieties provide a decent crop when grown solo (without a pollinating partner).

Hass **(Koch, 1983. Bender et al 2015. https://avocado.ucr.edu/avocado-variety-database).**

The original tree, a chance seedling, was grown and selected by Rudolph G. Hass in the early 1920s at 426 West Street at La Habra Heights, CA. Mr. Hass and Mr. H.H. Brokaw, father of the present owner of Brokaw Nursery, saw great promise in this seedling and it was registered with the California Avocado Society in 1932. Later, Mr. Hass applied for a plant patent on his tree and was issued Plant Patent Number 139, on 27 August 1935. A commemorative plaque, supplied by the California Avocado Society, has been placed next to the mother tree. This variety is a vigorous, moderately spreading tree that produces a high quality fruit, mostly dark-skinned at maturity, weighing 6 to 14 ounces. It is ovoid to pear-shaped with a tough, pebbly skin; ships well; has a good shelf life; and since the early 1970s has enjoyed wide consumer acceptance.

The commercial season is from April to November, although there is usually some fruit available year-round. Mature trees tend to have alternate bearing habits, are tender to frost below 30°F, and should be planted only in locations that are nearly frost-free. The Hass variety has replaced the Fuerte as the standard of the industry. As a spring and summer fruit, it complements the Fuerte, a fall and winter fruit. [20' x 20' spacing is recommended for Hass]. Growers in the Ventura-Santa Barbara area have noted that the set on Hass trees is improved by being in close proximity to Bacon [or Zutano] variety trees. Hass has an "A"-type flower that is complemented by the "B" type of the Bacon and Zutano. (Koch, 1983)

Bergh (1984) summarized problems with Hass: (Adapted after Bender et al 2015)
1. Cold tender. 2. Inferior productivity. 3. Alternate bearing. 4. Production varies year to year. 5. Black color not universally preferred. 6. Tree is too large. 7. Tree requires more fertilizer. 8. Tree is more subject to stresses. 8. Fruit size averages too small. Despite all of these problems, Hass has done so well at the market that it has displaced the winter greenskin cultivars.

The consequence of the popularity of this fruit is that produce buyers started purchasing Hass from Chile in the winter months to fill the displays at the supermarkets. This demand for Hass fruit in the market year-round eventually led to pressure on the USDA to allow importation of Hass from Mexico, Dominican Republic, New Zealand and Peru (in 2011).

Tree bears better than Nabal in cool areas of CA, but grows tall & requires topping. This was the leading cultivar in New Zealand, representing 50% of all commercial plantings; 25% in Queensland. Has been second in importance to Fuerte in Chile. (J.Morton 1987) Propagates readily. Parentage unknown (but of Guat. type). Has a tendency to be undersized except in New Zealand. Nov.-Jan. in Queensland; mid-Nov. to Mar. in New Zealand; Aug.-Sept. in New South Wales. (https://avocado.ucr.edu/avocado-variety-database)

The minor cultivars. During the twentieth century, there were many cultivars selected from chance seedlings found in groves and dooryards in California. Many were named and registered with the California Avocado Society, but only a few had the qualities that made them a lasting success at the market place. Fuerte was a leading cultivar in the first half of the century, but has slowly disappeared due to the overwhelming popularity of Hass. Some of the newer cultivars were selected by researchers at U. C. Riverside in a continuing search for a more productive cultivar than Hass; these include Gwen, Lamb Hass, GEM, SirPrize, and now Luna.

Carmen Hass avocado.

(GregAlder.com)

Carmen Hass avocado (Homesteadandchill.com)

Flower/Pollination: Type A. Zones: 9-11.

Growing Habits: A medium-large tree (up to 30 feet) with a round, dense canopy. More dense than Hass.

Cold-Hardy to: 30°F

Fruit Characteristics: Very similar to Hass, but slightly smaller fruit. Excellent flavor and high oil content. Pebbly thick skin that turns black as the fruit ripens.

Bloom Time: Carmen is unique in that it has two distinct blooming seasons, one in spring and often another in late summer.

Ripens: November through the following September to October (bears fruit a couple of months earlier than standard Hass)

Fuerte avocado
(etsy.com) B flower type.
8-16 oz. Green. Leathery skin.
Erratic production. Hardy at 27 F.

Fuerte (Koch, 1983. https://avocado.ucr.edu/avocado-variety-database)

This variety, found by Carl Schmidt as a dooryard seedling tree in Atlixco, Mexico in 1911, has long been the standard of the California avocado industry and is referred to as a fall and winter variety. The tree is large and spreading and intermediate in its cold resistance to about 27°F. The fruit is green in color, pear-shaped, 8 to 16 ounces in size, and of very high quality. It performs best away from the coastal influence but not in the hot interior growing areas. Although good crops are produced regularly in a few areas, yield generally tends to be erratic in most of the areas where it is planted. Individual trees in a grove may produce good crops while many may produce little or nothing. The suggested tree spacing is 20' x 20' to be thinned as they crowd. Fruit is said to be "set" when the flower has been pollinated, most frequently by bees. For pollination to be effective, nighttime temperatures need to be 50°F or above and daily average temperatures 70°F. In addition, conditions should be favorable for good bee activity to transfer the pollen from one flower to another. The Fuerte is known to set better crops when interplanted with varieties such as Jalna and Topa Topa which have "A" type flowers that cross pollinate the "B" type Fuerte flowers.

Because the Fuerte has a long period of bloom that may extend from Labor Day to the Fourth of July, there may be more than one set of fruit on the trees at the same time. If warm periods occur during this time, some fruits may set and produce “off bloom” fruit that matures in early fall and brings better prices. Off bloom fruits generally have a flattened bottom and are squatty in appearance. The first fruits of the regular crop set are known as “early bloom.” These mature earlier than the main portion of the crop, are of the normal Fuerte size and shape, and may be harvested at the same time or slightly later than the off bloom fruits. When temperatures are borderline for good fruit set, “cukes” may be formed. These small, finger-sized, unpollinated, seedless fruits are marketed as “Cocktail avocados” and bring a good price. They are formed as a result of incomplete pollen tube growth from cool weather.

It is the leading cultivar in Chile where it bears more dependably than in CA. It is a very erratic bearer. Represents 42% of all AUS plantings. Has long been the leading avocado on the European market. (J.Morton 1987) Season Apr.& May in Queensland, & New South Wales; mid-Aug. to Oct. in New Zealand. (https://avocado.ucr.edu/avocado-variety-database)

Cocktail Avocados (Seedless Cukes) from Fuerte Trees, a result of incomplete pollen tube growth from cool weather. (Specialtyproduce.com)

Fuerte avocado (Homesteadandchill.com, https://avocado.ucr.edu/variety-list#fuerte, https://avocado.ucr.edu/avocado-variety-database)

Introduced as budwood in 1911 from Atlixco, Puebla, Mexico by Carl Schmidt of West India Gardens, Altadina, CA. A hybrid Mexican Guatemalan variety that is ready to pick in November and is good through June. Hangs on the tree well. A long time California commercial variety valued for its winter season.

Flower/Pollination: Type B. 8-16 oz. 12-18 % oil.   Zones: 9-11.

Growing Habits: A large tree (up to 35 feet) with a wide sprawling canopy. Spacing 20x20 feet.

Cold-hardy down to 27°F. Protect from cool coastal wind for best fruit set. Like Hass, Fuerte is less heat-tolerant than some avocado varieties.

Fruit Characteristics: Produces large long pyriform oval green-ripening fruit, with leathery skin that is easy to peel. Fuerte is known for its excellent flavor and creaminess, but with slightly less oil content than Type A avocado varieties. Peels: Yes   Seed Size: Med-Large

Bloom Time: May to November. Ripens: November to June.

Other Unique Facts: The Fuerte was the second most popular commercial variety behind Hass, and commonly grown as a cross-pollinator for Hass. Alternate year bearing habit. Springtime temperatures strongly affect blossom set. May form cukes. Production of Hass improves near Fuerte, a B variety. Subject to scab and anthracnose in FL.

Now second to Hass because of a trend to summer rather than winter since 1972.

Zutano avocado. (etsy.com) 8-14 oz. Light Green. Hardy to 26 F.

Productive. Note corky end spot, a defect. Smooth leathery skin. B flower type.

Zutano. (Koch, 1983. Bender et al 2015. HomesteadandChill.com)

This variety is believed to have originated in Fallbrook, CA on the old Truitt Ranch on Alvarado Street. Zutano is a vigorous, upright, precocious and cold resistant variety (26°F). It is a regular and heavy producer of green, pear-shaped fruit of medium size (8-14 oz.), but of modest quality, and fruit tends to get an end spot on the bottom when over mature. It bears well over a wide range of climatic conditions and complements the Fuerte variety as a cross-pollinator for the Hass. Zutano has a "B" type flower. The fruiting season is October to February. For marketing purposes Zutano fruit, along with several other green fruits, are referred to as "other greens." Trees are planted at a spacing of 15' x 15'. (Koch, 1983)

Zutanos are still grown in the San Joaquin Valley where it is too cold for Hass in the winter, but even this acreage is declining due to poor prices for fruit. (Bender et al 2015)

Zutanos may be useful in acting as a pollinizer tree for Hass, since Hass is an A flower type and Zutano is a B flower. Farm advisors have often noted that Hass trees near a Zutano usually have substantially larger crops than Hass trees farther away from the Zutano. Several trials were established in Ventura County in the late 1990's to determine the best pollinizer tree for Hass. Preliminary data indicate that Zutano appears to be the best of the B flower type trees, and the effect is best when the Hass tree is one tree away from the Zutano. Great variation may occur from year to year; however, some years there seems to be no effect (M.L. Arpaia and B. Faber, personal communication).

Prices have been so low for Zutano fruit that the sale of fruit seldom pays for the water. The dilemma for the grower remains, does the effect of the pollinizer tree on the surrounding Hass trees increase the yield enough to make up for the loss of a Hass tree in the space now occupied by a Zutano tree? This question has not been answered yet, but some growers are planting Zutanos around the edge of the Hass grove, or along the grove roads, and pruning them like a pole, not to produce fruit, but to provide some flowers for the bees to visit.(Bender et al 2015)

Zutano fruit are lower in oil and higher in water content, making them less rich, creamy, and flavorful than many other avocado varieties, but they can be good at the end of their season (HomesteadandChill.com). The author won a guacamole contest using Zutano fruit (McNeil, 2024). See recipe on the last page.

Zutano avocado (Homesteadandchill.com, https://avocado.ucr.edu variety-list#zutano, https://avocado.ucr.edu/avocado-variety-database)

Regist.1932 Orig.1926 at Fallbrook by W.L.Truitt. Originated in Fallbrook, California, by W.L. Truitt. Introduced in 1941 from a selection made in 1926. Ripens in Oct. to Dec. in San Gabriel Valley, Ca.; and Jan. to Feb. in Ventura County, Ca. Tree; consistent producer; more hardy than Fuerte (26 F). Commercial variety. Fruit are oval/pear in shape with waxy bumps on the skin. Mexican parentage? Parentage unknown; probably a hybrid between Mex. & Guat. Types.

Flower/Pollination: Type B Cross pollinates Hass. Zones: 8b-11.

Growing Habits: A large avocado tree, reaching heights over 40 feet when mature. Spacing 15 x 15 feet. Hardy to 26 F. Consistent and heavy producer.

Fruit Characteristics: Medium large, light green, smooth, fair to good-tasting fruit with thin green-ripening skin. Flavor fair to good. Zutano fruit are lower in oil and higher in water content, making them less rich, creamy, and flavorful than many other avocado varieties, but good when fully mature. 8-14 oz. Russets in inland areas.

Bloom Time: Spring. Ripens in Oct. to Dec. in San Gabriel Valley, Ca.; and Jan. to Feb. in Ventura County, Ca. In Queensland it is considered of poor quality, delicate to handle, & prone to disease during ripening.

Bacon avocado. 7-14 oz. Large seed. Green. Hardy to 24 F. End cracking when overmature. Productive. B flower type. (https://gregalder.com/yardposts/the-bacon-avocado-tree-a-profile/)

Bacon (Koch, 1983. Bender et al 2015.)

Ecotype Guat x Mex Orig. in Buena Park,CA, by James E. Bacon. Introd.1951. Chance seedling, Mex.-Guat. hybrid type; planted1928. (Bender et al 2015)

In his search for a cold resistant variety that could be grown on his ranch in Buena Park, California, James E. Bacon planted large numbers of seed and fruited the resulting seedlings. One of these showed exceptional hardiness, was named Bacon, and was introduced to the trade in the late 1920s.

The tree is upright, hardy to 24°F, and used in the colder avocado producing areas. While the tree and the fruit tolerate cold remarkably well, the fruit stem is its "Achilles heel" and weakened fruit will require prompt harvesting after a cold snap. Because the variety is mostly grown where cold is a threat, the fruit should be marketed before cold becomes a problem, but the fruit stem will be damaged during the cold temperatures and the fruit must be harvested immediately after the cold snap.

The fruit is dark green, oval in shape, of medium quality, and from 7 to 14 ounces in weight. During warmer winters, if fruit is left on the tree past January, dark cracked areas will often develop on the bottom of each fruit.

The season is November to January. When the fruit is marketed, it is classed as "other greens" along with other green-skinned fruit marketed during the fall and winter.

A planting combination of Bacon and Hass varieties complement each other, resulting in improved fruit set. The Bacon has a "B" type flower, Hass an A flower.

The fruit is better quality than Zutano, but overall yields are not as good as Zutano. Bacon fruit are lumped with the "greenskins" at the market and consequently command a poor price. The tree is an upright growing tree and is commonly grown on a 15' x 15' spacing. The leaves, when crushed, have an anise smell. Like the Zutano, Bacon (a B flower) may be useful as a pollinizer for Hass.
(Bender et al 2015)

Bacon avocado (https://avocado.ucr.edu/avocado-variety-database. Homesteadandchill.com. https://avocado.ucr.edu/variety-list#bacon).

Zones: 8b-11. Flower Type B Fruit Color Green Ecotype Guat x Mex Orig. in Buena Park, CA, by James E. Bacon. Introd.1951.Chance seedling, Mex.-Guat. hybrid type; planted 1928. Reg.1948. Orig. James E. Bacon at N.E. corner of La Palma & Grand, Buena Park, CA about 1928.

Fruit: 7-14 oz; ovoid; skin green, thin, smooth; flavor good; flesh an unusually pale yellow-green; oil content high; keeping quality good; Fruit Characteristics: Large green smooth fruit stay green (but darken slightly) as they ripen. The skin is quite thin, making them difficult to peel. Bacon avocado flesh is yellow and creamy, but with less oil content than Hass. Matures Nov.-Jan.in Orange County & Dec.-March in Ventura County, CA. Bloom Time: Late winter into spring.

Tree: tall, upright, slender; consistent, heavy producer; frost tolerance excellent (24 F). Growing Habits: Medium and upright. Reaches an average of 20 feet in height when mature. Space 15x15 feet.

Flower type B, valuable pollinizer of Hass.

Color, green. Wt., 7-14 ozs. Shape, ovoid. Skin, thin & smooth. Flavor, fair. Oil, 17.85% Keeping Quality, good. Quality of flesh slightly better than Zutano. Season: slightly later than Zutano. Seed size large. Peels: Not easily. Leaves have an anise smell.

Reed Avocado (Etsy.com) 17-26 oz. Productive. Green. Slightly pebbly. Tender at 30-32 F. A flower type.

Reed (Koch, 1983. https://avocado.ucr.edu/avocado-variety-database.)

The late James S. Reed found and observed a chance seedling in his 6-acre grove in Carlsbad, California in 1948. After several years of records, he became so impressed with its virtues that he applied for a patent. Patent number 1967 was granted to him on 16 August 1960 and expired in 1977. It can now be propagated without paying a patent fee. The Reed variety is thought to be a hybrid between the Nabal and Anaheim varieties. It seems to be the result of a “perfect marriage” because it has all of the positive attributes of the parent varieties with none of the negative attributes of either. Mr. Joe L. (Roy) Shields, who married the widowed Mrs. Reed, has been active in the promotion of this variety that has won a place on the California Avocado Society’s recommended list. The Reed has an “A”-type flower and the trees may be planted at a spacing of 15’ x 15’. The tree is upright and a heavy and regular producer of fruit. Reed fruit are large, green, nearly round, and weigh from 17-26 ounces. This commercial variety is of very fine quality when harvested after Labor Day, though it is harvested July through September and selectively picked to the middle of November. The tree’s frost tolerance is comparable to Hass (30°F), and the fruit has good shipping and shelf life qualities.

Reed avocado (Homesteadandchill.com. Koch,1983. https://avocado.ucr.edu/avocado-variety-database. https://avocado.ucr.edu/variety-list#reed)

Flower/Pollination: Type A. Zones: 10-11. Ecotype Guat. Orig. Plant patent1967;16 Aug. 1960. Chance seedling; hybrid type; planted in1948. Originated in Carlsbad, California, by James S. Reed. Introduced in 1960 from a chance seedling planted in 1948. A seedling, possibly of a AnaheimXNabal hybrid. Fruit may remain on tree for a relatively long time after reaching maturity. Now of minor commercial importance in California. Patent gone.

Growing Habits: Reed trees grow more slender and upright than some other avocado varieties. It can make for a good compact tree in tighter spaces. Though it is still a large tree, reaching up to 37 feet at maturity. Known to be very prolific, and also produce well without a partner pollinator tree. Spaced 15x15 feet. Resistent to salt burn, sun blotch.

Cold-Hardy to: Frost sensitive at 30 F. More tolerant to heat than Hass. Fruit Characteristics: Produces huge round fruit reminiscent of green softballs. Thick slightly pebbled skin peels easily to reveal extremely buttery flesh with excellent flavor. Reed fruit easily weigh over a pound each, and are the largest of most avocados! Oil 18.9-20%. Fruit 17-26 oz. Good shipping and shelf life. Large seed. Peels easily.

Bloom Time: Spring to summer. Ripens: The following summer. Like Hass, they need nearly a year on the tree after first developing! Harvested July through November. Late Feb.-Apr.in New Zealand where it is one of the most promising cultivars. Other Unique Facts: Reed avocados require less water than Hass.

Pinkerton avocado

9-18 oz. Pebbly. Productive. Green. Tender at 30 F. A flower type. (https://www.plantclearance.com/pinkerton-avocado)

Pinkerton (Koch, 1983. https://avocado.ucr.edu/avocado-variety-database)

This variety originated in the grove of John Pinkerton located in Saticoy, Ventura County. Mr. Pinkerton died in 1979. It is believed that the tree was a cross between the Hass and Rincon varieties with cold tolerance about equal to the Hass (30 F). The tree was patented by Mr. Pinkerton and assigned Patent Number 3712 on 29 April 1975.
Exclusive propagating rights was given to the Brokaw Nursery in Saticoy and trees were sold with a patent charge of $1.00 per tree. The tree is of medium size, but more spreading than Hass. It is clearly from the Guatemalan race with an “A”-type flower. Typically it has two sets of fruit in Ventura County that mature in October and November with the bulk of the crop coming off in the winter and very early spring. Marketing season in general is November to June. The tree is a very heavy bearer.

Warren Currier III, a keen observer, has reported in his "The Agricado Market Weekly" newsletter the following interesting points: a. The tree seems to have much greater limb strength and tolerates winds better than most other varieties; b. It is much less alternate bearing in its production habits than Hass and is a precocious bearer; c. It has a long shelf life and will hold in cold storage for two weeks. The fruit is green with a medium-thick leathery skin that is pebbled much the same as the parent Hass and weighs from 9 to 18 ounces. The high quality flesh has a high oil content and is smooth in texture. It ships well and has a good shelf life. It has at least one drawback, because some years the fruit has a "neckyness" (a long neck), which seems to be a peculiarity of juvenile trees, that does not mix well with the packer's equipment. The weather may also be a factor that is involved in the production of these longnecked fruits.

Pinkerton avocado (Homesteadandchill.com. Koch, 1983. https://avocado.ucr.edu/variety-list#pinkerton. https://avocado.ucr.edu/avocado-variety-database)

GxM race. Orig. in Saticoy, Ventura County, CA, by J. Pinkerson, Ventura. Introd.1974. Plant pat. 3712; 29 Apr.1975. Seedling of HassxRincon; discovered1960. Seedling, probably of Rincon. Flower/Pollination: Type A. Zones: 9-11. Cold-Hardy to: 30 F.

Growing Habits: The Pinkerton tree is considered more manageable than some other avocado varieties. Medium size but with a sprawling canopy. Tree; med., spreading, very vigorous; heavy bearer. The tree is of medium size, but more spreading than Hass. Greater limb strength and tolerates winds better than most other varieties. It is much less alternate bearing in its production habits than Hass.

Fruit Characteristics: A heavy and early producer of oblong slender pear-shaped fruits. Pinkertons have excellent rich nutty flavor much like Hass, but with notably smaller pit. Early crop roundish; later, pear-shaped with neck. The skin is moderately thick, pebbled, easy to peel, and stays green as the fruit ripens. 9-18 oz. Up to 25% oil. Skin med.-leathery, pliable. smooth-textured, of good flavor, high in oil, rated as of good quality but inferior to Hass & Fuerte; tends to darken in the latter part of the season. Small seed, separates readily from the flesh with the coat adhering to the seed. Fruit ships well & has good shelf-life, but the neck is a disadvantage on the fresh fruit market. The late-season fruits are sent to the processing plants.

Bloom Time: Spring. Harvest: November to June. Other Unique Facts: Pinkertons are particularly dependent on having a Type B pollinator partner tree.

Lamb Hass

Productive.

(etsy.com) 10-18 oz. Pebbly.

Not Hardy. 30 F. Black.

A flower type.

Lamb Hass. Type A flower. (https://www.plantithawaii.com/avocado)

Lamb Hass

Lamb Hass is a California selection bearing spring and summer fruit. It is a heavy regular bearer, with fruit averaging 10 to 18 ounces with skin black when ripe. Fruit may have a larger seed when grown in rainy areas. Type A flowers.

Lamb Hass avocado (Homesteadandchill.com. https://avocado.ucr.edu/avocado-variety-database. https://avocado.ucr.edu/variety-list#lamb-hass)

Guat x Mex Hybrid from the University of California avocado breeding program. Originally named BL122. Flowering group A. Fruit black when ripe. Usually is a shouldered pear shape with pebbly skin texture weighing from 10 to 18 oz. Tree grows upright. Is being grown commercially in California. Matures later than Hass.

Flower/Pollination: Type A. Zones: 9-11. Growing Habits: Medium size upright and compact tree. Lamb-Hass is a cross between the traditional Hass Avocado and a Gwen (semi dwarf) avocado varieties.

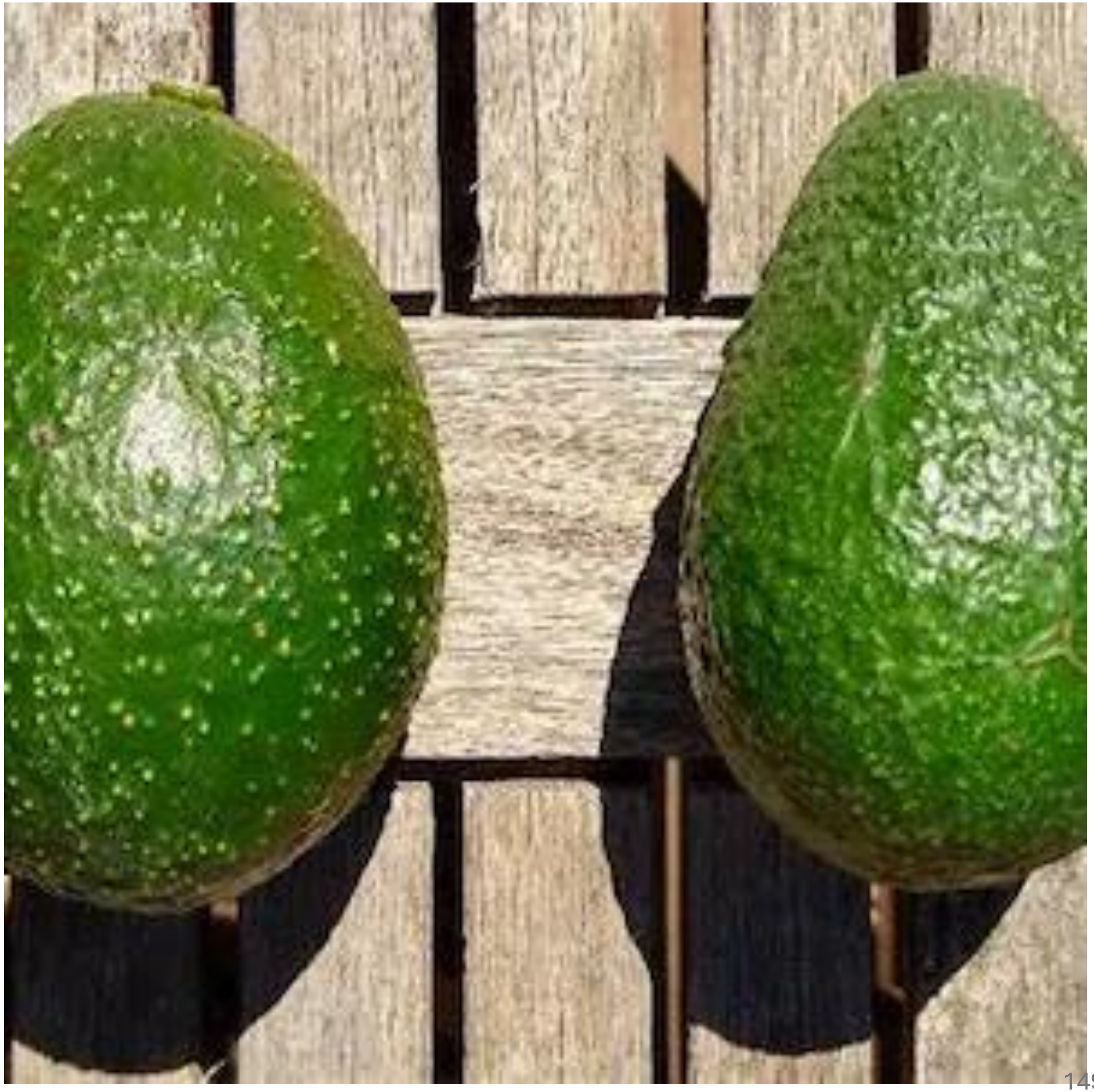
Cold-Hardy to: Sensitive below 30° F. More cold and heat-tolerant than Hass.

Fruit Characteristics: Similar but larger than Hass. Excellent flavor and high oil content. The thick pebbly skin turns black as the fruit ripens, isn't as pliable as Hass and therefore less easy to peel. Medium skin thickness. Medium sized seed. Obovate fruit shape. Black unripe and ripe.

Bloom Time: Late winter to spring. Ripens: The following April to November. The Lamb Hass has a longer and later season than Hass (extends the typical Hass season), but also takes slightly longer to mature on the tree. Give Lamb Hass at least one year (up to 18 months) on the tree after the fruit first develops until harvest.

Gwen avocado

(etsy.com) 6-15 oz. Slightly pebbly. Dark Green. Tender at 30 F. Productive. Small tree.15 ft. A flower type.



Gwen avocado (Homesteadandchill.com. https://avocado.ucr.edu/avocado-variety-database. https://avocado.ucr.edu/variety-list#gwen.)

Orig.in Univ. of CA avocado breeding program by B.O.Bergh; seedling of Hass. Introd. in 1982. Plant patent 5298; 23 Oct.1984. Prolific production. Flower/Pollination: Type A. Zones: 9-11 Cold hardy to 30 F.

Growing Habits: One of the smaller avocado varieties,15 feet. Very susceptible to Persea mite damage, sunburn and tree stress due to very heavy production. Stressed fruit has a round shape whereas non stressed fruit is more pear shaped. Heavy bearer (approx. 20,000 lbs/acre).

Ready to pick from April through October (at South Coast Field Station, Orange County, Ca.). Tree is small. Fruit is pear/oval with stem tending to come out on one side.

Fruit Characteristics: 6-15 oz. Similar to Hass in regards to fruit texture and flavor (nutty and buttery) but slightly less creamy. The fruit are slightly larger than Hass, with medium thick pebbled skin that turns dark green when ripe rather than black. Fruit: obovate; flavor excellent; skin green, moderately thick & rough skin; seed medium sized. Peels not easily.

Bloom Time: Spring. Ripens: the following April through October. Due to the compact size and prolific fruit production, Gwen is a great urban backyard tree – and able to grow in large containers.

Sir Prize avocado Light yield.

(etsy.com) 10-20 oz. Black. Rough Fuerte skin. Not Hardy. 30 F. B flower type.

Sir Prize avocado (Homesteadandchill.com)

Sir Prize avocado (Homesteadandchill.com. https://avocado.ucr.edu/variety-list#sir-prize. https://avocado.ucr.edu/avocado-variety-database)

Mexican hybrid. Black when ripe. Type B. Originally 4-15-18 in UCR Breeding program. Mexican-race type avocados are typically more cold resistant than 'Hass' so this tree is being tried in inland valleys and other regions unsuitable for Hass. Early results do not indicate it is any more cold tolerant than Hass. Fruit shape is pear with distinctive ridge along one side. Skin texture is not truly pebbled like 'Hass' but does have tiny islands of varying yellowish shades giving the illusion of 'Hass'-like pebbles. Zones: 9-11.

Growing Habits: Medium sized upright tree, reaching 25 to 35 feet when fully mature. Bloom Time: Spring to Summer. Peak bloom period is earlier than 'Hass' by several weeks. Ripens: Earlier than Hass by 6-8 weeks, in winter to early spring. Frost-sensitive below 32°F.

Fruit Characteristics: 10-20 oz. Obovate shape. Lopsided oval pear shape. More like Type A avocado varieties in regards to flesh texture and fat content. As a descendant from Hass, Sir Prize is very similar – with creamy, nutty flesh that turns black as it ripens, but grows larger fruit with a smaller pit! The fruit doesn’t turn brown (oxidize) when cut or kept refrigerated. Green unripe. Black ripe. Small seed. Skin not thick or pebbly. Thin skin. Peels easily. Medium texture like Fuerte. Light yield.

Gem avocado. (etsy.com)

Less alternate bearing. Black. Slightly pebbly. 8-12 oz. Not Hardy. 30 F. A flower type.

Gem (https://avocado.ucr.edu/avocado-variety-database. https://avocado.ucr.edu/variety-list#gem)

Regist.1944 Originated by Wm. L. Troyer at 1544 N. Hill Ave., Pasadena, CA, from Lyon seed. Chance seedling; discovered among a number of trees grown from seeds of a Mex. seedling of unknown parentage planted about 1907. Orig.in Fullerton, CA, by Lawrence W. Sherwood, Sherwood Specialty Nursery. Introd.in 1947. Plant patent 773; 30 Dec.1947. Patented under the experimental name "3-29-5" in 2003. A "Gwen" seedling. Guatemalan. Chance seedling; discovered among a number of trees grown from seeds of a Mex. seedling of unknown parentage planted about 1907.

Tree has an open and spreading growth habit and exhibits less alternate bearing than that of the "Hass" variety. Season is roughly the same as that of "Hass." Tree: upright spreading; bears well; blooms 1.50 to 2 months before Fuerte. Flower type A.

Fruit has excellent flavor and tends to oxidize much slower than the "Hass" variety. Fruit season, July-Sept.; color, green to black unripe, black ripe, shape, ovoid or ellipsoid; seed medium, skin medium-thick, peels; flavor, fair plus; oil 19.33%. Fruit: 8-12 oz, pyriform; skin bright purple, attractive, smooth, glossy; medium seed; flesh pale yellow, flavor mild, buttery, oil content high, quality very good.

Holiday avocado (etsy.com) 18-24 oz. Prolific production. Tender at 30 F. Semi-dwarf. 12-15 feet. Green. A flower type.

Holiday. **(Bing.com) The Holiday avocado is a recently introduced semi-dwarf variety characterized by its large fruit and distinctive weeping habit. Developed at the University of California at Riverside, it tends to ripen between Labor Day and Christmas/New Year's, making it a popular choice for backyard or container planting.**

Holiday avocado.
(https://www.louiesnursery.com/plants/avocado-trees/holiday-avocado/)
Parentage Guatemalan
Flower Type-A
Fruit Shape Pyriform to Obovate
Skin Color (When Ripe) Green
Skin Thickness Medium
Fruit Season September-January
Fruit Weight 18-24 oz.
Seed Size Medium
Oil Content 16-18%
Tree Size Small
Hardiness Tender to 30°F
Flavor Very Good

Holiday. https://avocado.ucr.edu/variety-list#holiday-xx3
Dwarf tree has very large fruit. Beautiful tree with spreading, umbrella shape that skirts the ground. Not extremely small, but certainly not a towering tree. Tree is smaller than Wertz. Fruit are attractive and have good flavor. Released from the breeding program for nursery propagation in 2001. Marketed by one nursery as the 'Holiday' avocado.
Guatemalan
Peels: Yes
Seed Size: Medium
Skin Texture: Medium
Blossom Type: A
Fruit Shape: Obovate
Skin Color Unripe: Green
Skin Color Ripe: Green
Skin Thickness: Medium
Average Fruit Weight oz: 18 to 24

Holiday (https://avocado.ucr.edu/avocado-variety-database. Homesteadandchill.com. https://avocado.ucr.edu/variety-list#holiday-xx3)

Flower Type A Fruit Color Green Ecotype Guat Tender at 30 F. Prolific Production.

18-28 oz. fruit, pear shaped, green, dark yellow flesh, excellent flavor, medium pit, peels easily, glossy leaves. Oil 16-18 %.

Persea mite and thrip resistant, small tree with skirting shape, A blossom type. Zones 9-11. Growing Habits: Semi-dwarf, usually reaching a maximum of 12 to 15 feet tall. Distinct weeping canopy.

Peels: Yes Seed Size: Medium Skin Texture: Medium. Dwarf tree has very large fruit. Beautiful tree with spreading, umbrella shape that skirts the ground. Not extremely small, but certainly not a towering tree. Tree is smaller than Wurtz.

Fruit are attractive and have good flavor. Released from the breeding program for nursery propagation in 2001. Marketed by one nursery as the 'Holiday' avocado.

Produces well. Fruit is hidden inside tree. Holds well. Tree should be made available to the home gardener for it has the best fruit for a small tree. A green, good-quality fruit, commercially too large; on a tree that was short & spreading-easy to pick,& to spray if necessary.

Fruit Characteristics: Known for its large oval fruit that stays green as they ripen. Medium oil content and good flavor. Bloom Time: Spring. Ripens: September to January. Released to home growers as the "Holiday." XX3 is a good producer of rather similar large, fine, green fruits.

Six New Black Fruit from California: Mexicola Grande, Gem, Sir Prize, Lamb Hass, Stewart, Luna. (McNeil, 2024)

Mexicola Grande (Bing.com). Cold hardy. 20-22 F. Black. Large.

Gem avocado. (etsy.com)
Less alternate bearing. Black.
Slightly pebbly. 7-11 oz. Not Hardy.
30 F. A flower type.

Sir Prize avocado Light yield.
(etsy.com) 10-20 oz. Black. Rough Fuerte skin. Not Hardy. 30 F.
B flower type.

Lamb Hass
Productive.
(etsy.com) 10-18 oz. Pebbly.
Not Hardy. 30 F. Black.
A flower type.

Stewart. (Walmart.com). Hardy to 20-22, or 25 F. Black. Smooth skin. Medium sized. Variable production. A flower type.

The new Luna UCR avocado.
B type flower. Could cross-pollinate Hass.
Tree half the size of Hass.
More trees per acre.
Therefore more production per acre.
Easier to harvest.
Same production as Hass.
Consistent.
Similar size fruit as Hass.
Fruit store better when ripe.
A very good eating fruit.
Earliest field plantings in fall 2024. 1000 trees from Brokaw Nursery. Full production in five years.

Miscellaneous cultivars that are still seen in some groves and dooryards are summarized in Table 6. Other cultivars can be found on Dr. Arpaia's UC Riverside website: http://www.ucavo.ucr.edu/AvocadoVarieties/AvocadoVarieties.html

Table 6. Descriptions of Miscellaneous Avocado Cultivars (after Silva et al. 2002)

Cultivar	Parentage	Fruit peel color	Fruit peel texture	Fruit peel thickness	Fruit quality	Fruit flavor	Seed size	Bearing habit	Flower type	Cold limit	Mature season
Duke	Mexican	green	smooth	Very thin	Good	spicy	large	consistent	A	20 F	Sep-Oct
Not commercial due to its thin skin and short season. Valuable to the backyard grower for its good flavor and cold tolerance.											
Jim	Mostly Mexican	green	smooth	thin	Very good	Mild spicy	medium	Fairly consistent	B	24 F	Nov-Feb
Jim has a longer season and better fruit quality than Zutano, better fruit set than Bacon and shorter trees than both cultivars											
Mexicola	Mexican	purple	Very smooth	Very thin	good	Anise-like	large	consistent	A	20 F	Aug-Oct
Extremely cold hardy, but not commercial due to thin skin and too small a fruit. Flavor is very good.											
Stewart	Mostly Mexican	purple	leathery	thin	excellent	flavorful	medium	variable	A	25 F	Oct-Dec
Stewart is rated as one of the best cultivars for cold regions. Production good in some areas and inferior in others.											
Wurtz	Guatemalan	green	pebbly	medium	good	mild	large	alternating	A	31 F	May-Aug
Small tree ideal for gardens. May be sold as Littlecado, "Dwarf" or Minicado											

A and B varieties (Homesteadandchill.com)

Type A Avocado Varieties

Hass, Pinkerton, Lamb Hass, Carmen Hass, Gwen, Reed, Mexicola Grande, Stewart, Holiday, Pryor (aka Fantastic), Opal (aka Lila), Duke, Mexicola, Stewart, Wurtz.

Type B Avocado Varieties

Fuerte, Bacon, Zutano, Sir Prize, Joey, Winter Mexican, Brogdon, and Wilma aka Brazos Belle, Jim.

Cold Hardy* Avocado Varieties (Homesteadandchill.com)

Joey, Bacon, Zutano, Opal (aka Lila), Pryor (aka Fantastic), Mexicola Grande, Wilma (Brazos Belle), Duke, Jim, Mexicola, Stewart, Joey, and Brogdon. Each of these avocado varieties is described more below, including the temperatures they're known to be tolerant of.

***Please note that avocado trees are most tolerant of the cold temperatures listed once they are mature and established, or 3-5 years old. Young trees will require additional protection.**

Duke. 8-12 oz. Vigorous, productive. Yellow-green glossy. Smooth. Poor shipper. Root rot tolerance. Hardy to 20 F. Flower type A.

Duke (https://avocado.ucr.edu/avocado-variety-database)

DUKE Flower Type A Fruit Color Green Ecotype Mex Tree orig.1912 from seed planted at Sunnyslope Nursery, Bangor, CA. Vigorous, very hardy to cold (20 F), wind resistant, productive. Fine for home planting in cold interior districts. (CAS Yearbook 1950) Orig. in Bangor, Butte County, CA, by "Duke" Hornung. Introd. in the late 1920s. Chance seedling; Mex. type; Seed imported 1912, apparently from Mex., by Mr. Benedict for Sunnyslope Avocado Nursery, Bangor; following abandonment of this nursery, Hornung purchased the area, noted the seedling,& selected several; from one of these came Duke; selected in 1924 by Hornung; evaluated in 1924 & later by J. Eliot Coit, Vista,CA.

Parent tree dead. Fruit season, Late July-Nov.; color, green; wt, 8-12 ozs.;shape, pyriform; skin, nearly smooth; quality, excellent; oil content 14.5-21%. Seed, med., sometimes loose.

Fruit: size med.,8-12 oz; pyriform; skin yellowish-green glossy, nearly smooth, very thin; quality fair-good; poor shipper because of thin skin; seed lg, often loose in cavity; primarily for local markets; ripens early, Late July- Nov.

Tree: vigorous; productive; very hardy (20 F); wind resistant; blooms early; Duke seedlings & selected rooted clones of these seedlings show partial resistance to phytophthora root rot. Frequently used as rootstock. Flower group A, Season: Late July-Nov. in CA. Tree is lg., symmetrical & wind-& cold-resistant, & also highly resistant to root-rot, expecially when grown from cuttings. It is a poor bearer in some areas of CA; has borne 168 lbs annually from the 6th to the 15th year.

Mexicola Grande (Bing.com) Black. Smooth skin. Productive. Hardy to 20-22 F. Medium sized. A flower type.

Mexicola Grande Avocado

(https://www.louiesnursery.com/plants/avocado-trees/mexicola-grande-avocado/) **A flower type.**

The Mexicola Grande avocado is one of the most frost-resistant (20-22 F) of all avocado varieties. This high quality, black-skinned avocado is up to 25% larger than its parent, Mexicola. The trees have a tall, upright spreading habit. This variety is productive in both coastal and inland areas in California. The fruit ripens from August through October. The fruit is easy to peel.

Mexicola Grande. (https://avocado.ucr.edu/variety-list#mexicolagrande)

Shape of fruit is round bottomed obovate to ellipsoid.

Sold by one nursery as "Mexicola Grande.“

Mexican

Peels: No

Seed Size: Large

Skin Texture: Smooth

Blossom Type: A

Fruit Shape: Obovate

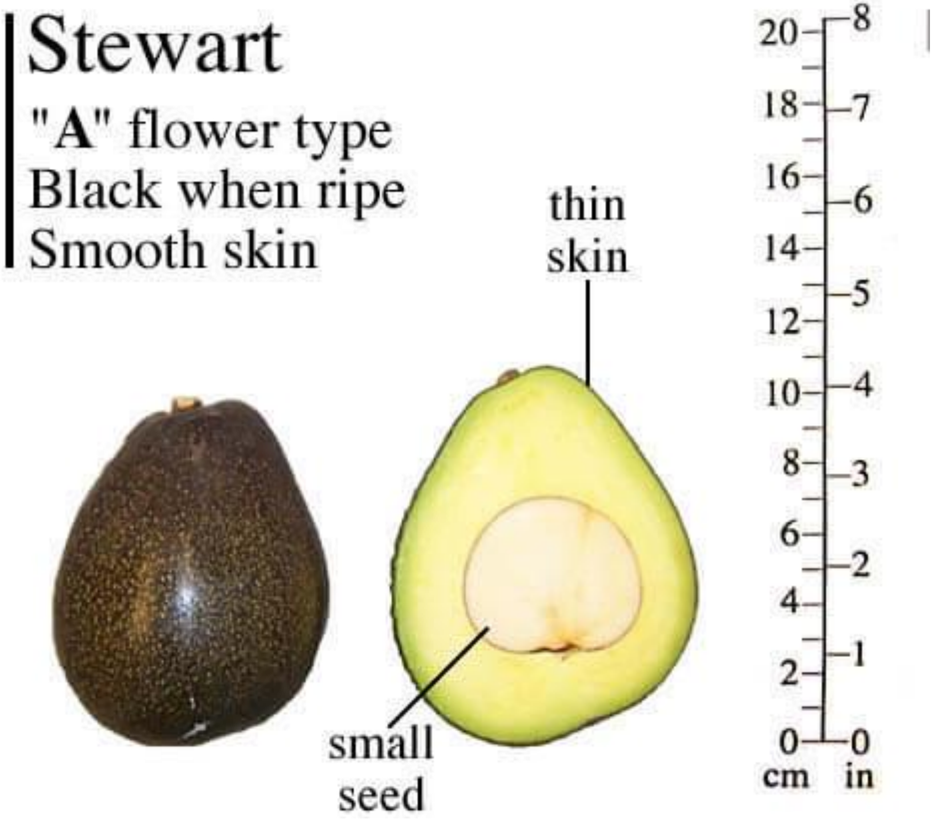
Skin Color Unripe: Black

Skin Color Ripe: Black

Skin Thickness: Thin

Average Fruit Weight oz: 6 to 7

Stewart. Hardy to 18-22 F. Black. Smooth skin. 6-13 oz. Good production. Flower type A. (https://www.louiesnursery.com/plants/avocado-trees/stewart-avocado/)



https://www.louiesnursery.com/plants/avocado-trees/stewart-avocado/

The Stewart avocado is a cold hardy, more compact version of its parent Mexicola. The fruits are shiny black with a thin skin. The firm melting flesh is clear, bright, light-yellow shading to green toward the skin and is of excellent quality. The tree is vigorous and compact and produces good crops. It is listed as an A-Type avocado but has shown B-Type characteristics. This is an excellent avocado variety for colder areas (18-22 F).

Stewart. (https://www.louiesnursery.com/plants/avocado-trees/stewart-avocado/. https://avocado.ucr.edu/variety-list#stewart. https://avocado.ucr.edu/avocado-variety-database. Homesteadandchill.com) Originated in Mentone, San Bernardino County, Ca, on the Stewart Ranch. Introduced in 1956. Blooms in spring. Ripens from early Oct. to mid-Dec. Tree: spreading, strong, vigorous. 20-25 feet when mature. Stewart is an offspring from Mexicola, but more compact. Exhibits B-like characteristics, though it is a type A pollinator. Zones: 8b-10.

Parentage Mexican Type-A
Fruit Shape Obovate or pyriform
Skin Color When Unripe and Ripe: Black
Skin Thickness Thin. Smooth. Leathery. Peels easily.
Fruit Season Early October-Mid-December
Fruit Weight 6-13 oz.
Seed Size Small
Oil Content 8-16%
Tree Size Medium. Spreading; strong; vigorous. Bears good crops.
Hardiness Very Hardy to 18-22°F
Flavor Good. Very creamy, nutty-flavored flesh.

Wurtz avocado fruit. (Bing.com)

Wurtz. 8-10 oz. Little Cado. Green. Small to medium sized fruit. Tender at 31 F. A dwarf tree. 10-15 ft.
A and B flower type. Alternating Production.

Wurtz avocado. (https://www.louiesnursery.com/plants/avocado-trees/wurtz-avocado/)

The Wurtz avocado (aka Littlecado) is a dwarf variety that can be grown in large containers and be easily maintained in smaller landscapes. The tree has a distinctive weeping growth habit with a dense cover of leaves and small limbs. This is an A and B-Type avocado and will produce fruit on its own.

Wurtz aka " Little Cado" (Homesteadandchill.com. https://avocado.ucr.edu/variety-list#wertz. https://avocado.ucr.edu/avocado-variety-database.)

GxM Parentage. Also called Minicado, Littlecado. Sometimes spelled Wurtz. Originated in Encinitas, California, by Roy Wertz. Introduced in 1948 from a chance seedling planted about 1935. Tree: production fair to good; distinctive weeping growth habit, with dense cover of leaves and small limbs. A dwarf tree sold for backyard use. Frost sensitive below 31 F. Flower/Pollination: Both Type A and B. Zones: 9-11

Growing Habits: Reaches 10 to 15 feet in height maximum, 10 to 12 is average. Can be grown in large planters. Tree production fair to good. Tree is small & slow-growing, bears moderately but regularly.

Fruit Characteristics: Green. 8-10 oz. Pyriform. Provides ample good-tasting small to medium-size fruit. The skin is fairly thin and stays green as the fruit ripens. Peels well. Large seed. Medium skin texture. Large seed.

Blooming Time: Late winter through spring. Ripens: May- September. Late in Queensland.

Other Unique Facts: This is the only true dwarf avocado variety and bears fruit young! Therefore, Little Cado makes for a great backyard tree and can also be grown in large containers – such as a half wine barrel, with ample drainage holes added.

Cultivated in Queensland for only the past 12 or 13 yrs.

Jim.

(https://www.louiesnursery.com/plants/avocado-trees/jim-bacon-avocado/)
Light Green. 6-16 oz. Smooth skin. Hardy slightly less than 24 F. Fairly consistent production. B flower type.

Jim (https://www.tomorrowsharvest.com/store/jim-bacon-avocado.html)

Jim (Koch, 1983. https://www.louiesnursery.com/plants/avocado-trees/jim-bacon-avocado/. https://avocado.ucr.edu/variety-list#jim. https://avocado.ucr.edu/avocado-variety-database)

Jim is a new variety developed by Jim Bacon in the Buena Park area from a Bacon parent. The tree is vigorous, semi-upright, and appears slightly more hardy to frost as the Bacon which tolerates temperatures slightly lower than 24°F. It is a precocious bearer, produces good crops regularly, and propagates easily from either buds or grafts.
The fruit is green, pear-shaped or ovate, has a medium-sized seed that is tight in the fruit and a medium thick skin, averages 6-16 ounces, and ships well. The fruit tests 12.2-18% oil content. This good quality fall fruit is marketed as "other greens" and commands about the same price per pound as Bacon and Zutano. [Its flower type is B.]

Jim. (https://www.louiesnursery.com/plants/avocado-trees/jim-bacon-avocado/. https://avocado.ucr.edu/variety-list#jim. https://avocado.ucr.edu/avocado-variety-database)

The Jim Bacon avocado is a selection of Bacon that produces flavorful, green-skinned fruit with smooth and creamy flesh. It can produce high yields on an attractive, upright tree. It is slightly more cold hardy than Bacon. This good quality fall fruit is marketed as "other greens" and commands about the same price per pound as Bacon and Zutano.

Flower Type Type-B. Mexican.

Fruit Shape Ovate to Pyriform.

Skin Color When Ripe: Green. Olive green to maroon.

Skin Thickness Thin. Smooth. Peels not easily.

Fruit Season November-February. Precocious bearer. Ships well.

Fruit Weight 6-16 oz.

Seed Size Medium.

Oil Content 12.2-18%.

Tree Size Large, vigorous, semi-upright.

Hardiness Very Hardy slightly less than 24°F.

Flavor Poor at first. Then Very Good. Smooth and creamy.

Lula. (https://www.fast-growing-trees.com/products/lula-avocado) Green. Smooth skin. 16-24 oz. Prolific and regular bearer. Cold hardy to 27 F.
Type A flower.

Lula.
14-24 oz. Green.
Slightly rough.
Cold tolerant,
27 F.
A type flower.
High production.
(FloridaAvocadoVari eties.pdf)(USDA)

Variety: LULA

Size: medium; **Shape:** pear, short neck; **Stem Attachment:** centered, thin; **Skin:** dark green, slightly rough; **Pulp:** greenish yellow, thin; **Seed:** tight to slightly loose; **Season:** October - January

Lula. (https://avocado.ucr.edu/variety-list#lula. https://avocado.ucr.edu/avocado-variety-database. https://www.avocadosource.com/AvocadoVarieties/QueryDB.asp)

Origin from seed from parent Taft tree planted 1915 by Mrs. Lula Cellon at Miami, Florida. Orig. in Miami, FL, by George B. Cellon, nurseryman. Introd. in 1921. Open-pollinated seedling of Taft; selected in 1919. A rapid grower in Florida, precocious & productive. More frost resistant than most 27 F. Fruit season Mid Nov.-Jan. October in Fla. Skin almost smooth, dark, glossy green. Seed tight in cavity. Very susceptible to avocado scab. Tree: vigorous & upright, prolific & regular bearer. It is the principal cultivar in Martinique for exporting to France; represents 95% of the crop.

Parentage: Guat. x Mex. hybrid

Peels: N/A

Seed Size: Large. Tight.

Skin Texture: Almost smooth

Blossom Type: A

Fruit Shape: Pyriform. Flesh pale to greenish yellow.

Skin Color Unripe: Green.

Skin Color Ripe: Green.

Skin Thickness: Slightly rough.

Average Fruit Weight oz: 16-24. Oil 12-16%.

Mexicola. (https://www.louiesnursery.com/plants/avocado-trees/mexicola-avocado)   4-6.5 oz. Black. Anise leaf smell. Smooth skin. Productive. Cold hardy to 18 F.   Flower type A.

Mexicola. (https:/louiesnursery.com/plants/avocado-trees/mexicola-avocado/. www.https://avocado.ucr.edu/avocado-variety-database.ucr.edu)

Orig. about1910 as seedling at Coolidge Rare Plant Gardens, Pasadena, CA, propagated about 1912.; Propagated about 1912 One of the first varieties to be commercial, planted by Mr. Henry Huntington around 1915-17. Grown only in home gardens in CA. Bears early & regularly.

The Mexicola avocado is an excellent quality, frost-hardy avocado variety. It is noted for its shiny purple-black skin, anise scented leaves and excellent quality flesh. The trees have an upright spreading habit and are vigorous. Mexicola trees have survived freezing temperatures as low as 18°F. Tree resistant to heat and cold. Appears to be resistant to Persea Mite. Keeping & shipping qualities poor.

Parentage Mexican. Flower Type-A.

Fruit Shape Obovate. Skin Color When Ripe or unripe. Black.

Skin Thickness Thin and Smooth. Difficult to peel. Edible peel.

Fruit Season August to October.

Fruit Weight 4-6.5 oz.

Seed Size Large. In demand for rootstocks. Loose in cavity.

Oil Content 20%

Tree Size Large. Very Hardy to 18°F. Tree resistant to heat & cold & consistent bearer.

Flavor Good to excellent.

The new Luna UCR avocado. *(https://news.ucr.edu/articles/)*

6-9 ozs

Luna UCR unripe left, ripe right. (Photo by Mary Lu Arpaia) (https://ucanr.edu/News/)

6-9 oz

The new Luna UCR avocado. 6-9 ozs. (https://news.ucr.edu/articles/)

The variety is the result of a University of California avocado tree breeding program that started at UCLA 86 years ago, was transferred to UCR in the 1950s, and continues today. It offers consumers a nutty flavor and a smooth texture that's ideal for guacamole. The Luna UCR™ also has a rind that turns a tell-tale black when ripe and is bred to maintain its quality well after it is harvested.

Growers, meanwhile, benefit from a smaller tree size, allowing denser plantings for more efficient and safer harvesting, and minimal pruning. It also has a type of blossom that makes it an efficient pollinizer for various avocado varieties, including the Hass, the world's leading variety.

The new Luna UCR avocado. 6-9 ozs. (https://news.ucr.edu/articles/)

A United States plant patent for Luna UCR™ under its official variety denomination, ‘BL516’ will be issued on Oct. 31, according to a notice from the United States Patent and Trademark Office. The patent (No. PP35444) will credit as inventors Mary Lu Arpaia, a UC Cooperative Extension horticulturist based at UCR, and her colleague Eric Focht, a UCR staff research associate in the Botany and Plant Sciences Department in the College of Natural and Agricultural Sciences. Other credited co-inventors are former UCR scientists Gray Martin, the late David Stottlemyer, and the late B.O. “Bob” Bergh.

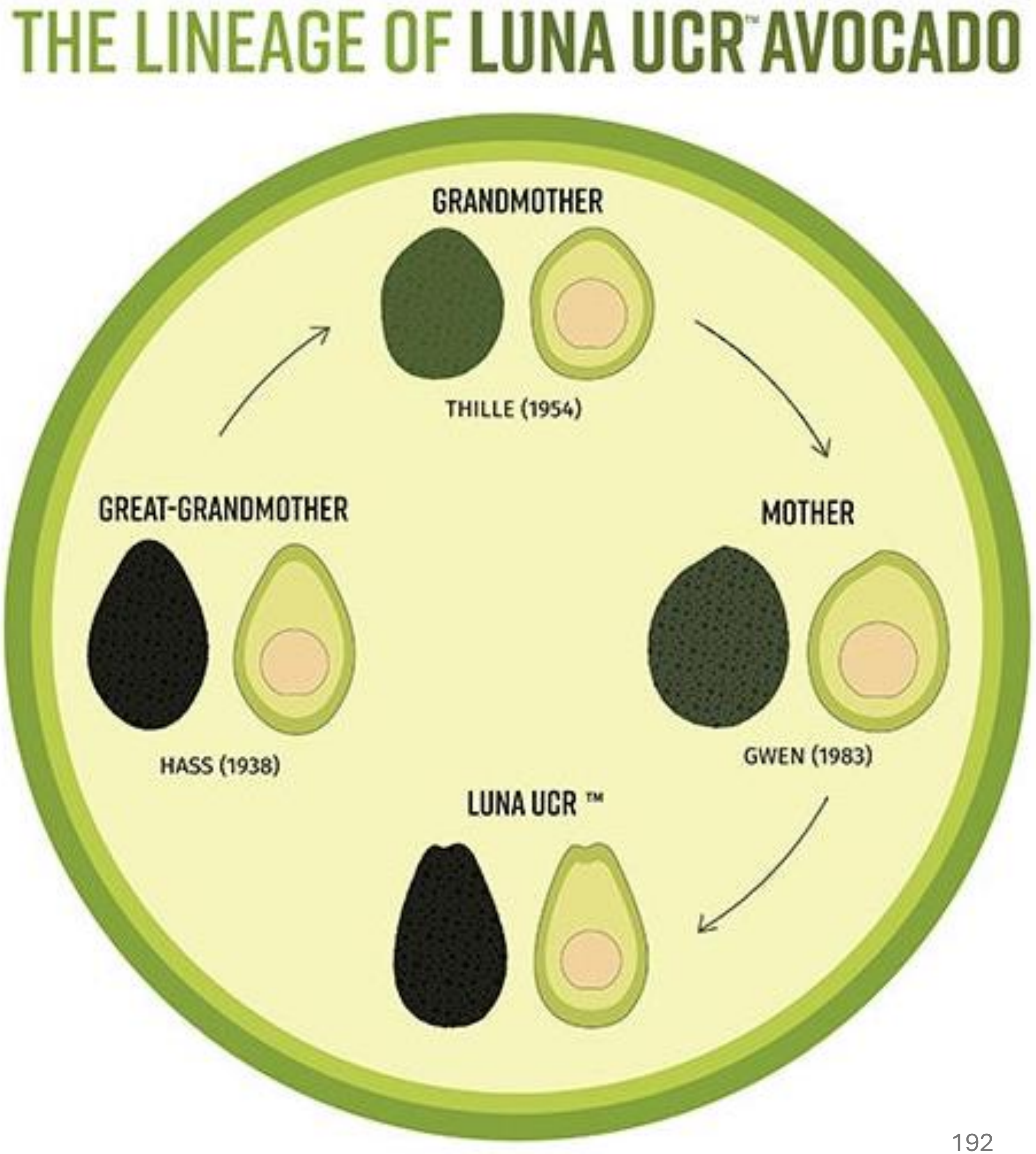
The new Luna UCR avocado. 6-9 ozs. (https://news.ucr.edu/articles/)

The variety is being marketed to commercial growers worldwide through a partnership with Eurosemillas, SA, a company based in Spain that specializes in international sales of proprietary crop varieties. Under an agreement executed by UCR's Office of Technology Partnerships, Eurosemillas is the master licensee of the variety. Eurosemillas has established partnerships with growers in 14 countries outside of the USA to grow the Luna UCR™. Commercial growers interested in planting the variety may make inqueries through Green Motion Avocados. The Luna UCR is not yet available to backyard growers but discussions are underway to make it available in the near future.

The new Luna UCR avocado. 6-9 ozs. (https://news.ucr.edu/articles/)

So, Bergh and Martin went back to work and planted as many as 70,000 genetically distinct seedlings from Gwen mother trees at three sites with different microclimates in San Bernardino, Ventura, and San Luis Obispo counties. One of the Ventura County trees that grew in Camarillo became the first of what is now the Luna UCR™ avocado, with the preferred black skin when ripe. Unfortunately, Bergh died in 2021 at age 96 – two years before the release of Luna UCR™.

The new Luna UCR avocado. 6-9 ozs. (https://news.ucr.edu/articles/)



A Luna UCR Tree, upright and tall, but half the size of Hass. (https://ucanr.edu/News/?routeName=newsstory&postnum=57734)

6-9 oz

A Luna Tree. Fruit 6-9 oz.
Upright and tall.
But half the size of Hass. But with the same fruit production.
(https://ucanr.edu/News/?routeName=newsstory&postnum=57734)

Row of Hass on top, Luna on bottom. 6-9 oz.

(https://ucanr.edu/News/?routeName=newsstory&postnum=57734)

Luna Characteristics

(https://ucanr.edu/News/?routeName=newsstory&postnum=57734)

B type flower. Could cross-pollinate Hass, an A type.

Tree half the size of Hass. More trees per acre. Therefore more production per acre. Easier to harvest.

Same production as Hass. Consistent.

Fruit size. 6-9 ozs.

Fruit store well when ripe.

A very good eating fruit, smooth and nutty.

Earliest field plantings in fall 2024. 1000 trees from Brokaw Nursery, Saticoy, CA. Full production in five years.

BL516 Luna, was Marvel

(https://avocado.ucr.edu/avocado-variety-database)

Variety BL516

Flower Type B

Fruit Color Black

Ecotype Hybrid

(Hybrid) Previously referred to as "Marvel". Hass like variety, B flower type, 6-9 ozs, peels easily, pear to oval pear shaped, attractive flesh, green or green & black when hard, black when soft, seed is very small to medium in size, ripens much later than Hass. (J.R. Frink 1998) Narrow, upright growth habit with drooping branches that protect fruit from wind and sun (Focht 2023)

(etsy.com)


TYPES OF
AVOCADOS
ONLY FOODS
Choquette
Large, oval;
Mild taste
Reed
Large, round;
Nutty flavor
Maluma
Large, oval;
Nutty taste
Gwen
Small, pear-shaped;
Nutty flavor
Hass
Medium, oval;
Superior rich taste
Lula
Large, pear-shaped;
Slightly sweet
Pinkerton
Large, elongated;
Rich, nutty flavor
Bacon
Medium, oval;
Light, creamy flesh
Cleopatra
Medium, pear-shaped;
Rich creamy flesh
Brogden
Medium, pear-shaped;
Rich nutty flavor
Fuerte
Medium, pear-shaped;
Rich, creamy flesh
Ettinger
Medium, pear-shaped;
Mild taste
Zutano
Medium, pear-shaped;
Mild taste
Monroe
Very large, club-shaped;
Mild taste
Sharwil
Medium, pear-shaped;
Mild taste

Old Avocado Varieties grown at CalPolySLO for many years. Sold at farmers markets.

Anaheim
Dickinson
Jalna
Nabal
Rincon
Ryan
Santana
Topa Topa
MacArthur
Leucadia

Anaheim (Avocadosource.com)

Category	Breeding
Subject	Cultivars
Title	Anaheim Cultivar
Description	Anaheim fruit from Santa Paula in July
Location	Santa Paula, CA
Date	7/3/1969
Source	Bob Platt
Larger Picture	1000 x 730 (101 kb)


6
5
4
3
2
1
0
ANAHEIM
SANTA PAULA
JULY

Anaheim. (Bing.com)

Anaheim This variety originated in 1910, in Anaheim, California, and is derived from the Guatemalan type of avocados. It is large, softball-shaped and may grow up to two pounds. 18-32 oz. The skin is medium-thick, glossy, and green in color, and can be easily peeled off. The seed is small to medium in size, and the flesh is soft and pale-yellow in color. Type A flower. Very tall narrow tree. Fruit in top. Productive. Not cold hardy.

Anaheim. 18-32 oz. Medium rough. Very Tall narrow tree. Fruit in top. Productive. Not cold hardy. Type A flower. (https://avocado.ucr.edu/variety-list#anaheim. https://avocado.ucr.edu/avocado-variety-database)

Guatemalan. Tree originated in 1910 in Anaheim, California. A seedling from E.C. Dutton planted on Otto Keup place at the corner of Palm Ave. & Ball Road, Anaheim, CA. Bears regularly up to 220 lbs annually per tree. Ripens June - August. Cold sensitive. Shape of tree, tall and slender. Flavor, fair to good. Production very prolific. Considered of poor quality & subject to disease during ripening in Queensland.

Seed Size: Medium to small.

Skin Texture: Medium rough, glossy. Skin Thickness: Medium. Peels: Yes.

Fruit Shape: Ellipsoid to Obovate.

Skin Color Unripe: Green. Skin Color Ripe: Green.

Average Fruit Weight oz: 18 to 32. 15-22% oil.

Dickinson (Avocadosource.com)

Category	Breeding
Subject	Cultivars
Title	Dickinson Cultivar
Description	Dickinson fruit in July from Irvine, Ca
Location	South Coast Research and Extension Center, Irvine, CA
Date	7/5/1973
Source	Bob Platt
Larger Picture	1000 x 743 (90 kb)


DICKINSON
SCFS
JULY

Dickinson. Black. Med-large. 9-18 oz. Brittle skin.

(https://avocado.ucr.edu/avocado-variety-database)(https://www.avocadosource.com/AvocadoVarieties/QueryDB.asp)(https://avocado.ucr.edu/variety-list#dickinson)

Tree originated about 1899 as seed from Guat. City planted at A. J. Dickinson's place 679 West 35th Street, Los Angeles, propagated 1912. Tree moved to Exposition Park,1931. Medium thick skin. Fruit texture is rough with fine, seed-like raised bumps. Med-large, pebbly fruit. Poor quality, not worth growing. It is no longer grown in FL or CA. Author says good quality from experience.

Guatemalan Hybrid. Blossom Type: A.

Peels: No. Seed Size: Small-medium. Sometimes large. Tight. Skin Texture: Pebbly. Skin Thickness: Thick. Hard shell affects marketability. Difficult to tell when fruit is soft.

Fruit Shape: Narrowly obovate. Skin Color Unripe: Black. Skin Color Ripe: Black. Season June-Oct in CA. Feb.& Mar. in FL; Jan & Feb. in Puerto Rico.

Average Fruit Weight oz: 9-18. 13.5% oil. Moderate to regular bearer.

Jalna. 6-7 oz. Green. Very early maturity. Some stringiness.
Tall narrow tree. Long thick neck. Heavy bearer. End cracking. Good frost tolerance. A type flower. (https://avocado.ucr.edu/avocado-variety-database)

Fruit Color Green Ecotype Mex

(Mex.) Regist.1935 Originated 1928 from seed planted at Encinitas, CA. by Dr. J. Eliot Coit. Moved 1929 to Vista, CA., fruited 1931. Introd. in 1936 by Armstrong Nurseries, Ontario, CA. Parentage unknown (but of Mex. type); selected in 1933.

Better bearer near coast than most Mex. race varieties. A heavy bearer. Fruit drops early. Then must pick.

Fruit season, Nov.-Jan. Shape, pyriform. Skin, smooth. Flavor, good plus. Oil, 20%. Keeping quality good.

Seed, small. Fruit: pyriform; skin green, thin, end-spots; quality fair; Tree: heavy bearer, but tends to alternate; good frost tolerance; Was minor commercial cultivar in CA.

Nabal (Specialtyproduce.com)

Nabal (Specialtyproduce.com) (https://avocado.ucr.edu/variety-list#nabal)

The Nabal avocado is a rare Guatemalan variety with smooth, dark green, medium-thick skin that peels easily and is covered with yellow freckles. Nabal avocados are very large, weighing up to thirty-five ounces,16-35) and they have a rounded, softball shape.

They are known for having exceptionally high-quality flesh that is deliciously creamy and greenish-yellow in color, and surrounds a large central pit. T

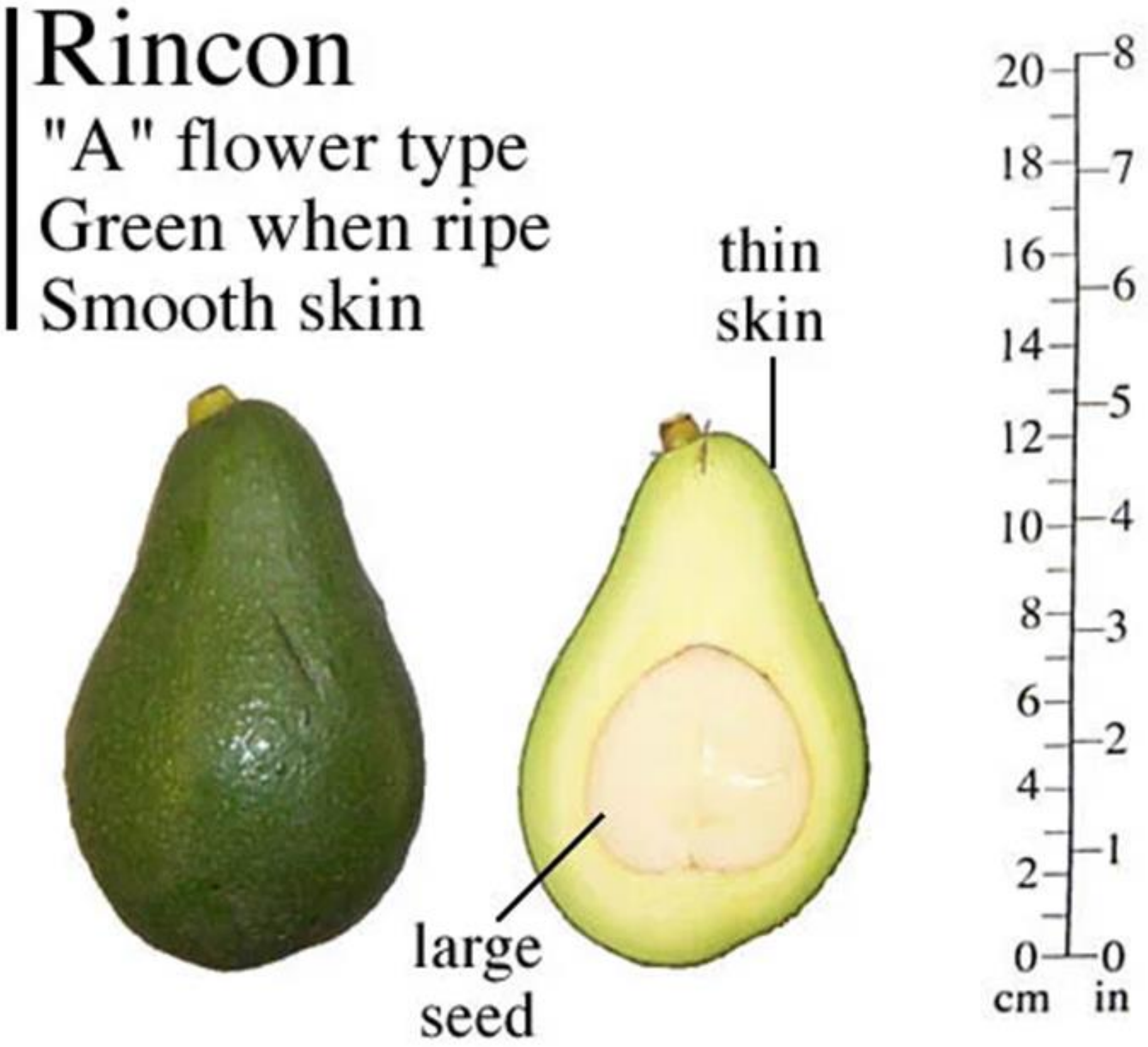
he Nabal avocado tree has a greater tendency to alternate bearing than other commercial varieties, but it is known to be a vigorous producer of the hefty, flavorful fruit. It is one of the more frost-sensitive Guatemalan cultivars, and when planted in windy areas, this variety can also be subject to wind scars and shedding, when nearly mature. Avocados on the tree are inhibited from ripening because of a hormone supplied from the leaves, and hence farmers can store the fruit on the tree for up to eight months after maturity. Once the fruit is harvested it starts to ripen, and unlike most fruit, the sugar content of avocados decreases rapidly during ripening. Nabal avocados are available in the summer and early fall (June-Oct in CA). B type flower. Productive. Alternate bearer.

Nabal. 16-35 oz. Type B. Productive but alternate bearing. Green. High quality. (https://avocado.ucr.edu/variety-list#nabal)(Specialtyproduce.com)(https://avocado.ucr.edu/avocado-variety-database)

Guatemalan. Imported into the U.S. by F. W. Popenoe in 1927, in Florida in 1937. Introd.1917 by F. W. Popenoe, USDA from Antigua, Guat., elevation 5100 ft. Parentage unknown. Being propagated in HI and FL. Marketability, good. Season June-Oct in CA. Jan. & Feb. in FL; Oct. & Nov. in Queensland. Tree is strongly alternate bearing. Tree a good grower & heavy bearer in alternate years. Tree bears well in central FL; In Queensland, bears in alternate yrs. very heavily, but is rated as of med. quality & disease-prone during prolonged ripening. **Frost-sensitive (30 F)**, and when planted in windy areas, this variety can also be subject to wind scars and shedding of fruit.

Skin and Flesh: Peels: Easily. Skin Texture: Smooth. Skin Thickness: Medium-thick. Hard and shell like. Flavor, excellent. Flesh of high quality. Creamy and greenish yellow. **Fruit** Shape: Spheroid. Average Fruit Weight oz: 16 to 35. Oil 10-22%. Seed large, tight in cavity.

Rincon. (https://avocado.ucr.edu/variety-list#rincon)



Rincon. 7-14 oz. Small spreading tree. Productive. Moderate cold hardiness. A flower type. (https://avocado.ucr.edu/variety-list#rincon) (https://avocado.ucr.edu/avocado-variety-database)

Hybrid GxM. Originated in Carlsbad, California, by Sam Thompson. Introduced in 1948. Chance seedling; Registered 1945. (CAS Yearbook 1956) Parent of Pinkerton, two trees are growing at South Coast Research Station, Irvine, CA. Discovered before 1945. Propagated by Stanley Shepard at Carpinteria, CA.

Thin, tender green skinned fruit with a pear shape. Some fruit have a small neck and a flat bottom. Ripens Jan. to May; resembles Fuerte. Minor commercial variety in coastal areas.

Seed Size: Large. Skin Texture: Smooth. Color Green. Skin Thickness: Thin, smooth, leathery, peels well; flesh fine.

Fruit Shape: Narrowly obovate to pyriform. Average Fruit Weight oz: 6 to 14. 15-26.5% oil. Flavor rich. Flesh buttery, fibers in flesh near base turn black when fruit is cut.

Tree, medium to small, spreading, very precocious relative to bearing, somewhat alternating, but a very good producer.

Still sold in nurseries in No. Chile. Season: Mar. & Apr. in Queensland, where it is rated as of poor quality.

Ryan (Bing.com.)

Similar to Fuerte. 8-14 oz. Green. Slightly rough.
Erratic bearer. Moderate hardiness.
B flower type. Guat. x Mex.

Ryan. Similar to Fuerte. 8-14 oz. Green. Slightly rough. Erratic bearer. Moderate hardiness. B flower type. (https://avocado.ucr.edu/avocado-variety-database)

Flower Type B   Fruit Color Green   Ecotype Guat x Mex

Summer Fuerte Found about 1927, probably seedling of Amigo, on A.R. Rideout Ranch, at Whittier, CA by Edward R. Ryan. Orig.in Whittier,CA by A.R. Rideout. Introd. in 1936. Hybrid between Guat. & Mex. types; possibly an open-pollinated seedling of Amigo.

Tree easy to propagate, a vigorous grower but rather an erratic bearer. Fruit: season, May-Sept.; color, green; wt, 8-14 ozs.; shape, pyriform; skin, leathery, slightly rough; flavor, good; oil, 25%. Seed, lg.

Fruit quality fair to good;moil content high; Tree: vigorous; propagates readily; suitable for planting in inland areas of CA. No longer propagated commercially. Moderate hardiness.

Season: July -Oct. in Queensland. Tree lg. & bears regularly but not as heavily as Fuerte or Hass in Queensland. Important in Chile.

Santana

(https://avocado.ucr.edu/avocado-variety-database) Green. Similar to Zutano. Less end spot. Hardy. Productive. B flower type.

SANTANA

Variety

SANTANA

Flower Type

B

Fruit Color

Not available

Ecotype

Mex

Description

Origin, CA; Race, Mex.; Flowering group, B (Lahav & Gazit)

Santana (Koch, 1983)(Specialtyproduce.com)

Around 1960, Stephen R. Nemcik of Buena Park, California planted a Zutano seed in his backyard. Since it came into bearing it has carried a heavy crop of fruit every year. During the fall of 1971 this tree was brought to the attention of James E. (Jim) Bacon, a long-time avocado grower and developer of the Bacon and more recently the Jim avocado varieties. He found the fruit to have early maturity and excellent size and appearance. After checking the fruit for quality and even ripening he reached the conclusion that here was “the most promising early fall variety yet.” Because of this, Mr. Nemcik applied for and was awarded Plant Patent 3,703 on 15 April 1975 for this tree under the name Santana.

The tree is an upright grower, resembling its parent, the Zutano variety. It is precocious in bearing with first year grafts often setting fruit and setting heavy crops in the second year. No end spot like Zutano.

The tree appears to be about as hardy as the Zutano (26 F).
The fruit resembles Zutano in appearance but is somewhat larger and has no end spotting, while the seed is average in size and the skin thicker than most fall varieties. Maturity dates are earlier than both the Bacon and Zutano varieties in Buena Park, with fruit ready to pick by the end of September. Quality is good at earliest maturity and progresses to very good. It differs from other early varieties because it hangs well on the tree as late as March.

The first season in California is from May to July, and the second season is from September through November (Specialtyproduce.com).

SANTANA (https://avocado.ucr.edu/avocado-variety-database)

Flower Type B

Fruit Color Green. Slightly Larger than Zutano.

Ecotype Mex

Description

Origin, CA; Race, Mex.; Flowering group, B (Lahav & Gazit)

1 oz = 1.917222836966 tbsp, 28.3495231 gm

Fruit = 600-700 gm, 21.178 oz – 24.692 oz

Santana (Specialtyproduce.com)

Santana avocados are medium to large in size, averaging 600 to 700 grams (21-25 oz.) in weight, and have a uniform, pyriform shape with a broad, curved base tapering slightly to a rounded top. The variety's skin is thick, semi-smooth, leathery, easy to peel, glossy, and textured with small bumps. The surface also has an olive-green to forest-green hue, a coloring that remains even when the avocado is ripe.

Underneath the surface, the yellow-green flesh is dense, smooth, and low in fiber, with a creamy, buttery, and tender consistency.

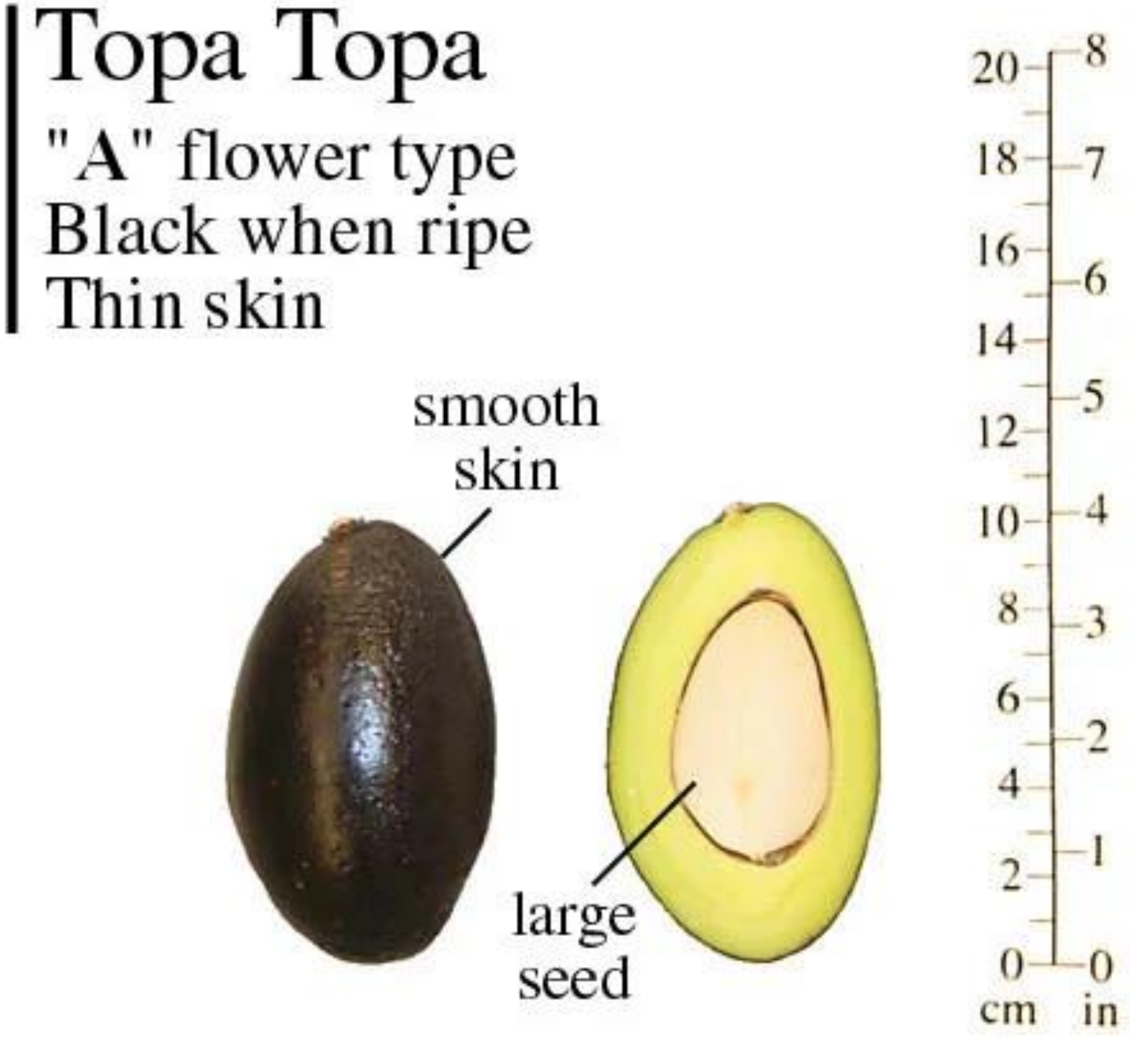
The flesh also encases a moderately sized central seed that is firm, round, and tan. This seed can be removed from the flesh without effort. Santana avocados ripen consistently and can be consumed raw when mature. The variety has a rich, mild, slightly nutty, and earthy taste.

Santana avocadoes are harvested over two main seasons in Colombia. The first season is from May to July, and the second season is from September through November.

Flower type B. Hardy. Less end spot than Zutano. Productive.

TopaTopa (Specialtyproduce.com)

(https://avocado.ucr.edu/variety-list#topatopa)



TopaTopa (https://avocado.ucr.edu/variety-list#topatopa)

(https://avocado.ucr.edu/avocado-variety-database) (Specialtyproduce.com)

Cold hardy. Used as Mexican rootstock. Productive. 3 - 10 oz. Black. Flower type A.

Originated 1907 from seed in Ojai, California. Fruit season, Sept - Dec. Poor flavor, used mainly as a rootstock.

Mexican

Peels: No

Seed Size: Large

Skin Texture: Smooth

Blossom Type: A

Fruit Shape: Ellipsoid, oblique, pyriform.

Skin Color Unripe: Black. Skin Color Ripe: Black.

Skin Thickness: Thin, edible. Anise skin taste.

Average Fruit Weight oz: 3 to 10. 15.5% oil. Poor flavor.

TopaTopa. **Cold hardy. Used as Mexican rootstock. Productive. 3 -10 oz. Black. Flower type A.**
(https://avocado.ucr.edu/avocado-variety-database) (Specialtyproduce.com)

Flower Type A. Fruit Color Black. Ecotype Mex.

Originated 1907 from seed at E.S. Thatcher place Ojai, CA. Planted in orchard in 1909, fruited 1912, propagated 1913.

Fruit: season, Sept.-Dec.; color, black; weight, 3-10 ozs.; shape, oblique, pyriform; skin, smooth, glossy; flavor, poor; oil, 15.5%. (CAS Yearbook 1950) Origin, CA; Race, Mex.; Flowering group, A.

Seeds are used as rootstock for grafting because they grow early and with vigor. They tend to be susceptible to phytophthora however. The fruit is of very low quality for eating.

MacArthur. Guatemalan. Good bearer. Green. 14-18 oz. Cold hardy. Bell-shaped. Pebbly skin. Hardy. (https://how-to-grow.org/vr/macarthur/r/avocado)(GregAlder.com)

Macarthur (Specialtyproduce.com)

McArthur. **Guatemalan. Green. Good bearer. 14-18 oz. Cold hardy. Bell-shaped. Pebbly skin.** **(https://avocado.ucr.edu/avocado-variety-database)(Specialtyproduce.com)**

Orig.1922 by Thos. H. Shedden of Monrovia, CA. Parentage unknown.

A vigorous grower & good bearer. Very resistant to cold as compared to other Guats. Recommended for coastal areas of Ventura & Santa Barbara Counties.

Shape, pyriform. Skin, med. thin. pliable. Pebbly. Flavor fair to good. Seed med.-large.

Tree: vigorous; spreading; high N-requiring variety; bears well in coastal districts of CA. & was a minor commercial variety in Ventura & Santa Barbara counties.

Flesh has sweet, nutty but watery flavor, contains 13-16.7% oil; silky and creamy texture with a mild, subtly sweet, and nutty flavor.

Season: Aug.-Nov. in CA; Aug. & Sept. in Queensland where it is rated of poor quality.

MacArthur (Specialtyproduce.com)

MacArthur avocados are large fruits, averaging 14-18 oz.,13-16.7% oil, and have a pyriform shape with a bulbous base, tapering to a small and slender, curved neck.

The skin is semi-rough with a pebbled, bumpy texture and matures to dark green with some brown discoloration. The skin is also very thin and pliable, causing the fruit to be easily damaged or punctured.

Underneath the surface, the flesh is bright green below the skin, transitioning into a yellow-green hue closer to the seed, and has a smooth, oily, soft, and fibreless consistency.

The central seed is firm, hard, and tan with a bumpy surface, encased in a papery and brittle, dark brown layer that frequently sticks to the flesh when opened.

MacArthur avocados have a silky and creamy texture with a mild, subtly sweet, and nutty flavor. MacArthur avocados are available in the late fall through winter. Cold hardy. Pebbly. Good bearer. Medium-large seed.

Leucadia avocado. Actually a Winter Mexican. Looks like Leucadia.

Leucadia. (https://avocado.ucr.edu/avocado-variety-database)

Regist. 1932 Originated 1927 at Rancho Leucadia, Encinitas, CA, fruited 1930. (CAS Yearbook 1950) Orig. in Encinitas, CA, by J. Eliot Coit. Introd. in 1932. Parentage unknown (but of Mexican type); selected in 1929.

Propagates easily & is a vigorous grower. It is erratic in its bearing habit. Fruit season, Oct.-Jan.

Color, purple to black; weight, 10-12 ozs.; shape, pyriform; flavor, excellent minus; oil, 22.7%. Similar to Puebla but averages larger. Fruit: size good; skin handsome, purple, thin, smooth; resembles Puebla.

Tree: moderately spreading. No longer propagated.

Flower Type Not available. Fruit Color Black Purple. Ecotype Mexican.

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Homesteadandchill.com

Chapter 3. Avocado Rootstocks

Avocado trees are grafted onto a rootstock to propagate them. A tip graft or saddle graft is used. See chapter 4. A seed or leafy cutting is used to propagate the rootstock. In the early years of the industry Mexican race varieties were used with large seeds. Mexicola or Topa Topa varieties were used. Any Mexican race variety with large seeds have been used more recently such as Zutano or Bacon. Mexican varieties are more resistant to chlorosis [from high soil pH] and are cold hardy. Sometimes large seeded Guatemalan varieties (Lula) from Florida are used. Texas uses Lula extensively. They produce vigorous seedlings quickly, however, but may be subject to chlorosis and may be cold tender. Root rot resistant rootstocks are propagated by rooting of leafy cuttings. Trees on root rot resistant rootstocks may cost a higher price than standard seedling rootstocks. The third race, the West Indian, has not been used because of their tenderness to cold. Topa-Topa is very susceptible to both avocado root rot and salinity.
An avocado rootstock table of characteristics is below (Bender et al 2015).

	Topa Topa	Lula	G-6	Duke 7	Thomas	(Martin Grande)	Barr Duke	Toro Canyon	D9	Borchard
Normal Propagation Method	seed	seed	seed	clonal	clonal	clonal	clonal	clonal	clonal	clonal
Horticultural race	Mexican	Guat. X West Indian	Mexican	Mexican	Mexican	Hybrid-*P. americana x P. shiedeana*	Mexican	Mexican	Mexican	Mexican
Parentage			seedling	Duke	escape seedling	market collection	Selfed Duke 6 seedling		Irradiated Duke seedling	
Geographic origin	California	Florida	Antigua, Guatemala	UC Riverside	Escondido, CA	Guatemala	Fallbrook, CA	Saticoy, CA	UC Riverside	Camarillo, C
Productivity "clean" soil (a)	3	?	3	4	2	1	3	3	2.5	4
Productivity "root rot" soil (b)	1	?	3.5	3	3	2	3	3.5	3	2
Tree size "clean" soil (a)	5	?	5	5	5	5	5	4	4	5
Tree size "root rot" soil (b)	0.5	0.5	1	2	4	1.5	1.5	3	2.5	0.5
Tolerance to P. cinnamomi (c)	0	?	2	3	4.5	5	3.5	2.5	3.5	0.5
Tolerance to P. citricola (d)	3	?	3	4	2	3	3	5	4	3
Salt tolerance (e)	2	?	2	3	1	2	2	3	3	3
Frost tolerance (f)	4.5	1	4.5	4	4.5	1	4.5	4.5	4.5	4.5
Tolerance to Dothierella (g)	5	?	2	5	2	?	5	5	5	5

Footnotes:

a. Yield and canopy volume expressed as percentage in comparison to Topa Topa, based on 7 years of data (6 years for Thomas) at South Coast Field Station (Arpaia et al. 1993)

b. Yield and canopy volume expressed as percentage in comparison to Thomas (consolidated data from J.A. Menge, 2002)

c. Consolidation of performance of young replant trials, ratings by John Menge

d. Results from greenhouse trials by A. Alizadah and J. Menge (unpublished)

e. Rootstock trial in sand tanks treated with three levels of saline water (Oster and Arpaia, 1991)

f. Observations by G. Bender and J. Menge after freezes in 1988-1991.

g. Results from greenhouse trials by A. Alizadah and J. Menge (unpublished).

e. Rootstock trial in sand tanks treated with three levels of saline water (Oster and Arpaia, 1991)

Yield per Tree (lbs)

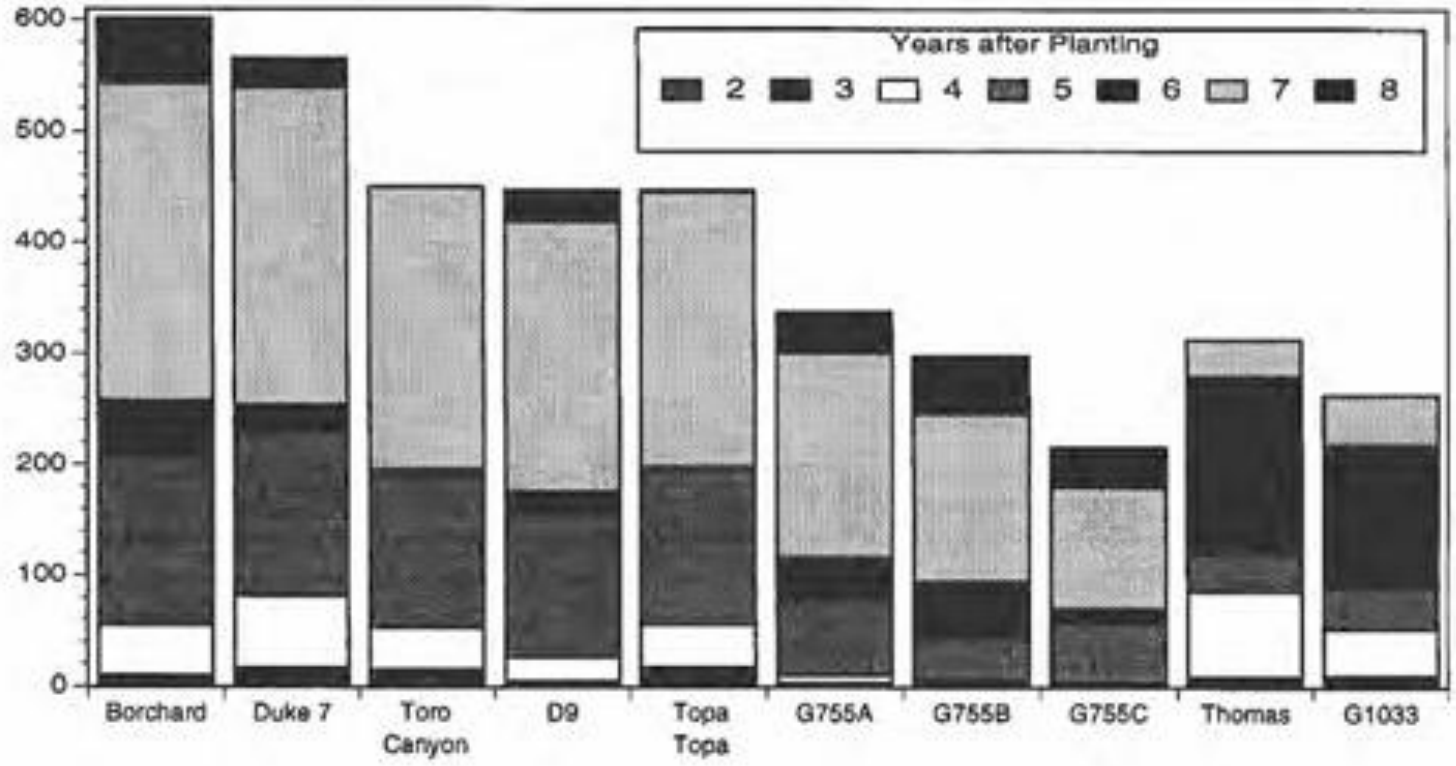

Figure 1. Cumulative yields (lbs/tree) of Hass avocado on clonal rootstocks after 8 years field production under *Phytophthora* – free conditions (Arpaia et al. 1995).

Yield per tree results

The greatest yield per tree for eight years were for the Borchard and Duke 7 rootstocks. It should be noted, however, that Borchard is susceptible to P. cinnamomi and would probably not be recommended if there were a possibility of root rot contamination in the grove. The Toro Canyon, D9 and Topa Topa rootstocks have comparable and moderate yields, and the three G755 rootstocks were less productive. Although they can't be compared directly, it should be noted that through the eighth year, Thomas and G1033 were bearing at a rate slightly ahead of G755A.

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https://journals.ashs.org/search?f_0=author&pageSize=20&q_0=Robert+J.+McNeil&sort=relevance

Article: EVALUATION OF ORCHARD PERFORMANCE OF THE HASS AVOCADO ON THREE Phytophthora cinnamomi Rands RESISTANT Rootstocks.

Anastacio Perez Naranjo, Robert J. McNeil

HortScience 06/1992; 27(6):604c-604.

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The experiment compared productivity and vegetative growth of the Hass avocado on three avocado root rot resistant rootstocks and one susceptible rootstock. Hass trees on Duke 7 reported the largest number of fruit per tree and on G 755c the smallest five years after planting. Trees on Topa Topa and Duke 7 reported the highest average production four years after planting. Trees on G 755c were significantly lower in the amount of leaf N. Trees on Toro Canyon and G 755c showed significantly lower amounts of Na. Trees on Duke 7 showed a significantly higher level of Mn. Trees on G 755c were significantly smaller two years after planting. Trees on Topa Topa and Duke 7 showed a significantly larger canopy diameter than those on G 755c four years after planting. Trees on G 755c showed the smallest mean shoot growth four years after planting. Trees on G 755c had significantly larger trunk circumferences three and four years after planting. No statistical differences were found among rootstocks as to freeze damage to the Hass scions.

Root Rot Tolerance (Bender et al 2015)

Rootstocks that have root rot tolerance and are currently available for the commercial industry include Duke 7, Thomas, G-6, Barr Duke, D-9, Toro Canyon, and Martin Grande (G755). Of this group, Thomas has consistently given the highest ratings for tree survival and growth when replanted into root rot soils. Care must be taken, however, because Thomas is susceptible to a trunk canker caused by P. citricola. Thomas may also have increased susceptibility to trunk cankers caused by Dothierella fungi (Menge, personal communication). Martin Grande has also performed well in some root rot replant trials, but is not recommended due to poor performance in yield trials (Arpaia et al. 1995). A new selection that is performing better than Thomas in root rot trials is the PP4 (recently named 'Zentmyer'). After further testing, this rootstock should be released to the industry by the year 2003.

Root Rot Tolerance continued.

Also available to California growers will be two selections from South Africa known as Merensky 1 (a Duke 7 seedling formerly known as Latas) and Merensky 2 (South African selection formerly known as Dusa). In limited trials in California, they have been performing slightly better than Thomas in root rot tolerance, and about equal to Zentmyer.

Salinity Tolerance

Field experience has indicated that Thomas would not be a good selection for replanting into areas with highly saline irrigation water. Of the rootstocks available to growers, Toro Canyon or Dusa (Merensky II) would probably the best choices for this situation, but long-term trials under saline conditions have not yet been conducted. Research is now being conducted by David Crowley (University of California, Riverside) with West Indian rootstock selections developed in Israel by A. Ben-Ya'acov. The Israeli program identified approximately 50 clones of high yielding West Indian selections when grown under saline conditions. Ben-Ya'cov and colleagues noted that under conditions where chloride in the irrigation water is 100 ppm, avocado production on West Indian vs. Mexican rootstock is approximately equal. However, when chloride levels equal 300 ppm, Hass avocado production from the VC 51 rootstock (West Indian) was approximately double that of VV57 (Mexican). (Ben-Ya'acov et al, 1991). Ben-Ya'cov noted that these trees must be grown under well-drained conditions in order to be successful.

Salinity continued

A recent field trial in which the California rootstocks were compared to the West Indian selections from Israel and two selections from South Africa gave surprising preliminary results: the Merensky I (Latas) rootstock from South Africa did better than any of the other rootstocks as far as growth and appearance of the Hass scions, followed closely by Merensky II (Dusa) (Crowley, Arpaia and Bender, unpublished). Research is continuing to determine if Hass, Merensky I, and Merensky II rootstocks will perform satisfactory in long-term yield trials.

If a salt-tolerant rootstock is found that shows some degree of cold tolerance and root rot tolerance, the rootstock choices for California growers will improve.

Dwarfing Rootstocks.

Some avocado rootstocks are known to have a dwarfing effect, and a true dwarfing stock would probably merit clonal propagation. The author observed a genetic dwarf stem on a Zutano tree 20-25 years ago at CalPolySLO, but neglected to propagate it. It may have had potential as a dwarfing rootstock. Research with potentially dwarfing avocado rootstocks is needed to keep trees shorter.

Chapter 3 Avocado Rootstocks. References Cited.

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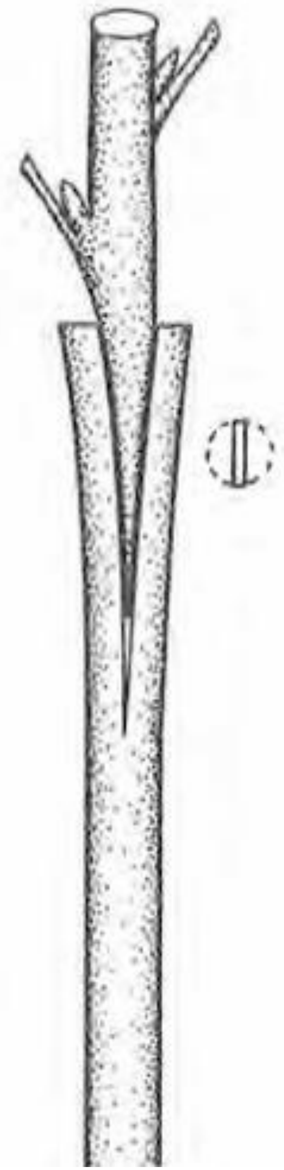
Chapter 4. Avocado Propagation. (Costa,1989)

Avocado varieties do not come true from seed, so they must be propagated vegetatively.

Avocados are grafted onto seedlings of standard rootstocks or rooted cuttings of root rot tolerant stocks. Seedlings of Mexican race varieties are usually utilized, such as Topa Topa, Mexicola, Bacon or Zutano. They are cold hardy and resist chlorosis, but may be susceptible to root rot or crown rot. They usually do not root easily from cuttings except for Zutano. Root rot resistant varieties are rooted from cuttings. Duke 7, Thomas, G-6, Barr Duke, D-9, Toro Canyon, and Martin Grande (G755) have been popular.

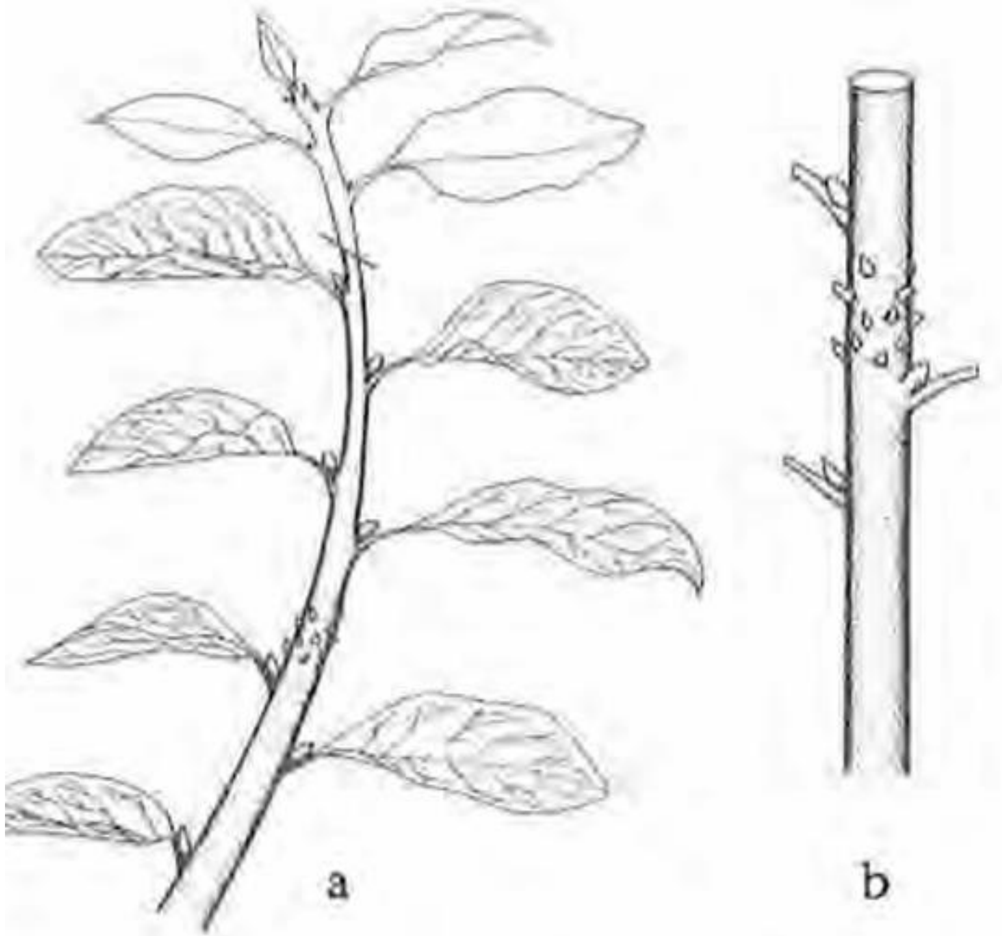
A cleft graft or tip graft is used in California nurseries. See the next page. The graft is wrapped with budding tape or plastic film. The tip of the scion is sealed with tree seal or grafting wax. The budsticks can be stored for 2 or 3 months at about 40°F in sealed, medium weight polyethylene bags. With thinner polyethylene or for longer storage, use double bags. Graftwood storage life can be extended by using a mild fungicidal dip, such as Captan, or by lowering the temperature slightly.



Cleft or tip graft for avocado propagation. Wrap with budding or plastic tape. Apply tree seal on top of scion.

(Costa,1989)

Source of vegetative buds for avocado grafting (Costa, 1989).



Greenhouse Environment

The Brokaw Nursery maintains a night temperature of about 55°F and a day range of about 72° to 80°F. This is somewhat cooler than would be required for maximum growth of young avocado plants, but has several advantages: delayed plant crowding, sturdier plants, and lower night heating costs. Relative humidity is kept above 55 percent. Some nurseries prefer a higher temperature for more rapid seedling development.

Seedling Rootstocks

The development of clonal stocks, especially with uniform tolerance of root rot, has minimized the importance of seedling rootstocks. Of the three horticultural avocado races, the West Indian is best for salinity tolerance. Unfortunately, in its pure form it is too tropical to thrive in our cool winter soils. The Guatemalan race has some salinity tolerance and produces vigorous seedlings, but the Mexican race is generally used for California stocks because its trees produce larger numbers of fruits with greater seed ratios, and together with greater cold hardiness this makes it a surer source of annual fruit; and provides a hedge against basal stem injury of newly planted trees in freeze years. Its seedling roots also average more resistance to

chlorosis than Guatemalans, and apparently to Dothiorella disease and Verticillium wilt. Topa Topa has been the most popular source of seedling stocks because it germinates uniformly and is unusually vigorous for a Mexican variety. Individual nursery operators may have other, individual preferences that are quite satisfactory where root rot or other adverse conditions are neither present nor likely.
Some nurseries use Guatemalan stocks from Florida (Lula) because of large seed size therefore vigorous seedlings. There may be a danger of chlorosis for the orchard trees however, and cold susceptibility. Lula is widely used in Texas. Seeds are commonly planted in the greenhouse during the autumn Mexican cultivar harvest season.

Clonal Rootstocks

Until about 1977, practically all of Califomia' s commercial avocado trees grew on sexually produced seedling rootstocks; only the fruiting tops (Fuerte, Hass, etc.) were asexually produced. Since then, some half-million trees have been planted on clonal stocks, imparting to roots the same advantage as asexual tops: genetic uniformity. Today, about half of our commercial stocks are clonal. Clonal rootstock uniformity is most important for consistent resistance to Phytophthora root rot. Salinity resistance is now available in the Borchard clone. Other useful resistances may be identified in the future. Some are known to have a dwarfing effect, and a true dwarfing stock would probably merit clonal propagation. Another possibility is a dwarfing (clonal) stem interpiece , perhaps on a (clonal) root-rot resistant stock. The overriding importance of Phytophthora cinnamomi means that other desirable stock traits, including favorable fruit quality and quantity, may best be sought among clonally propagated rootrot resistant lines.

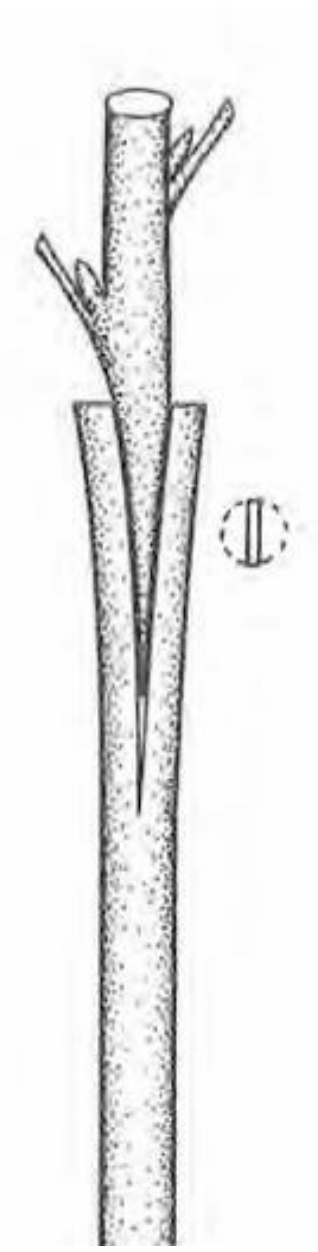
Frolich method. Practically all commercial clonal rootstocks now produced in California and elsewhere are based on the etiolation method developed by E. F. "Ted" Frolich, formerly of the University of California at Los Angeles. Vigorous seedlings are grown from large seeds in containers of about 1 quart, as a temporary nurse root system. Each seedling is grafted at a young age, and just above the soil line, to a clone that will become the tree's stock (usually chosen for its resistance to root rot). When the graft begins to grow, a singlebud is retained, and the plant is transferred to a darkened chamber. Here, further bud growth will be elongate, lacking chlorophyll [and increasing auxin levels]-the etiolated condition most conducive to avocado stem rooting. When the grafted shoot reaches a height of 8 to 10 inches, itis removed from darkness and enclosed in a cylinder about 6 inches high that is then filled with vermiculite, peat moss-perlite, or some other moist rooting medium. The shoot tip continues to elongate, developing normally in the light above the cylinder soil.

After the shoot completes a growth cycle and hardens off, the etiolated stem base is cut from the nurse seedling and the severed plant is transferred to a humidity chamber to complete its rooting. Then the plant is grafted to the desired fruiting variety by standard methods and grown indoors for 6 to 10 weeks before transfer to a shadehouse, or it can be transplanted to a field container and grafted outdoors. To keep the plant healthy, leaves should be retained on the rootstock stem until the new graft is leafed out. In essence, the method requires double grafting: frrst to establish the clonal stock, and then to establish the (clonal) fruiting variety, with rooting of the stock encouraged by darkness etiolation. The double-grafting method works most efficiently with a greenhouse, but is possible outdoors.

Different researchers and nursery operators have come up with various modifications of the Frolich method. Rooting hormones, especially indolebutyric acid (lBA), are often added in solution or as powder to cuts in the base of the etiolated stem. Containers and rooting media have varied widely. Individual experience has led to some high success rates.

Grafting Methods.

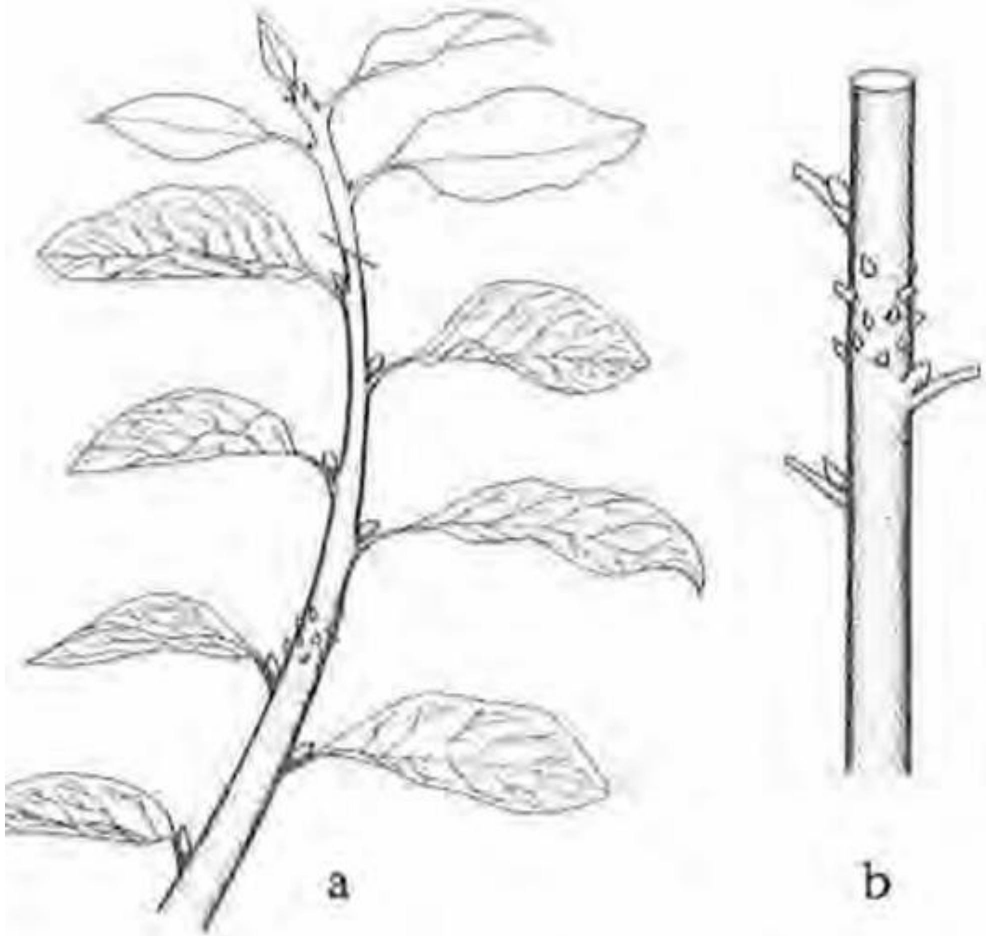
Small-cleft. Most avocado greenhouse propagation in California today uses the small-cleft graft, also referred to as a wedge or a tip graft. Compared to the larger, outdoor cleft grafts, in which only one side of the scion matches its cambium with that of a much larger stock, both sides of the small-cleft scion usually match with the cambium of the similar diameter stock. The method is conducive to speedy grafting; a talented propagator can make 600 or 700 grafts a day, with a success rate of 90 percent or better. Suitable scions are about 3/16 to 1/4 inch in diameter. The scion should begin to grow in 4 weeks or less.



Cleft or tip graft for avocado propagation. Wrap with budding or plastic tape. Put tree seal on top of scion.

(Costa,1989)

Source of vegetative buds for avocado grafting (Costa, 1989).



A young avocado tree in a plastic sleeve ready for orchard planting.

See more nursery techniques and topworking techniques at Costa, Jim.1989. Propagating Avocados. Publication 21361. University of California. Division of Agriculture and Natural Resources.

Micropropagation of Avocado in California.

(Anonymous, 2022).

Avocado trees can be propagated faster and in greater numbers with micropropagation (tissue culture). See the reference above for the latest in micropropagation for California avocados.

At this time (Spring 2022), more than 50 cultivars and rootstocks have been successfully established. The group has successfully started the first avocado in vitro repository in the United States with more than 15 genotypes. The Huntington Botanical Garden, San Marino, CA in partnership with the University of Queensland, also developed the first cryopreservation protocol for avocado clonal materials and will continue studies in an effort to establish the first cryobank for this crop.

Avocado clonal propagation is very slow and labor intensive, which places limits on the trees' availability and increases the costs of new trees. To address these challenges, the California Avocado Commission partnered with The Hun tington Botanical Gardens to explore how clonal micropropagation can be improved in order to increase plants' availability and decrease their cost.

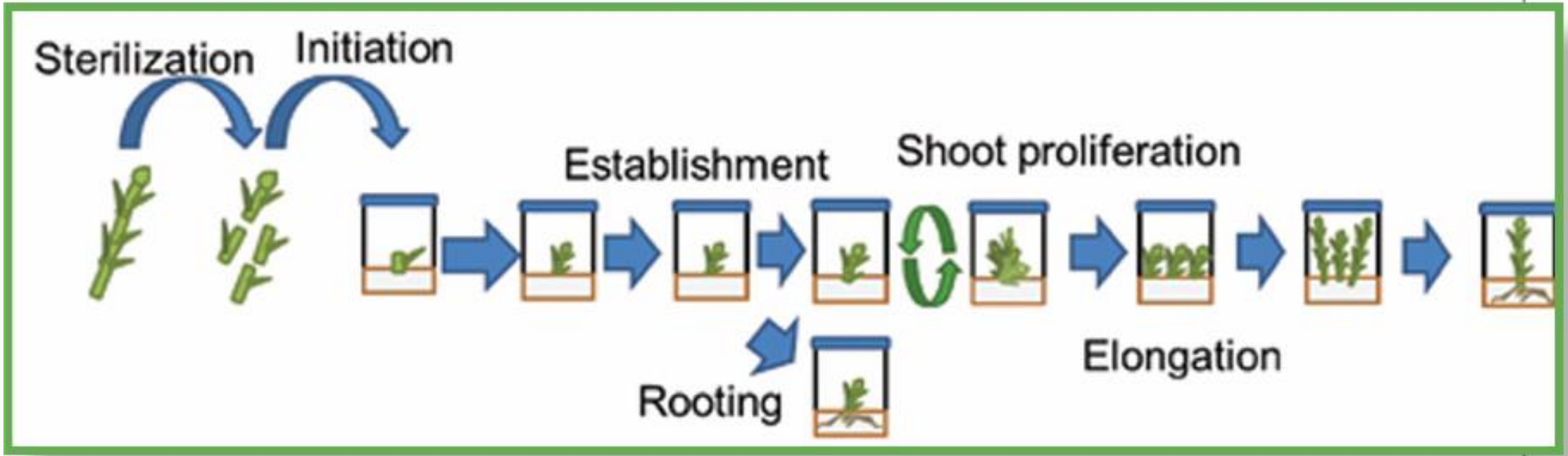


Figure 1. An illustration of the avocado micropropagation system developed by the Huntington Botanical Gardens. Illustration by Dr. Raquel Folgado, HBG.

Figure 2. In vitro avocado shoots at the initiation and establishment phases. Photos courtesy of Dr. Raquel Folgado, HBG.

Figure 3. In vitro avocado shoots at the propagation stage. Photo courtesy of Dr. Raquel Folgado, HBG.

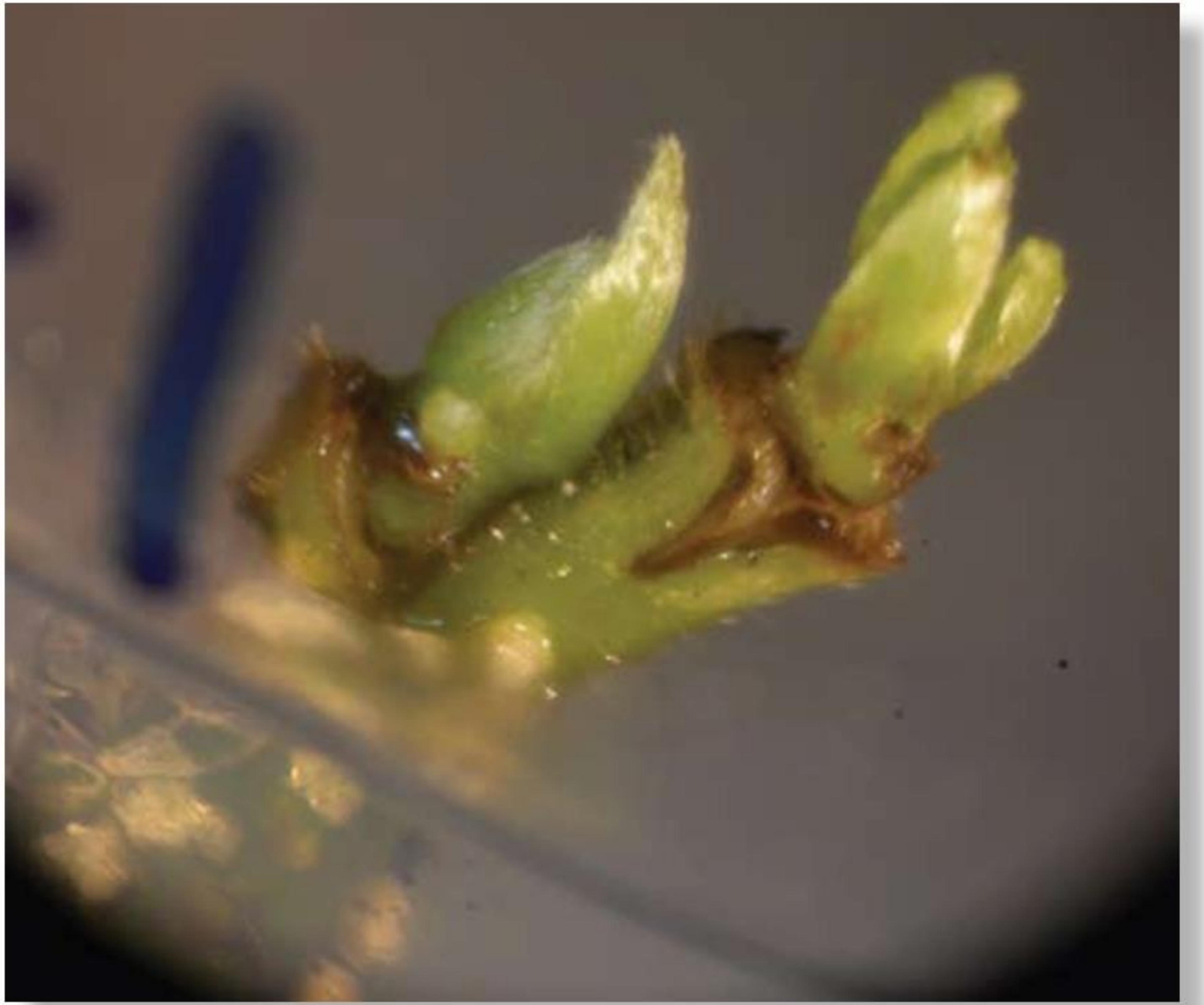


Figure 4. Examples of avocado micrografting. Shoot tips are dissected and grafted in tissue-cultured rootstocks. Photo courtesy of Dr. Raquel Folgado, HBG.

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Chapter 5. Avocado Pollination and Fruit Set (McGregor, 1976)

Avocado trees have male and female flower openings. Nature has provided for avocado cross-pollination by creating two kinds of botanical varieties. The A type flower is functionally female in the morning of the first day and functionally male in the afternoon of the second day, if the weather is warm. The B type flower is functionally female in the afternoon of the first day and functionally male in the morning of the second day, as diagrammed below. Since different flowers open on different days, the two types of avocado cultivars complement each other with their diurnal synchrony. Both are functionally female on their first day and functionally male on their second day, but they differ in the time of day that they are male and female. A variety of one type provides pollen (functionally male) when a variety of the other type is receptive (functionally female). Therefore, the pollination and fertilization necessary for fruit set can occur. See figure 4 and tables 1 and 2 below. (Bender et al 2015)

Type A flowering takes 36 hours, type B 20 hours. See table 1. The female stage for type A takes 2-3 hours, male for type A several hours. A and B varieties are listed in table 2. (McNeil, 1997)

Type A & Type B Avocados Explained) ~ Homestead and Chill.com

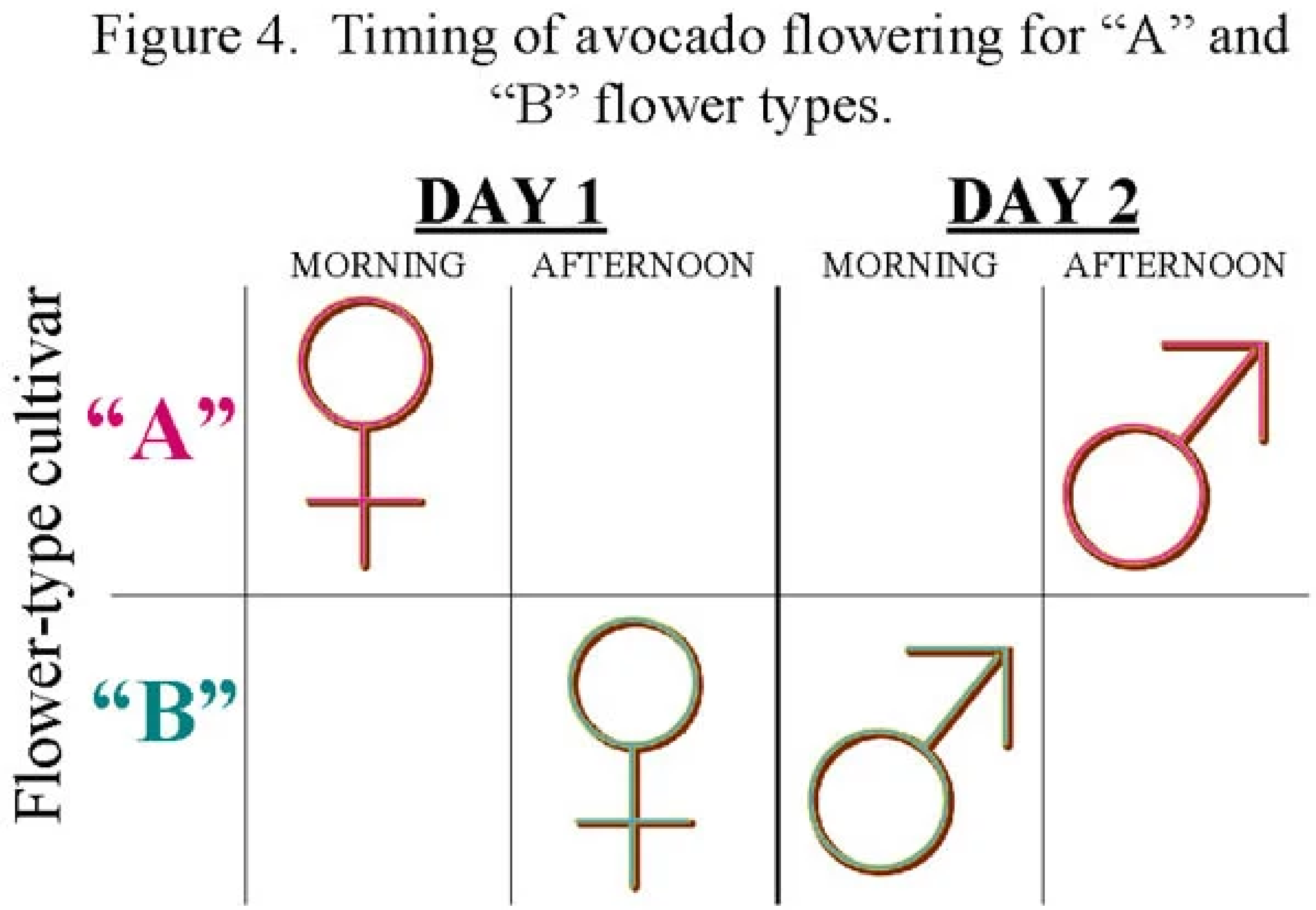


Table 1 Avocado flower opening sequence under 'ideal' temperatures (maximum 25°C and minimum 20°C) for flowering types A and B

https://www.agric.wa.gov.au/spring/growing-avocados-flowering-pollination-and-fruit-set (Adapted by McNeil, 2024)

Flower t	Day 1 Morning	Day 1 Afternoon	Day 2 Morning	Day 2 Afternoon

https://www.agric.wa.gov.au/spring/growing-avocados-flowering-pollination-and-fruit-set

All avocado varieties are cross and self compatible (McNeil, 1997). See more at (https://www.agric.wa.gov.au/spring/growing-avocados-flowering-pollination-and-fruit-set)

Table 2 Flowering classification of common avocado varieties

Flower type A	Flower type B
Anaheim	Bacon
Gwen	Edranol
Hass	Ettinger
Hazzard	Fuerte
Lamb Hass	Zutano
Pinkerton	Nabal
Reed	Nobel
Rincon	Sharwil
Wurtz	Luna
Gem	Shepard
Harvest	

Temperature Effects on Avocado Fruit Set (McNeil, 1997)

Avocado Pollination Problems Affecting Some Varieties:

Less than 60 F mean temperatures (Cool coastal areas):

Delays female opening of B varieties too late in the evening for honeybee activity.

Also may inhibit pollen tube growth and fertilization needed for fruit set. Cukes may form especially for Fuerte variety, a B variety sensitive to cool and hot temperatures.

60-70 F mean temperatures: Much variability of male and female stages. Could get more or less overlap of male and female flower stages.

70 F mean temperatures: Clocklike exactness of male and female stages. Usually 5-10% overlap of male and female stages, enough for a good crop.

More than 70 degree F mean temperatures: Much variability of male and female stages. Could get more or less overlap. More or less fruit set. Cukes may form especially for Fuerte variety, a B variety sensitive to cool and hot temperatures. May inhibit pollen tube growth and fertilization if too hot.

https://homesteadandchill.com/20-avocado-varieties-type-a-b-explained.

While ideal, it is not absolutely necessary to have one of each type, A and B. Most avocados varieties are considered "self-fruitful" and therefore do not need a partner tree for cross-pollination. Even without cross-pollination, they should develop some avocado fruit. Hass and Reed are particularly good at providing a decent crop when grown alone. On the other hand, having that opposite Type A or Type B partner tree around guarantees a much larger and more successful crop.

It has been said that avocado cultivars when grown alone will have 5-10% overlap of male and female flower stage openings (McNeil, 1997). 10% of 3000 flowers per tree will yield 300 fruit per tree, 150 lbs or 16,350 lbs per acre for 109 trees per acre at 20x20 feet spacing. 5% of 3000 flowers will yield 150 fruit per tree or 8,175 lbs per acre, all without cross-pollination.

Pollinating Insects (Some adapted from Bender et al 2015) (https://industry.nzavocado.co.nz/progress-towards-developing-new-pollination-options-for-growers-part-1-bumble-bees)

Honeybees are required for avocado tree pollination, 1-4 hives per acre. Bumble bees are also effective for avocado trees in California (McNeil and Pidduck, 2003) and Israel, especially if honeybees have not been effective. But bumblebee hives are much more expensive to rent.

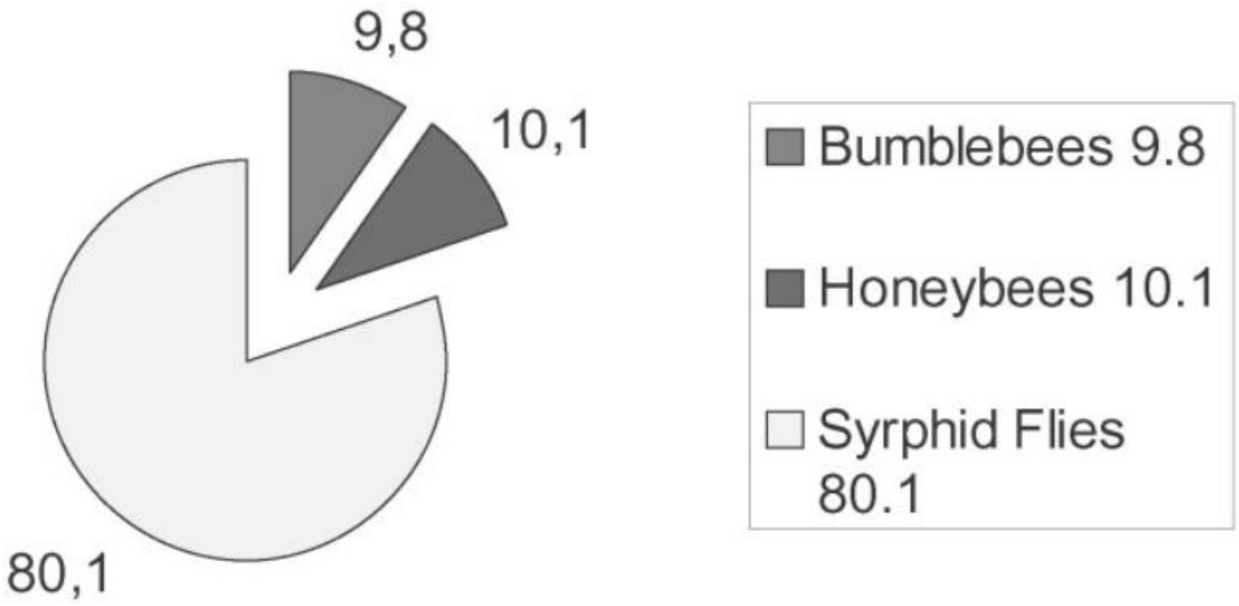
Bumble bees are common across the country and are produced commercially to pollinate greenhouse tomatoes. Bumble bees can transfer large amounts of pollen between flowers and continue foraging in inclement weather conditions that might deter honey bees. Using bumble bees to complement honey bee pollination is likely to be a significant advantage for avocado production.

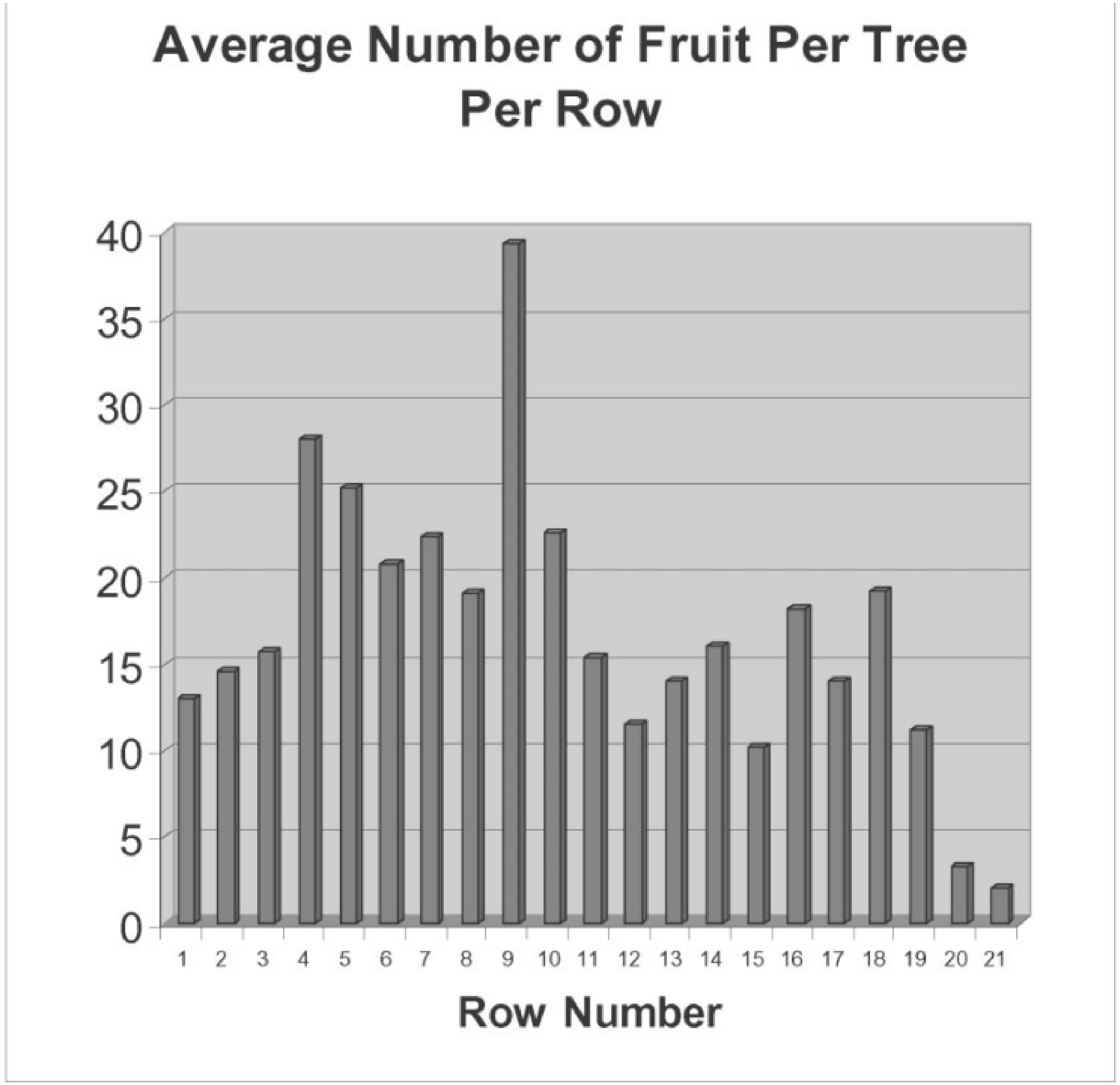
McNeil and Pidduck (2003) Bumblebee research on avocados. CalPolySLO.

ABSTRACT

There has been recent interest in the use of alternative pollinators for the Hass avocado in Cali fornia. Eight bumblebee hives were placed in the middle of a .86 hectare (2.125 acres) block of 2-year old Hass avocado trees during bloom in May. Numbers of three types of pollinating insects (bumblebees, honeybees, and syrphid flies) visiting blossoms were surveyed for three weeks. The number of fruit set on each tree was counted in the next winter. Percentages of insect pollinators visiting blossoms were 9.8% for bumblebees, 10.1% for honeybees, and 80.1% for syrphid flies. Fruit numbers per tree were greater in four out of six rows within 16.46 meters (54 feet) of the bumblebee hives than they were for trees in rows further from the hives. This was statistically sig nificant for three of these rows. This study demonstrated that the western bumblebee (Bombus occidentalis) will pollinate Hass avocado flowers and thereby increase fruit numbers per tree. A hive spacing of 32.92 meters (108 feet) is recommended for young trees. Pollinator counts are in the figure below. Number of fruit per tree per row are in the second figure below. It is not known whether syrphid flies pollinate avocados effectively.

Percentages of Pollinators Viewed





Row 7 = hive row; bumblebee hives in middle of row

Row 4,5, and 9 = rows with significantly higher fruit numbers per tree than the average per tree for the block

Bumblebees will work in inclement weather, cold or wet. The author observed a bumblebee visiting fruit tree flowers in his yard in New Jersey at 39-40 degrees F. Honeybees will not work at such cold temperatures.

Wild bumble bees already contribute to pollination, but their contribution is currently unmanaged. Because bumblebee colonies are much smaller than honeybee colonies, the challenge is to provide sufficient colonies in orchard environments to make a significant contribution.

Read more about bumblebees for orchards at https://industry.nzavocado.co.nz/progress-towards-developing-new-pollination-options-for-growers-part-1-bumble-bees.

https://avowest.com.au/wp-content/uploads/2020/02/3-Bees-20191200px.jpg

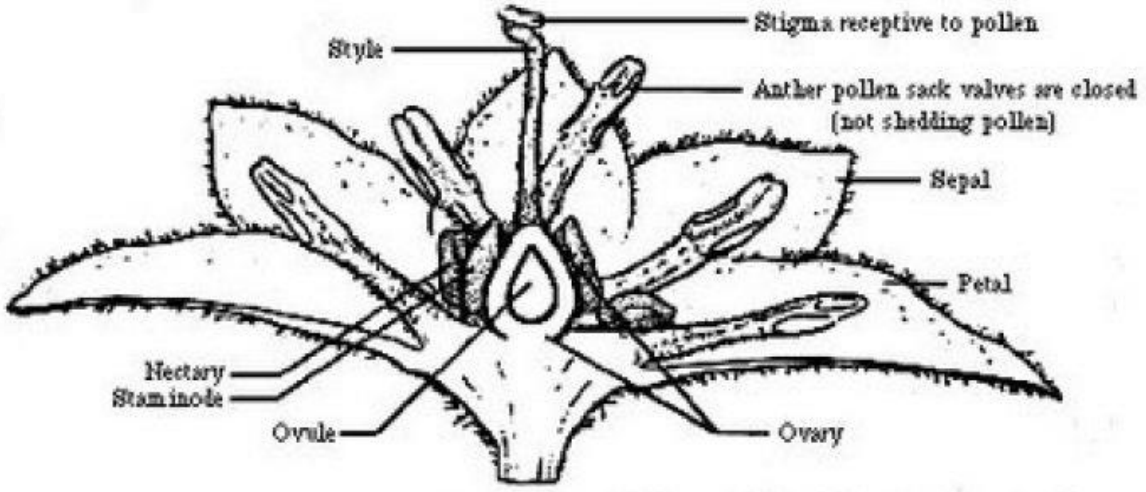
Honeybee visiting avocado flowers in female stage.

AVOCADO FLOWERS

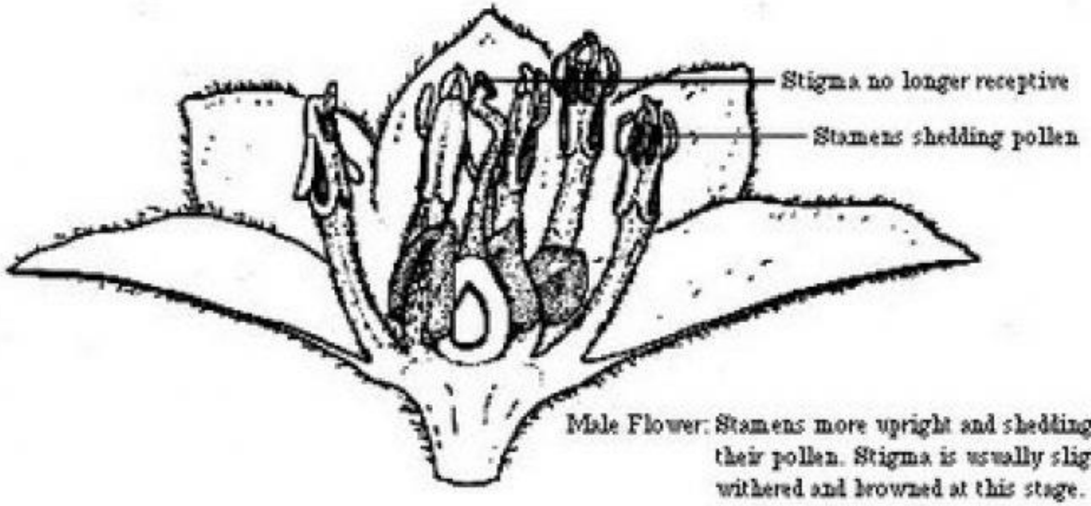
(Yahoo.com)

Diagrammatic representation of the female and male phase flowers in avocado

Note that in the female phase the petals and the male portion of the flower (stamens) are reflexed down and laying flat. In the the male phase the stamens are upright.



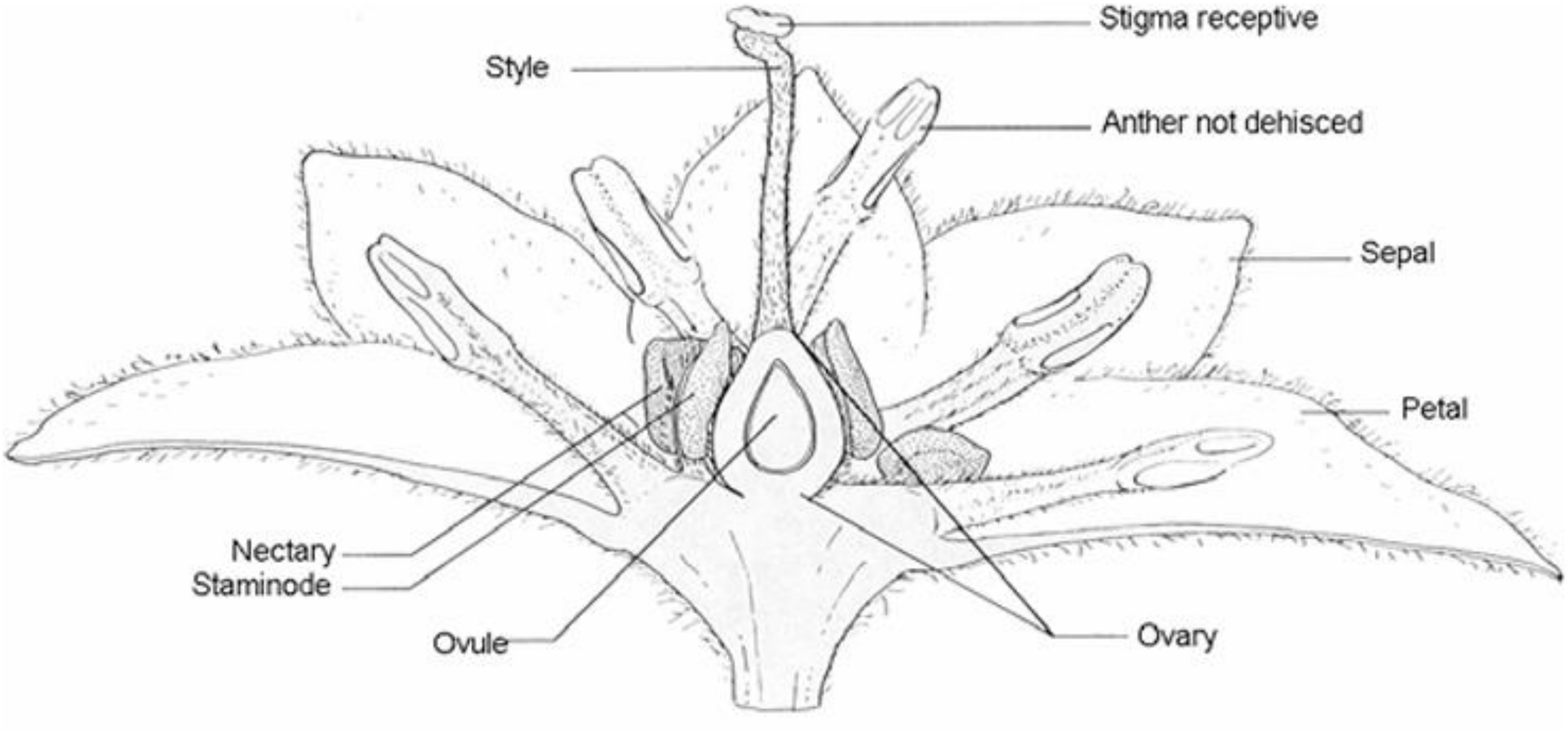
Female Flower: Pistil stands alone with stigma receptive. Stamens bent outward and anthers not shedding pollen



Male Flower: Stamens more upright and shedding their pollen. Stigma is usually slightly withered and browned at this stage.

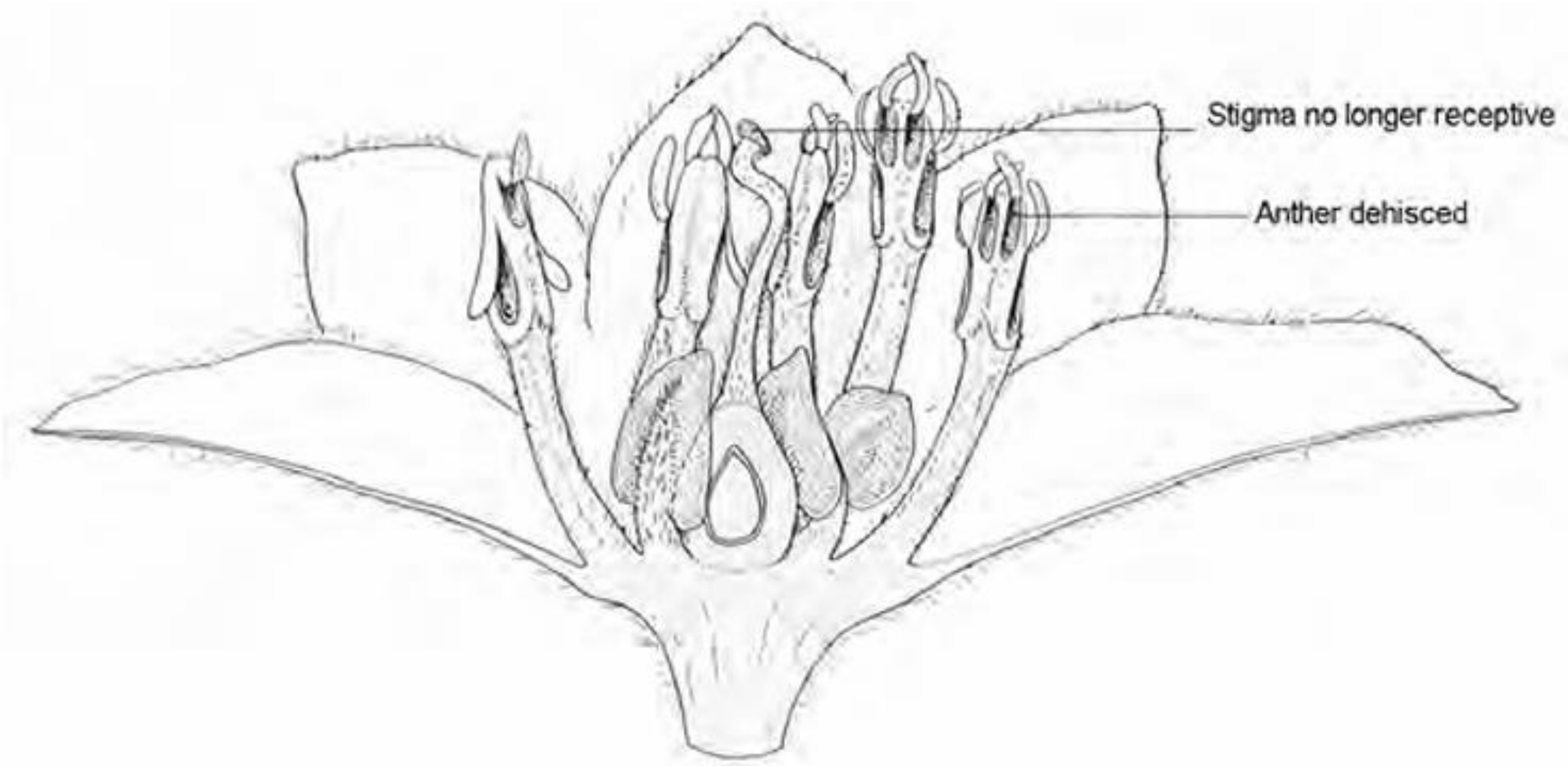
Taken from McGregor, S. E. 1976. Insect Pollination of Cultivated Crop Plants. USDA Agric. Handbook. No. 496

Female avocado flower stage **(McGregor, 1976).**



Avocado Female Flower Stage. Stigma White and Receptive. (Growingfruit.org)

Male avocado flower stage (McGregor, 1976).



Male Stage. (https://www.agric.wa.gov.au/spring/growing-avocados-flowering-pollination-and-fruit-set)

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https://www.ars.usda.gov/ARSUserFiles/20220500/OnlinePollinationHandbook.pdf

Chapter 5: Tree Fruits & Nuts and Exotic Tree Fruits & Nuts

AVOCADO Persea americana Mill., family Lauraceae

The avocado is grown primarily in California, to a lesser extent in Florida, and on only a few acres in Hawaii, Puerto Rico, and southern Texas. Crop production in 1970 amounted to 83,400 tons valued at $30 million. California produced 64,600 tons and Florida produced 18,800 tons.

On mature trees, about 2 tons of fruit per acre are harvested, although productive orchards will yield 3 to 6 tons. Year-to-year production varies, depending upon many factors, but a year of high production is frequently followed by a year of low production. Weather has a strong impact upon production. Prolonged cool weather, subfreezing weather, low humidity, strong winds at flowering time, or tornadoes can all result in low set of fruit and low production. The most critical effect of temperature occurs during flowering.

Plant:

The avocado is a tropical evergreen, upright shrub or tree that grows to 60 feet high, but usually between 15 and 30 feet in height (fig. 46). Its dark green leaves are 4 to 10 inches long and 2 to 3 inches wide. The plant may exhibit two or more growth flushes during the year in contrast to the single growth period of most deciduous plants. It may flower in summer or in winter, and may have a flowering period lasting 6 months. It is less tolerant of cold than lemons or navel oranges and prefers high humidity and calm weather. The fruit, which can remain on the tree for several months after maturity, is a nutritious, fresh food rich in oil and high in calories and vitamin E. A few seedling dooryard trees are estimated to be 100 years old, but commercial trees last about 35 years (Goodall et al. 1970). Hundreds of cultivars have been tried in the United States, but about two dozen are of commercial importance (Rowland 1970)

The cv. 'Fuerte' has for years provided the bulk of the avocado crop (Bergh et al. 1966, Rock and Platt 1968, Rowland 1970). Its fruit weighs 8 to 16 ounces and contains 18 to 28 percent oil. It is cold resistant and ripens over a long period - December to May. By comparison, the Florida cv., 'Pollock', weighs 30 to 50 ounces and contains only 3 to 5 percent oil. The ‘Hass' cv. was second in importance to 'Fuerte.' Its fruit weighs only 6 to 12 ounces. Other important California cvs. include the 'Bacon', 'Zutano', 'Rincon', 'Nabal’, 'McArthur', 'Anaheim', 'Carlsbad', 'Dickinson', and 'Puebla'. In Florida, the most important cultivars include 'Booth 8', 'Lula', 'Booth 7', 'Waldin', 'Pollock', end 'Hickson' (Rowland 1970).

Avocados can be grown from seed, but the plants are usually propagated by grafting. They are set in the grove 20 to 40 feet apart depending upon whether the type of growth is spreading or upright. Sometimes they are set at 15 to 20 feet with the alternate plants removed after a few years. Older orchards with spreading trees may have as few as 40 trees per acre. Orchards with upright trees may have 150 trees per acre. About 90 trees per acre is average (Lee and Burns 1967). Fruit bearing begins at 3 to 6 years of age and may continue for 50 or more years.

The honey bee is attracted to the plant for both the nectar and the pollen, although citrus, mustard, and many other plants that flower at the same time as avocado are much more attractive to bees than are avocado flowers. Pellett (1926, 1947*) reported that bees collect only a small amount of avocado honey. Vansell (1931) stated that avocados are visited moderately by bees for nectar and pollen. In general beekeepers consider the plant as a source of buildup for their bees rather than as a source of surplus honey.

Inflorescence:

A full-grown avocado tree may bear a million flowers in a season, the flowers occurring in panicles of several dozen to several hundred on the ends of the numerous branches (Robinson and Savage 1926).The relatively inconspicuous blossom is about one half inch in both width and depth. Three sepals and three similar-appearing green petals make up the perianth. The single pistil has a simple, bulbous, smooth ovary and a somewhat elongated style terminated by a slightly enlarged stigma. There are nine stamens inserted in two whorls. The inner whorl consists of three stamens, with three prominent, orange, nectar-producing staminodes (sterile or abortive stamens) alternating between them. Opposite each stamen and staminode of the inner whorl is one of the six stamens of the outer whorl. There is an orange nectary, slightly smaller than the staminode, on each side of each outer stamen. The flower opens twice, on subsequent days or in two stages. In stage 1, the first receptive to pollination (Hodgson 1930), but the stamens, bent out at right angles to the pistil, release no pollen. Some nectar appears on the staminodes. After a few hours, the flower closes.

In stage 2, the second day, the flower opens again. This time, nectar on the six true nectaries is secreted more profusely than occurred on the staminodes. The pistil is shriveled and dark and no longer receptive. The stamens are longer and larger, the inner three overtopping the stigma but facing away from it, and the outer stamens at about a 45 deg angle from the style and facing it, and both sets releasing sticky clumps of pollen. Each stamen has four pollen sacs, the valves of which hinge at the top. When the flower closes the second day, it never reopens. It is therefore, structurally bisexual but functionally unisexual. This dichogamous condition was first noticed by Nirody (1922) and enlarged upon by Stout and Savage (1925) and Peterson (1955a, b, 1956).

The unusual part about the avocado flower is that in some cultivars stage 1 occurs in the morning of the first day and stage 2 in the afternoon of the second day. These cultivars are referred to as type A. In other cultivars, referred to as type B, stage 1 occurs in the afternoon, and stage 2 occurs the following morning. If cultivars of both types are interplanted within the same orchard, pollen should always be available when the stigmas are receptive (Stout 1932, Robinson 1930, 1933, Ward 1933, Bergh and Gustafson 1958, Bergh and Garber 1964). At least one cv., 'Collinson', produces no pollen; therefore, it is incapable of setting fruit unless pollen is transferred to it from other cultivars that release pollen when its stigmas are receptive (Anonymous 1930).

If the temperature is too low, some flowers, for example, those on the 'Fuerte' cv., may fail to open in the female stage, making fruit set impossible. On the other hand, hot weather and low humidity are not conducive to fruit set. Also, too much disturbance of the flowers by wind can cause shedding. A mild climate with calm humid days is best for the flower. Bergh (1968) showed that trees set more fruit when there are flowers of different avocado cultivars nearby. This may not be true for all cultivars or all years, but such effects have been thoroughly demonstrated. For example, he showed that the 'Fuerte' and the 'MacArthur', which are considered to be self-fertile, increased production as much as 50 percent when exposed to pollen of other interplanted cultivars.

Avocado flowering may extend from one to several months depending upon conditions affecting fruit setting. A sufficient supply of pollinating agents will tend to shorten the period of flowering. The number of flowers that may set fruit has been variously estimated by different people. Purseglove (1968*) stated that only one in 5,000 flowers produces a fruit. Gustafson and Bergh (1966) considered that a set of less than 1 percent of the flowers is usually sufficient for a good fruit crop. Chandler (1958*) stated that flower clusters containing 1,000 or more flowers may be found on a branch less than a foot long in space enough for no more than two fruit. He stated that less than one flower in 500 [.2%] on a 'Fuerte' tree set fruit. If a tree produces a million flowers and there are 90 trees per acre, 90 million flowers should be produced. If one flower in 5,000 produces [.02%] a fruit that weighs 12 ounces, the grower should harvest 18,000 fruits, or over 6 tons per acre. That this is seldom done is a good indication that only a small fraction of 1 percent of the flowers produce fruit. [Actually .1% say others (McNeil, 1997).]

Pollination Requirements:

Peterson (1955b) showed that the pistillate stage, or stage 1, of the 'Rincon' cv. Type A was open for 3 hours 40 minutes, the maximum time in which pollination of this cultivar could take place. He showed that the flower was incapable of selfing because first flowering began at 7:25 a.m. and ended by 11 a.m.; whereas the second stage of the 2-day-old flower did not begin until 11 a.m., by which time the current-day stigma had withered and was no longer receptive. In the 'Zutano' cv., type B stage 1 extended from 2:50 p.m. to 6:20 p.m., and stage 2 (the next morning) from 8:40 a.m. until after 11 a.m. [All at 70 F mean temperature.] [Cool weather 60 F mean would make type B female stage open up too late in the evening when honeybees are no longer active. (McNeil 1997)]

When the flowers of type A, for example, 'Rincon' cv., are receptive to pollination, the pollen is being shed by flowers of type B, for example,'Zutano' cv. and when flowers of the 'Rincon' are shedding pollen, flowers of the 'Zutano' are receptive to pollination. This condition is considered by horticulturists to be highly fluid and influenced by the cultivars involved and various environmental conditions.

Peterson (1955a) showed that at least the 'Zutano' and the ‘Hass' cvs. were capable of setting fruit when isolated from other cultivars if honey bees were present in abundance. He caged four individual trees, two of each cultivar with one tree of each group in a cage with honey bees during the flowering period. When flowering was over, the bees and cages were removed and the fruit counted. The results concerning the treatment and fruit produced were as follows:

Cultivar

No bees in cage 'Zutano'...4 120

Bees in cage Hass...5 284

Whether the pollen was carried over on the bees from the normal time of anther opening until the time of stigma receptivity, whether the opening phases overlapped, or whether the bees forced open the anthers when the stigma was still receptive was not determined, but in any event the effect of the bees was striking.

The evidence is clear that avocados must be insect-pollinated, and that production is best when varieties are interplanted. Bees usually transfer avocado pollen no greater distance than two avocado rows (Bergh 1961). The varieties should intermesh in their blooming dates so that pollen is available on one cultivar when the stigmas on another are receptive, and vectors should be available to move the pollen to the receptive stigmas. Maximum set can only be achieved through adequate provision for cross-pollination - the interplanting of appropriate flowering types and the availability of adequate pollinating agents (Bergh 1969).

Pollinators:

Various pollinating agents visit the avocado flowers for nectar and pollen. These include the honey bee, various species of wild bees, wasps, flies, and hummingbirds (Chapman 1964*). The consensus of various research workers who have studied the flowering and fruiting of the avocado is that only honey bees are sufficiently abundant on the blossoms at all times to set satisfactory crops of fruit (Clark 1923,1924; Clark and Clark 1926; Boyden 1930; Traub et al. 1941; Lemmerts 1942; Lesley and Bringhurst 1951; Winslow and Enderud 1955; Lecomte 1961; Popenoe 1963). Many observers have noted that a bee tends to visit a single tree and thus fails to afford the cross-pollination desired. This can occur when the trees are separated by some distance, for example, when they are small or spaced too far apart (Bergh 1966). It also occurs when there is an insufficiency of bees in relation to the number of blooms available.

When the flowers per bee ratio is low, the bees are required to visit many flowers to obtain a load of food and their efficiency as cross-pollinating agents is increased. Ruehle (1958) stated that good crops are set consistently in groves a considerable distance from any bee hives but that the presence of bees would increase production. Wolfe et al. (1942, 1946) stated that it is quite possible that a hive of bees per acre with sets of five in the middle of each 5-acre tract would materially increase production. Popenoe (1963) stated that honey bees are probably necessary for good pollination unless there is an abundance of wild bees in the area.

In an excellent survey of the reasons for low yield of avocados in California, Bergh (1967) unequivocally stated: "Practically every avocado fruit set means that a honey bee transferred pollen to that flower from some other flower. Gravity or wind may act, but they are so rare they can be ignored by the practical avocado grower." Further on, he stated, "At the present time the California avocado industry is dependent upon the honey bee. The greater the bee population, the more likely the bees are to travel from flower to flower and so make the best of such inter-flower overlap in male and female stages as may be present. This is probably the chief source of avocado set in California."

Pollination Recommendations and Practices:

Peterson (1955a) stated that there was no evidence that addition of bees to the "natural population of wild bees and other large insects" would increase fruit set. He gave no indication as to the population of wild bees honey bees, or other large insects present on the trees. Wolfenbarger (1954) showed that honey bees were more abundant within 375 feet of a 64-colony apiary than at more remote distances, and more avocados were harvested per tree within 250 feet of the apiary than at a distance of 1,000 feet. Wolfe et al. (1946) and Ruehle (1958) recommended that one colony of bees per acre be used with five colonies set in the middle of each 5-acre tract. Stout (1923) recommended providing "bees in abundance" and control of other plants in the area that might attract the bees. LeComte (1961) suggested one colony per acre. Stout (1933) went even further by stating that one hive per acre for other fruit is satisfactory, but the flowering habits of the avocado make it desirable to employ more than one hive per acre to supply the honey bees in abundance.

Bergh (1967) stated that the average California avocado grower would have better crops if he would use more honey bees. He recommended that growers use two to three strong colonies per acre, the colonies placed in groups no more than one-quarter mile apart with 0.1 mile being preferable. Bergh (1967) made the following recommendations: (1) Place hives or have them placed by the beekeeper after the avocados begin blooming so the bees will "get the avocado habit" right away; (2) place hives in the grove if possible, at least avoid locations where the bees must fly past citrus or other attractive pasturage; (3) control other blooms, such as mustard; (4) avoid use of insecticides during the blooming season, (5) and for crosspollination, interplant types A and B to increase production 50 to 150 percent.

Thus, after careful study of the research by these scientists, one must conclude that for commercial production of avocados bees are essential, that honey bees are the primary pollinators, and that two to three colonies per acre should be used, the colonies placed within or alongside the groves, and that steps should be taken to insure protection of the bees and discouragement of associated plants attractive to them. The majority of avocado growers only passively encourage the keeping of bees in the area of their groves. Few if any actively contract for the bees or pay any type of pollination fee to insure the presence of adequate numbers. Many of them know that beekeepers usually move the colonies to the avocado growing areas to obtain nectar and pollen for buildup of the colonies. The bee population the beekeeper desires on the flowers for colony buildup, however, is far short of the population needed for maximum avocado pollination. Colonies vary enormously in strength and pollination effectiveness. Also, unless contracted for, the colonies may be transported to avocados when forest, range, or desert

conditions are unfavorable for beekeeping, but may be placed elsewhere at avocado flowering time if the other flora is more favorable. For dependable pollination and maximum avocado fruit set, the grower should see that his trees are amply supplied with strong colonies of honey bees.

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Chapter 6. Climate for Avocados

(https://www.google.com/search?q=climate+for+avoc)ados+growing)

Avocado trees (Persea americana) are tropical or subtropical plants that grow best in warm climates with moderate temperatures, humidity, and lots of sunlight. Some cultivars can withstand temperatures as low as 25°F (-4°C), but both low temperatures and high temperatures can restrict growing them. Avocado trees are especially vulnerable to temperatures above 104°F (40°C), and temperatures below 50°F (10°C) and above 86°F (30°C) can significantly impede growth. Signs of temperature stress include wilting, browning, or dropping leaves, or the tree getting leggy, bolting, or dropping its fruit.

Avocado Climate

Avocado trees grow best in USDA zones 9–11, but some varieties may tolerate zone 8 with extra protection. They can only survive outdoors in the southern parts of Florida or California, and in Hawaii and Puerto Rico. In other areas, you can grow avocado trees indoors in zones 4–11.

Avocado trees also require good soil, steady drainage, and a soil pH between 6 and 6.5. The soil should be sandy and well composted to ensure good drainage, and you should protect the trees from salt-laden winds in seaside locations. Avocado trees also need full sun and shelter from frost and strong winds. You can plant your tree in March through June, but if you plant during the summer, there is a risk of sunburn damage to the bark.

Avocado Climate

Avocado trees perform best in temperatures between 60°F to 85°F in areas with medium or high humidity. You can grow the tree outside if you live in one of the warmest parts of the U.S. Avocados grow in Hardiness Zones 8-11, and are only able to survive outdoors in southern parts of Florida or California, and in Hawaii.

Avocado plants thrive in soil temperatures between 68 and 77°F (20 and 25°C), whereas temperatures below 50°F (10°C) and above 86°F (30°C) significantly impede root growth. To bloom, these trees require a minimum of four weeks of cool weather in the fall and winter.

60-85°F (16-29°C) is the temperature range for avocado plant health. Avoid extremes: Below 60°F or above 85°F harms growth and fruiting. Monitor and adjust with tools like thermometers to maintain ideal conditions.

Avocado Climate (https://greg.app/avocado-temperature/)

Wilting, browning, or dropping leaves are telltale signs your avocado is being stressed. In the heat, it might get leggy, bolt, or drop its fruits like hot potatoes. Cold snaps, on the other hand, can turn leaves into a sad, brown mess, or cause parts of your plant to just give up and collapse.

Extreme temperatures are like a bad breakup for your avocado plant's growth cycle. Too hot, and the flowers might drop before they've even had a chance to bloom properly. Too cold, and you can kiss those baby avocados goodbye. It's a delicate dance between too much sun and not enough warmth, and getting it wrong can lead to a fruitless relationship.

Avocado Climate (https://greg.app/avocado-temperature/)

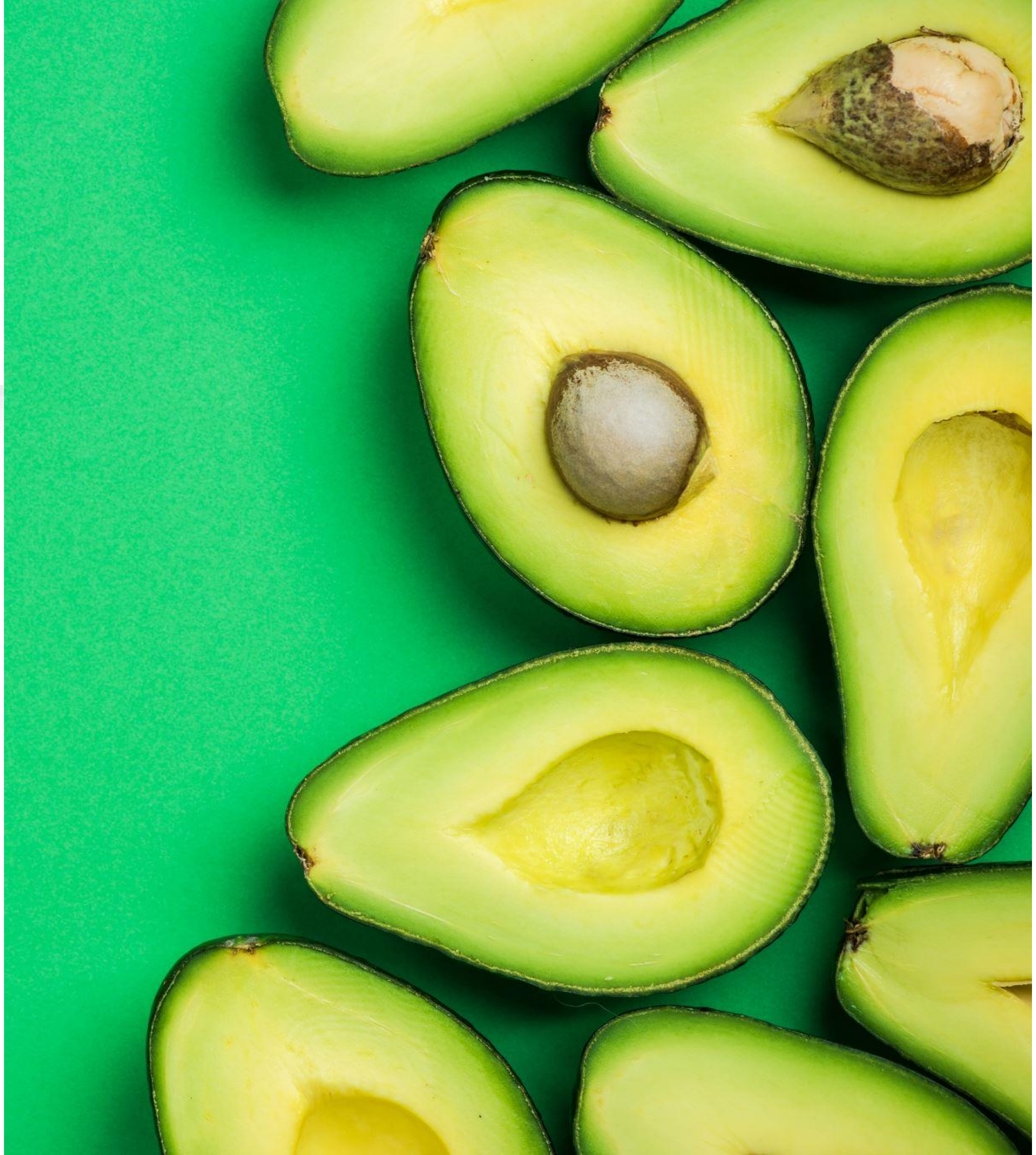
Avocado plants are sensitive when it comes to their comfort zone. Cold drafts, frost, and freezing temperatures can turn their lush green foliage into a brown, wilted mess. The chill can cause leaves to darken, collapse, or sport unattractive brown spots, especially on new growth.

Cold Damage. Avoid temperatures at or below 30 F especially for Guatemalan varieties (McNeil, 2024).

Freezing Damage Tolerances for Avocado Fruit. Calif Agr Code (McNeil, 1997) Count is now 10%.

<u>20% of Fruit, Flesh</u>

<u>15% of Fruit by Count</u>



Freezing Damage Tolerances for Avocado Fruit Calif Agr Code (McNeil, 1997). Count is now 10% according to USDA. See current CA Agr Code at https://regulations.justia.com/states/california/title-3/division-3/chapter-1/subchapter-4/article-11/section-1408-7/

% of Fruit, Flesh	% of Fruit by Count
20 %	15%

Frost Protection

One must know the freezing temperatures of the tree and the fruit to know when to protect them from freezing. Hass tree foliage freezes at 30 degrees F. Zutano at 26 F. Bacon at 24 F. Fuerte at 27 F.

Hass fruit can stand temperatures as low as 29°F for four hours before showing freeze damage in the fruit, Fuerte fruit can similarly withstand temperatures to 26-27°F before showing damage, and Bacon can withstand temperatures as low as 25°F before showing fruit damage. (Bender et al 2015.)

Maintaining the orchard at 31 F. will protect all the foliage and fruit.

(https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Frost_Control_Freeze_Damage_/Protecting_Avocados_from_Frost_/)

Variety Frost Resistance

Race. Typical varieties. Critical temperature below which fruit and/or trees are subject to damage.

Mexican: Duke,Topa Topa, Mexicola, Zutano, Bacon 25 Degrees F

Hybrids: Fuerte, Puebla 26-27 Degrees F

Guatemalan (Tender): Ryan, Hass, MacArthur, Nabal, Endranol, Rincon 29 Degrees F

Guatemalan (Very Tender): Anaheim, Dickinson, Carlsbad, Challenge, Hellen 30 Degrees F

Freeze Damage Symptoms

Citrus and avocado leaves appear wilted or flaccid during periods of low temperature. This is a natural protective response to freezing temperatures and does not mean the leaves have been frozen. Leaves will be firm and brittle and often curled when frozen. Leaves become flaccid after thawing, and if the injury is not too great, they gradually regain turgor and recover, leaving however, dark flecks on the leaves. Seriously frozen leaves collapse, dry out, and remain on the tree. Foliage from recent flushes are most susceptible to this damage. If twigs or wood have been seriously damaged, the frozen leaves may remain on the tree for several weeks. If the twigs and wood have not been damaged severely, the leaves are rapidly shed. Trees losing their leaves rapidly is often a good sign and is not, as many growers believe a sign of extensive damage.

Cold damage to the twigs appears as water soaking or discoloration. In older branches and trunks it appears as splitting or loosening of bark where the cambium has been killed. Bark may curl and dry with many small cracks. Dead patches of bark may occur in various locations on limbs and trunk.

Nick Sakovich: Citrus Farm Advisor. Ventura County, Ca.

Ben Faber: Farm Advisor. Soils and water, avocados and subtropicals, Ventura County, Ca.

Freezing Weather Conditions
(https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Frost_Control_Freeze_Damage_/Protecting_Avocados_from_Frost_/)

There are two freezing weather conditions, a frost and a freeze. How Frosts and Freezes Occur. Before considering the methods of frost protection, one should understand the conditions under which low temperatures occur. To differentiate between the two major sources of the cold, the terms local radiation frost and freeze are used.

Local Radiation Frost. Frosts are caused by a cooling of the objects on the earth's surface during the night. This loss of heat from the foliage and soil is called radiation. Heat accumulated from sunshine during the day is radiated to the sky during the night. The cooled objects chill the surrounding air and usually the coldest zone is near the ground surface. Air temperatures are warmer as one goes higher until a height is reached where they are at a maximum for that location. This is called the ceiling. The temperature and height of the ceiling is different for each plane and situation.

When the ceiling is low, warm air is nearer the ground than when the ceiling is high. This phenomenon, occurring frequently in Southern California, is called temperature inversion and accounts for this area's ability to protect its orchards.

Colder air settles near the ground and then moves (flows) down the slope to still lower ground resulting in what is called the drift.

Terrain features and winds influence its direction and velocity. A strong drift maintains air temperatures higher than those existing when little or no drift is present

Freeze

The other type of [advective] freezing weather occurs when a large mass of cold air moves in from the north. Fortunately, these freezes have not occurred frequently. The major ones were in 1913, 1922, 1937, 1949, and 1950. Under freeze conditions, temperatures usually go below those experienced during local radiation frosts. [Freezes have occurred in other more recent years.] When this cold air moves in, high ground is no warmer than lower ground and there is little or no ceiling. Orchard protection at such times are difficult and methods employing the addition of heat are most effective.

Wind machines will still protect during freezes. Exposed surfaces will undercool 1-3 degrees F or more below the air temperature by radiation cooling to the clear sky. The 1-3 degree or more warmer air will warm the undercooled exposed surfaces by 1-3 degrees or more. This has been observed many times. So operate wind machines during freezes even without a temperature inversion.

Measuring Temperatures

Orchard temperatures are usually measured with a specially designed self-registering minimum thermometer mounted in a standardized shelter. In this way, readings are comparable and experience allows the grower to use these air temperature readings in judging his hazard and operating his equipment. The height of the thermometer above ground should be five feet in mature orchards and two feet in nurseries and recently planted orchards.

Most orchards have areas that are colder than other areas. You should have enough thermometers to measure temperatures in each of these areas. In establishing thermometer locations in a new orchard, set up one thermometer in a permanent reference location. Move the other thermometers around every few nights until you find the cold spots. With this experience, you can locate and determine the number of thermometers needed. The range in numbers will be from a minimum of two or three for small groves to one for each three to five acres in larger orchards.

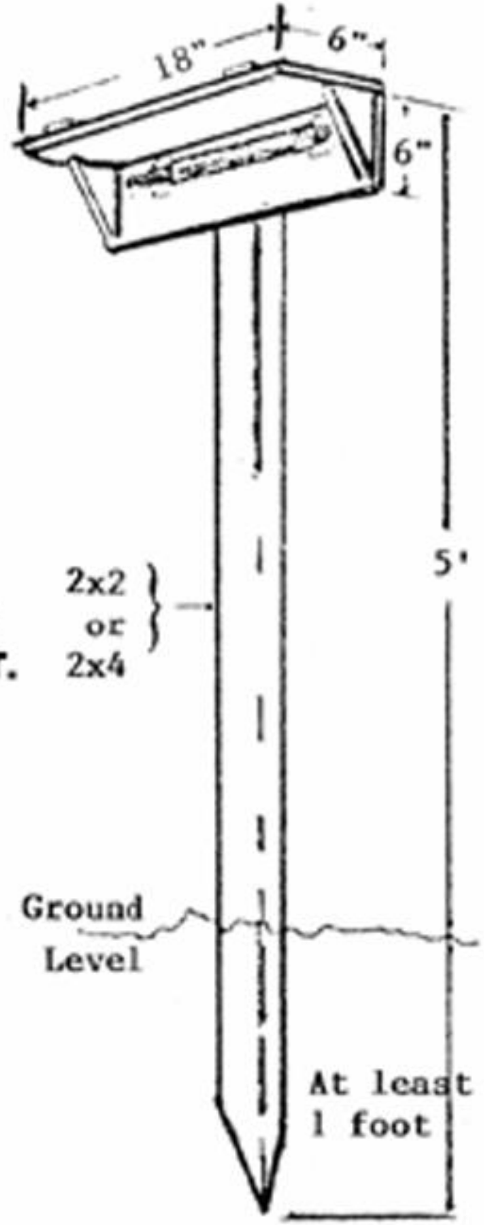
Sheltered Orchard Thermometer Station (Wikipedia.com)

A minimum orchard thermometer should be placed in a shelter covering it in the orchard. Only a single board needs to shelter the thermometer from the sky so it will not cool 1-3 degrees F or more below the air temperature by radiating heat to the clear sky and thus will show the actual air temperature. See simple station on next page.

Sheltered Minimum Thermometer Station

(https://www.avocadosource.com/books/AvocadoHandbook/FrostControl_files/protecting.pdf)

It shelters the thermometer from being exposed to the clear sky where it could under cool 1-3 degrees F or more below the actual air temperature. Position it five feet above the ground.



Standardized shelter for self-registering minimum temperature thermometer.

Taylor Minimum Orchard Thermometer. Will register the minimum temperature. Must be reset daily.


Freeze damaged avocado leaves (Bing.com). Dry and wilted

Effects of Freezes on Avocado Trees (Ca Avo Commission)

While healthy avocado trees can tolerate freezes between 30˚ F and 32˚ F, severe freezes are capable of destroying individual avocado trees — particularly freeze temperatures falling below 30˚F. The colder and longer the freeze, the greater the potential for damage to your avocado grove.

Facts about avocado trees and freezes.

Young trees are most susceptible to freeze conditions.

The most susceptible avocado tree parts are (from greatest to least): young growth (new shoot flush and flowers); young avocado fruit; small branches (one to two years old); mature avocado leaves; mature fruit; large avocado tree branches and trunk.

Certain avocado tree varieties are more susceptible than others (from greatest to least): West Indian (28˚to 29˚ F); Guatemalan (27˚to 29˚ F), Hass (25˚to 29˚ F), Mexican (21˚to 27˚ F). These are general-temperature indications only.

Avocado trees can recover from a freeze with correct cultural management.

https://www.avocadosource.com/books/Avocado

Handbook/FrostControl_files/protecting.pdf

Variety Frost Resistance		
Race	**Typical varieties**	**Critical temperature below which fruit and/or trees are subject to damage**
Mexican	Duke, Topa topa, Mexicola, Zutano, Bacon	25 Degrees F
Hybrids	Fuerte, Puebla	28 Degrees F
Guatemalan (Tender)	Ryan, Hass, MacArthur, Nabal, Endranol, Rincon	29 Degrees F
Guatemalan (Very Tender)	Anaheim, Dickinson, Carlsbad, Challenge, Hellen	30 Degrees F

Symptoms of freezes on avocado trees (Bing.com)

Firm, brittle, dead and curled leaves, with a brown or bronze hue.

Water-soaked/discolored small branches.

Larger branches and trunks can split and lose bark.

Discolored fruit, with bronzed to blackened skin.

Browned buds and flowers.

Fruit stems can be killed or ring barked, causing heavy-fruit drop.

TYPES OF INJURY

Fruit Damage

Fruit damage consists of frozen stems, frozen fibers inside the fruit, or frozen flesh and skin, depending on the temperatures and their duration. This damage appears slowly and is difficult to appraise accurately.

For some varieties, principally in the case of the Fuerte, the first evidence of damage will show up as a browning on the stem a few days after a frost. Mature fruit with only the stems frosted can be picked and marketed. Nearly every year some of the crop from frosted Fuerte groves is salvaged by picking all the fruit showing frosted stems as soon after the frost as possible. Unless this fruit is harvested, it will fall from the tree. Frozen fruit of other varieties, particularly the Guatemalan types, may never show the browning, but will drop anyway.

Frozen fruit fibers (vascular bundles) turn black and California law prohibits the marketing of all seriously damaged fruits. Before you pick mature frosted fruit, you should call in your marketing organization representative and local agricultural inspector to help you determine how much of the fruit should be harvested. By cutting representative fruit, they can tell whether it is within the legal tolerance or not, and guide you in marketing your fruit.

Severely frozen fruit may show brown water-soaked spots in the skin, gray areas in the flesh, and may even crack or split. It is unmarketable and will drop from the tree in time.

Tree Damage

Frozen blossoms, leaves, and twigs turn black within a few days. But larger wood, although frozen, may never turn black. Great variation occurs in the location of tree damage. In some cases, only the lower part of the tree will be frosted, while in other cases only the top part is affected. Sometimes, only a limb on one side will be frosted. Thus, it is impossible to evaluate accurately the extent of wood damage until new growth comes out the following spring and summer.

Trees suffering moderate wood damage usually will not bloom properly and will produce a reduced crop the following season. Occasionally, trees have been killed all the way to the ground by severe freezes.

Irrigate trees less when freeze damaged and do not prune until damage is assessed which may be one year later after regrowth.

Protect most Mexican variety fruit at 25 F.
Hybrids at 27 F. Most Guatemalan fruit at 29 F.
and most tender Guatemalan fruit at 30 F.

Cold Tolerance of Avocado Varieties-maintain the sheltered air temperature above these freezing temperatures to prevent tree and foliage damage. (McNeil, 2024)

Hass 30 F (Bender et al, 2015)
Fuerte 27 F (Bender, et al, 2015)
Bacon 24-26 F (Homesteadandchill.com)
Reed 30 F (Arpaia)
Pinkerton 30 F (Bender, et al, 2015)
Lula 27 F
Gem 30 F
Zutano 26 F (Homesteadandchill.com
Lamb Hass 29-30 F (Bender, et al, 2015)
Gwen 30 F (Arpaia)
Sir Prize 30 F (Homesteadandchill.com)
Holiday 30 F (Homesteadandchill.com)
Duke 20 F (Silva et al, 2002)

Jim 24 F (Silva et al 2002)
Mexicola 20 F (Silva et al 2002)
Stewart 20-22 F (Silva et al 2002)
Wurtz 30 F (Silva et al 2002)
Mexicola Grande 20-22 F (Homestead andChill.com)

Methods of Freezing Protection

Location. Locating the orchard on high ground will help protect the trees from freezing temperatures. Cold air drains from high to low ground because it is heavier than warm air. The avocado trees on Radio Tower Hill at CalPoly San Luis Obispo, CA have never frozen during severe freezes or frosts while those in the lowland have gotten damaged.

The CalPolySLO Avocado orchards on Radio Tower Hill in the lower part A of the photo. No frost protection needed there, warmer on high ground. The lowland lemons on the right B and avocados on upper left C have needed frost protection, both with wind machines. Frost protection needed there on colder lower ground. (McNeil, 2024)

Radio Tower Hill
Avocado Trees.
Estimated 200 feet
elevation.
No Frost Protection
Needed. Warmer on
high ground.

CalPolySLO Lowland Avocado Trees, Frost Protection Needed. Near Sea Level.

(https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Frost_Control_Freeze_Damage_/Methods_of_Frost_Protection_/)

Mature Orchards

Only two general methods of protecting avocado groves have proved satisfactory - heaters and wind machines. A combination of these two also is used. Many makes and designs of heaters and wind machines are offered for sale and they must be compared on the basis of protection provided and cost of installing and operating. This publication is limited to their general application in avocado groves. Their actual operation is discussed in other available publications of the University of California.

Orchard Heaters

Experience has shown that a large number of small fires burning throughout the orchard provide better protection than a few large fires concentrated in spots. The value of heaters is noted below to provide a basis for selecting the general type of protection needed.

Their advantages are:
They usually furnish more adequate protection than wind machines. However, in extremely cold conditions they, too, can be inadequate.
Only enough heaters to maintain safe temperatures need to be lighted.
Additional heaters and oil can be stored in the field for emergency conditions.
They distribute heat to all parts of the grove.

Their disadvantages are:
Smokiness. However, certain types have low smoke output when properly operated.
Relatively high costs of investment and operation.
Fire hazard due to mat of leaves beneath the trees.
Trouble and work of operation and maintenance.
High labor requirements.

For colder locations and positive protection, orchard heating is the only proven method. Pipe line heaters, using either heater oil or natural gas under pressure from permanently installed pipelines, are efficient but very expensive. Economical and effective heating is provided by heaters with 9-gallon capacity bowls and improved designs of stacks burning a low grade of diesel oil (No 2). Usually 45 to 90 heaters are used per acre depending on the frost hazard. Number 2 diesel oil may cost $450 to $900 per acre at $1 per gallon, $900 to $1800 per acre at $2 per gallon.

Orchard Heaters (Bing.com). A return stack orchard heater. All three air holes are closed on the bottom. One, two, or three air holes can be open for more heat. The high value of avocados ($10,000-20,000/acre may warrant orchard heater use.

Burning Rate for Return Stack Heaters (McNeil, 2001)

Number of air holes open	Burning rate (gal/hour)	Burning Duration (Total # of hours)
closed	.5	20
½	.6	16.7
1	.8	12.5
2	1	10
2 ½	1.2	8.3
3	1.4	7.1

Orchard Heaters (Bing.com) Heater spacing when used alone on next page.

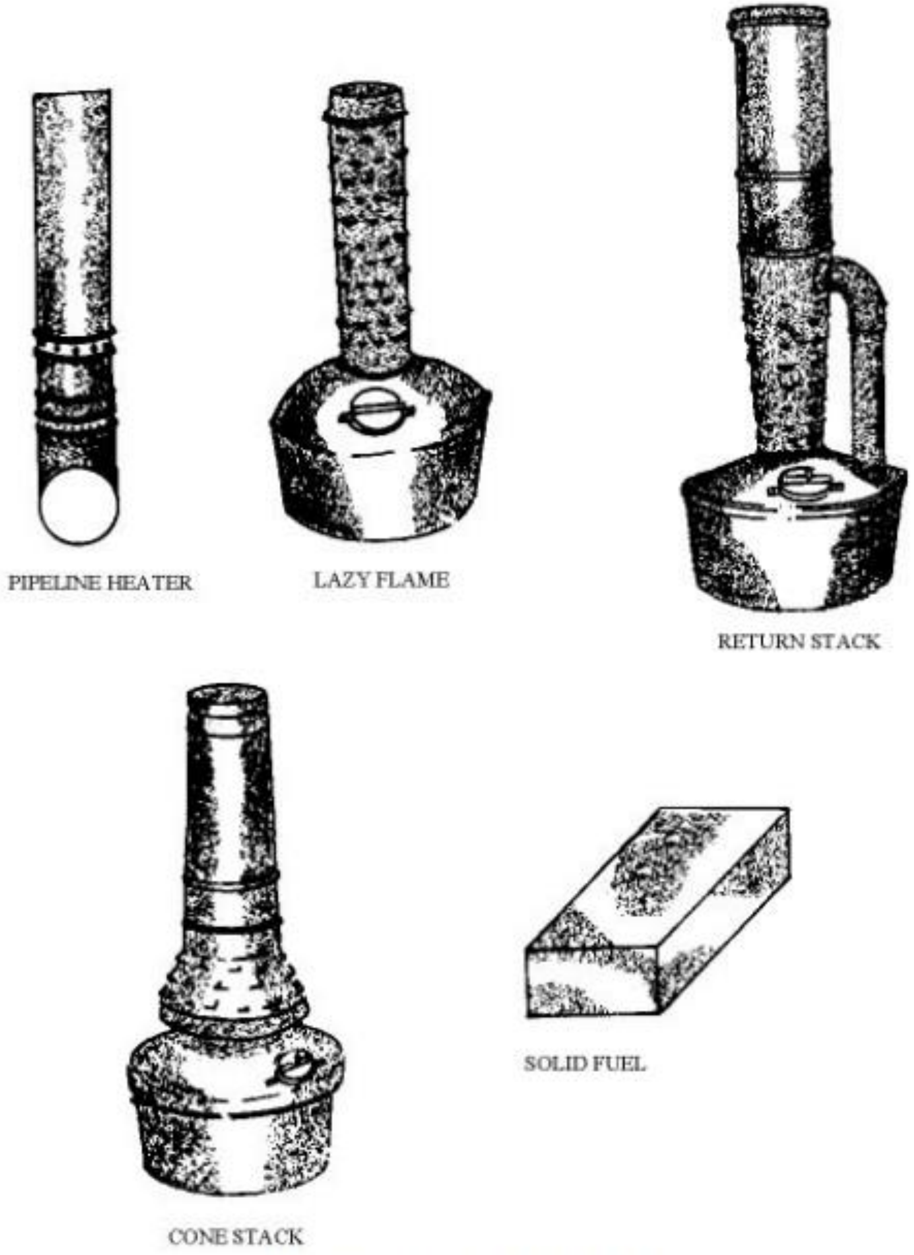
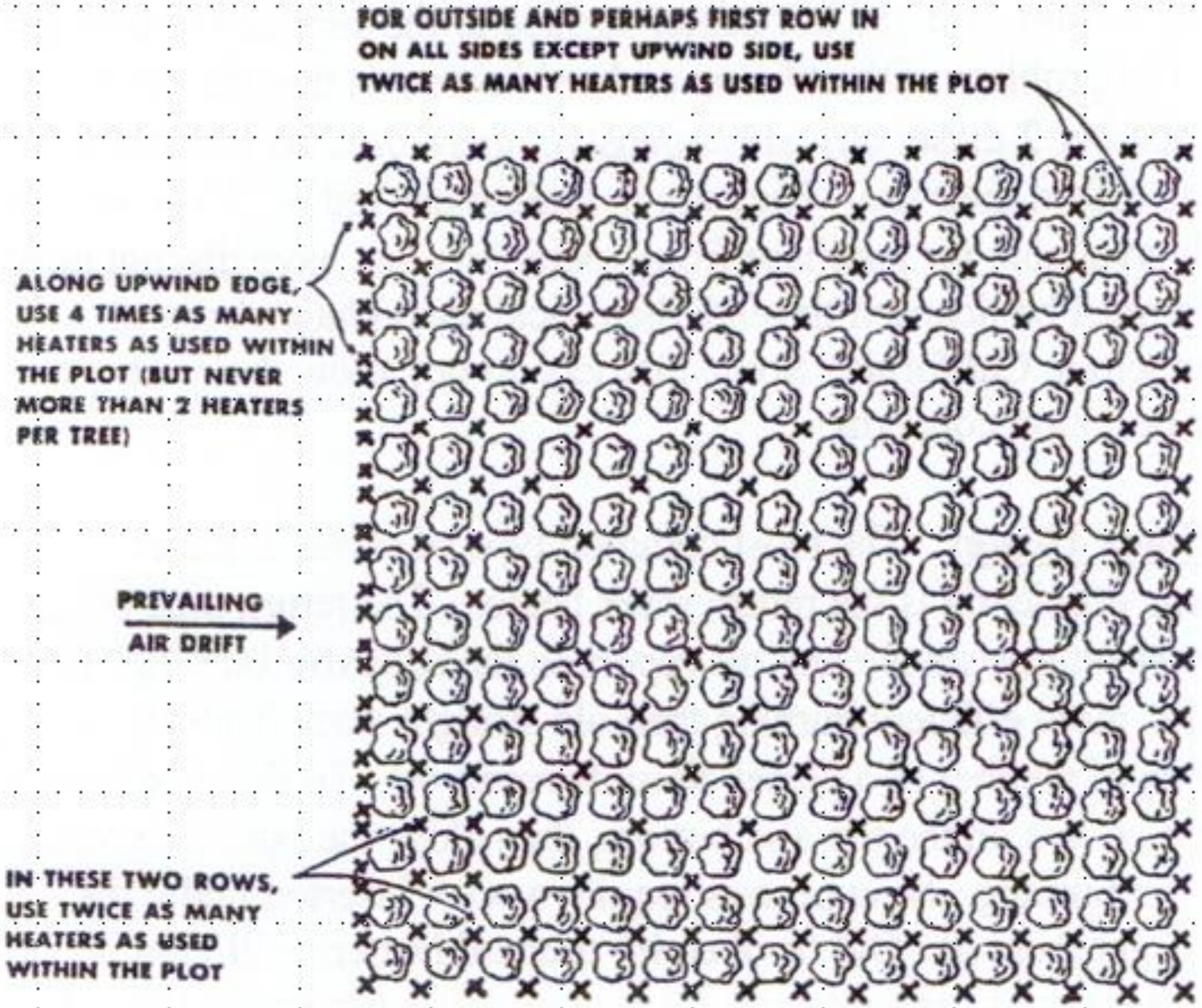


Figure 9.2.3-1. Types of orchard heaters.[6]



Typical example of border heater spacing, when using one heater per two trees within the orchard. Small crosses indicate heaters.

Taken from U.C. Bulletin No. 723, *Effectiveness of Orchard Heaters.*

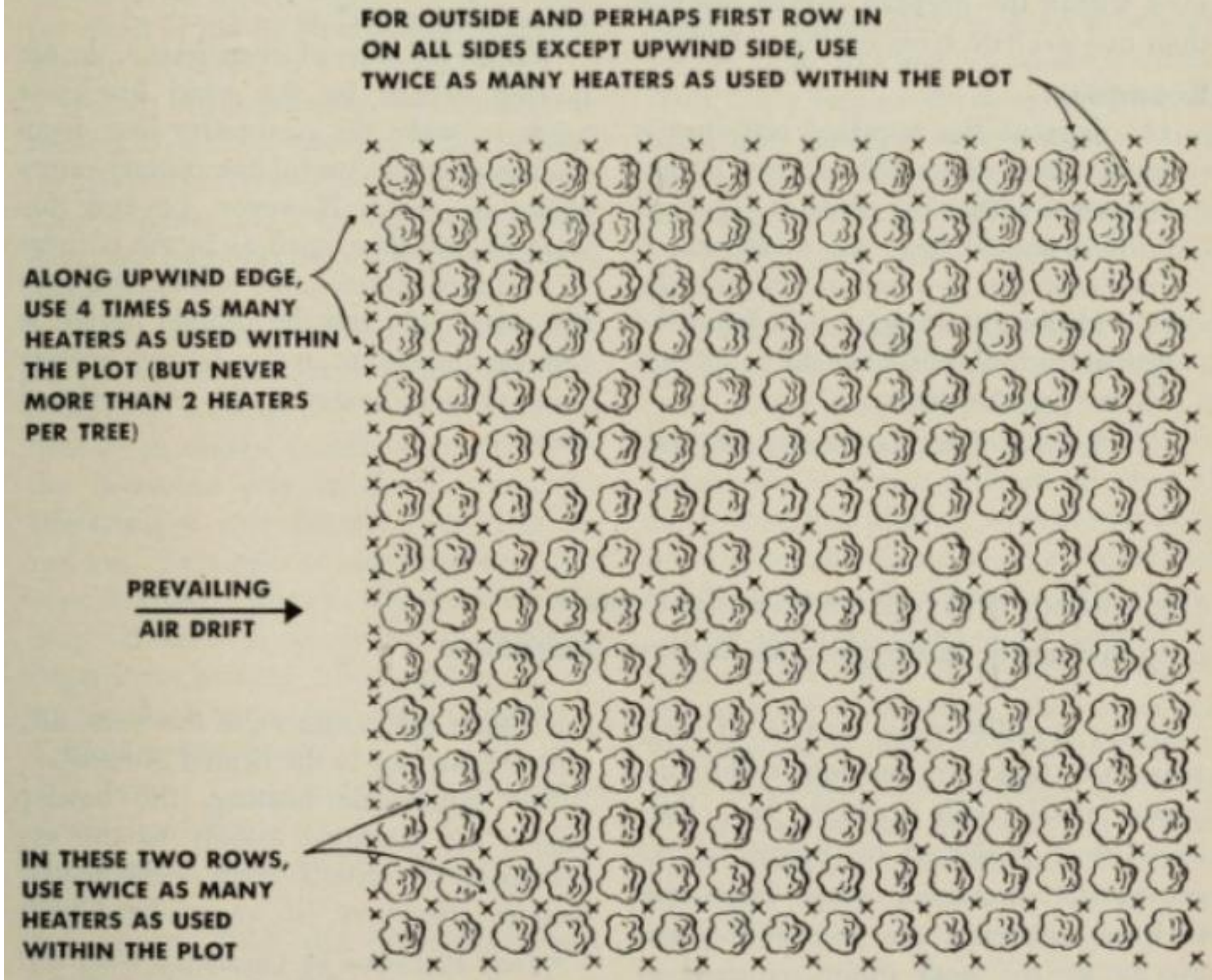


Fig. 19. Typical example of border heater spacing, when using one heater per two trees within the orchard. Small crosses indicate heaters. **(Univ of Calif Coop Ext)**

Wind Machines

In certain locations, wind machines have provided economical protection. Their effect is essentially that of a large fan which mixes the air within and above the orchard so that the average air temperature near the ground is raised. Their precise effects are not completely understood, but studies are being continued by the University of California. 5 brake hp is needed per acre.

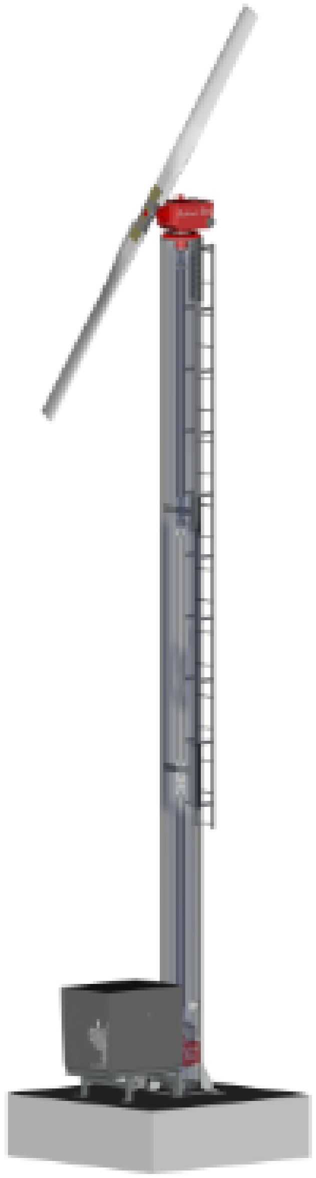
Their advantages are:
Most useful during frosts when there is an inversion layer (warm air above the orchard). But even effective during freezes without an inversion layer. [Helps prevent undercooling of exposed plant surfaces 1-3 degrees F. Blows warmer air on undercooled plant surfaces.]
More economical than orchard heaters.
Low labor requirements for operation.
Adequate protection against local radiation frosts when temperatures go only 2 or 3 degrees below the damaging point.
Useful in increasing air movement in groves where dead air occurs
Increases effectiveness of heaters.

Their disadvantages are:

Inadequate [less] protection with freeze conditions or when temperatures go 4 or 5 degrees or more below the damaging point.
Inadequate protection in locations where little or no ceiling occurs.
Unequal protection throughout grove.
Less effective in young plantings.
Machines providing at least 5 horsepower per acre should be selected on the basis of cost and ease of operation. The location of the machine or machines in an orchard depends on the drift, the topography, and the other variables. Consult other University of California publications for additional information.

Operate wind machines even during freezes with no inversion. Exposed surfaces will cool 1-3 F or more below the actual air temperature. Wind machines will blow the1-3 F or more warmer air onto the undercooled exposed surfaces. Has been observed many times.

Wind Machines (OrchardRite.com)
Power sources:
Electric (automatic)
Gasoline
Diesel
LP Gas



Combination Heaters and Wind Machines

Usually 8 to 25 heaters per acre uniformly scattered throughout the grove are sufficient when used with an effectively installed wind machine. The combination provides adequate protection for even the colder locations. The wind machine will protect the grove for some of the nights by itself, but for the very cold nights, the heaters are available to add heat and thus provide positive protection. Usually the heaters are lighted whenever the wind machines cannot maintain the temperatures above the danger point.

This combination method has the advantage over heaters used alone, in that it is cheaper, while providing more complete protection.

Irrigation

Do not irrigate frosted trees until the soil in the root zone approaches dryness. The loss of leaves reduces the use of water so the soil will remain wet longer than with unaffected trees. Careful, frequent examination of the soil is necessary to prevent excess moisture from normal irrigations. Avocado root rot occurs in soils with excessive moisture when the cinnamomi fungus is present, and growers must guard against this disease following frost damage.

Pruning

Do no pruning until you know how much of the tree has been killed. No foliage will grow from the remaining live wood and the tree will recover better without pruning.

When new shoots are at least two or three feet long, you can remove the dead wood. This will usually be mid-summer, 6 to 8 months following the frost. At the same time, suckers should be thinned out to select the new limbs to replace those lost. Large pruning cuts (3 inches or more) should be painted with an asphalt emulsion, or other sealing paint, to prevent drying and infection.

Water Application Methods (Sprinkler, Furrow, Flood). When to turn water on. (McNeil,1997) Turn on Temperature to Maintain 31 F at 30" Barometric Pressure:

Dew Point Range	Turn On Temperature
15-16 F	39 F
17-18	38
19-21	37
22-23	36
24-25	35
26-27	34
28	33

Frost Protection When to Turn sprinklers on and off (https://ucanr.edu/sites/Mendocino/files/17343.pdf)

Sprinklers have been used extensively for frost protection in California, and proper management is required to obtain beneficial results. One of the most critical decisions are when to turn the system on and when to turn it off. The decisions should be based on both temperature and humidity in the orchard. Recommendations given here can be used for either over-plant or under-plant sprinklers. Sprinklers can be turned on or off at higher, but not lower, temperatures than those recommended. All sprinklers in a protection area should be on when the temperature drops to a specified air temperature that depends on humidity and the "critical temperature" for crop damage.

A wet plant's temperature will not fall below the wet-bulb temperature, if sprinklers stop or if an application rate is inadequate. Consequently, starting and stopping sprinklers should always occur when the wet-bulb temperature is above the critical temperature for damage to the crop. Even if the sun is shining on the plants and the air temperature is above the melting point (O°C or 32 F), sprinklers should not be turned off unless the wet-bulb temperature is above the critical temperature. Permitting the wet-bulb temperature to exceed the melting point before turning off the sprinklers can be done safely- if soil waterlogging is not a problem.
The wet-bulb temperature can be measured directly with an instrument called a sling psychrometer or it can be determined from the dew point and air temperature (table 1).

The wet-bulb temperature is determined with a psychrometer by wetting the cotton wick and swinging the psychrometer (or aspirating with the fan) until the temperature of the wet-bulb thermometer stabilizes. If the temperature is below O°C (32 F), the water on the cotton wick should be frozen and aspirated until the temperature stabilizes. Touching ' the wick with cold metal or ice will cause freezing. Air temperatures for a range of wet-bulb and dew-point temperatures are given in Table 1. A wet-bulb temperature just above the critical temperature can be chosen and, if the dew-point temperature is known, the air temperature to turn the sprinklers on or off can be selected from table 1. If relative humidity and temperature figures are available instead of dew-point temperature, use table 2 to determine the dew point temperature; then use table 1 to obtain the desired air temperature.

Critical temperatures are specific to the crop being protected and sensitivity to frost damage during the growth stage when the frost night occurs. Generally, sensitivity increases from first bloom to the small nut or fruit stages when a crop is most likely to be damaged. Sensitivity is also higher when warm weather has preceded a frost night.

TABLE 1. Mlnlmum turn-on and turn-off air temperatures for sprinkler frost protection for a range of critical damage and dew-point temperatures * For OF 30 turn on at 37. Dew-point Wt-bulb temperature (OF) temperatures

(OF) 22 23 24 25 26 27 28 29 30 31 32
32 32
31 31 33
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'Select a wet-bulb temjxrature that is above the critical damage
temperature for your crop and locate the appropriate column.
Thcn choose the row with the correct dew-point temperature
and read the corresponding air temperature fmm the table to turn your sprinklers on or off.
This table assumes a barometric pressure of 1000 millibars.

TABLE 1. Minimum turn-on and turn-off air temperatures for sprinkler frost protection for a range of critical damage and dew-point temperatures*

Dew-point temperatures (°F)	Wet-bulb temperature (°F)										
	22	23	24	25	26	27	28	29	30	31	32
32											32
31										31	33
30									30	32	34
29								29	31	33	34
28							28	30	32	33	35
27						27	29	31	32	34	35
26					26	28	30	31	33	34	36
25				25	27	29	30	32	33	35	37
24			24	26	27	29	31	32	34	35	37
23		23	25	26	28	29	31	33	34	36	38
22	22	24	25	27	28	30	32	33	35	36	38
21	23	24	26	27	29	30	32	34	35	37	39
20	23	25	26	28	29	31	33	34	36	37	39
19	24	25	27	28	30	31	33	34	36	38	39
18	24	26	27	29	30	32	33	35	37	38	40
17	25	26	28	29	31	32	34	35	37	39	40
16	25	26	28	29	31	33	34	36	37	39	41
15	25	27	28	30	31	33	34	36	38	39	41

*Select a wet-bulb temperature that is above the critical damage temperature for your crop and locate the appropriate column. Then choose the row with the correct dew-point temperature and read the corresponding air temperature from the table to turn your sprinklers on or off. This table assumes a barometric pressure of 1000 millibars.

TABLE 2. Dew-point temperatures for a range of air temperatures and relative humidities

Relative humidity (%)	Temperature (°F)					
	20	25	30	35	40	45
100	20	25	30	35	40	45
90	18	23	27	32	37	42
80	15	20	25	30	34	39
70	12	17	21	26	31	36
60	8	13	18	23	27	32
50	4	9	14	18	23	28
40	0	4	9	13	18	22
30	−7	−2	2	7	11	15
20	−15	−10	−6	−2	2	6
10	−18	−24	−20	−16	−12	−8

To protect crops from frost, turn on sprinklers when the air temperature reaches 34°F. The sprinklers should operate continuously until the air temperature increases to above 32°F and the ice on the plants begins to melt. The critical temperature for crop damage depends on humidity.

Learn more at: https://smallfruits.org/files/2019/06/SRSFC-Weather.pdf and https://ucanr.edu/sites/btfnp/files/165673.pdf

(subtropicals)

https://smallfruits.org/files/2019/06/SRSFC-Weather.pdf

Irrigation for Frost/Freeze Protection: In using overhead irrigation for frost/freeze protection the heat lost from the plant part to its environment is replaced by the heat released when water changes to ice. Specifically, as one pound of water freezes, 144 BTU's of heat energy are liberated. This is called the latent heat of fusion of water. As long as liquid water is freezing on the plant at all times, the surface temperature will remain at or near 32° F. Adequate water must be applied to compensate for heat losses by radiation, convection and evaporation. If the irrigation rate is not adequate, the damage may be more severe than if no protection had been provided. If wind velocities are high and/or if relative humidities are low water may evaporate from the plant surfaces. If this occurs evaporative cooling will actually lower the temperature of the plant. As one pound of water evaporates 1080 BTU's of heat energy are absorbed from the surrounding environment. When compared to the 144 BTU's released by freezing it becomes apparent that 7 ½ times more water must be freezing than evaporating in

order to have a net heating effect. For this reason frost/freeze protection by irrigation is not usually recommended if wind velocities exceed five miles per hour. If the relative humidity is low, the sprinkler system should be started at a higher than usual temperature to compensate for the evaporative cooling that will occur as the first water strikes the plants. Typically, sprinkler systems should be started when the air temperature in the orchard reaches 34° F. It should operate continuously until the air temperature increases to above 32° F. and the ice on the plants has begun to melt.

Crops and Critical Temperatures:

The ultimate goal of frost/freeze protection is to prevent plant parts (particularly the flowers and fruit) from being damaged by temperatures that drop below the critical level. This critical temperature varies from crop to crop and also depends on the stage of flower and fruit development.

DESIGN OF OVERHEAD IRRIGATION FOR FROST/FREEZE PROTECTION **Overhead sprinkling for frost protection is not recommended for avocado orchards. Too much ice.** **(Personal comment. McNeil, 2024) Precipitation Rates and Sprinkler Spacing:The desired precipitation rate for adequate cold protection will depend on the crop to be protected. For low growing crops such as strawberries, the precipitation rate should be between 0.12 and 0.15 inches per hour; medium sized plants such as blueberries and grapes need 0.14 to 0.16 inches per hour; and large trees such as apples and peaches need 0.16 to 0.18 inches per hour. As a general rule precipitation rates should not exceed 0.2 inches per hour. At these high rates run-off becomes excessive and excessive ice build-up on trees causes increased damage from broken limbs. Table 2 indicates the degree of protection afforded by various precipitation rates at several wind velocities.**

Table 2. Precipitation Rates* for frost protection.

Minimum Temperature °F	Wind Speed (mph)		
	0-1	2-4	5-8
27	0.10	0.10	0.10
26	0.10	0.10	0.14
24	0.10	0.16	0.3
22	0.12	0.24	0.5
20	0.16	0.3	0.6
18	0.20	0.4	0.7
15	0.26	0.5	0.9

* Rates are inches per hour.

Source: Gerber, J. F. and J. D. Martsolf. 1965. Protecting citrus from cold damage. Univ. Fla. Arg. Ext. Cir. 287.

The precipitation rate applied by a sprinkler irrigation system will depend on the sprinkler discharge and the spacing between sprinklers. Generally, the desired sprinkler spacing will be determined first and then a sprinkler will be selected with an appropriate discharge rate and wetted diameter.

Sprinklers are typically spaced in the range of 40x40 feet to 80x80 feet. The precise spacing will often depend on the spacing of the crop to be watered. For tree crops, it is desirable to have a row of sprinklers in every other tree row in order to provide adequate coverage over the whole tree. Also, the outside row of sprinklers should be located at the edge of the field to provide adequate coverage for the outside row of trees. In order to provide uniform coverage, sprinkler spacing should be from 50 to 60 percent of the wetted diameter of the sprinkler. Under no circumstances should the spacing exceed 70 percent of the effective sprinkler diameter. Typically, every other row of sprinklers is staggered to provide a triangular pattern; however sprinklers may also be spaced in a square or rectangular pattern.

Once the spacing is determined, the desired sprinkler nozzle capacity may be determined using the equation for calculating precipitation rates:

R = 96.3 x Q / S x L

Where: R = application rate (in./hr.)

Q = output of one sprinkler (gal./min.)

S = spacing between sprinklers (ft.)

L = spacing between rows of sprinklers (ft.)

Table 3. Precipitation Rates for Selected Nozzle Capacity and Sprinkler Spacings.

Sprinkler Spacing (ft.)	Gallons Per Minute/Sprinkler								
	2	3	4	5	6	8	10	12	15
30 x 30	.21	.32							
30 x 40	.16	.24	.32						
40 x 40		.18	.24	.30					
40 x 50		.14	.19	.24	.29				
40 x 70		.12	.16	.20	.24	.32			
50 x 50		.12	.15	.19	.23	.31			
50 x 60			.13	.16	.19	.26	.32		
60 x 60				.13	.16	.21	.27	.32	
60 x 70					.14	.18	.23	.28	.34

Table 4. Pumping Capacity Required

Precipitation Rate (In./Hr.)	Pumping Capacity Required (GPM/Acre)
0.11	49.8
0.12	54.3
0.13	58.8
0.14	63.4
0.15	67.9
0.16	72.4
0.17	76.9
0.18	81.5
0.19	86.0
0.20	90.5

SUMMARY Overhead sprinkler irrigation has proven to be one of the most effective means of protecting a variety of crops against frost/freeze damage. A properly designed system can protect crops to temperatures as low as 20° F. In order to be effective in protecting crops, the sprinkler system must be properly designed. For this reason, it is always advisable to have the system designed by a competent irrigation designer. In addition, the system must be operated correctly to achieve the desired results. It is the grower's responsibility to see that he is properly informed to operate the system effectively. Timing is critical in protecting crops from frost/freeze damage, and it makes little sense to spend the money to install a sprinkler system and then not know how to operate it properly when a killing freeze occurs.

Overhead sprinkling for frost protection is not recommended for avocado orchards. Too much ice. (Personal comment. McNeil, 2024)

HortScience 17(5):799-801. 1982. Undertree Irrigation for Cold Protection with Low-volume Microsprinklers

Lawrence R. Parsons, T. Adair Wheaton, and Jodie D. Whitney. University of Florida, IFAS, Agricultural Research and Education Center, 700 Experiment Station Road, Lake Alfred, FL 33850

The effectiveness of microsprinkler irrigation for frost protection was examined during several cold nights in central Florida in 1981. Air temperatures ranged from 0 to 2.8°C warmer in the irrigated area above the spray zone than in the non- irrigated area, and were generally 0.5 to 1.5°C warmer. By irrigating under the tree, microsprinklers avoid some of the disadvantages associated with overhead sprinklers. Overhead sprinklers are not practical for freeze protection of large evergreen citrus trees because of limb breakage due to ice loading. During calm radiation cold nights, microsprinkler irrigation can provide some protection and is one alternative to burning petroleum. Precipitation rates were .21 in/hr, 20 g/hr at a 3.1 x 3.4 m spacing. And 0.5 to 1.5 C warmer (.9 to 2.4 F warmer).

The author (Dr. Robert J McNeil,CalPolySLO) got 1 degree F warming in an avocado orchard with 10 g/hr minisprinklers on a cold (30 F) morning. Parsons (1982) in Florida got .9 to 2.4 F warming with 20 g/hr minisprinklers. Also at a 20x20 ft spacing. 20 g/hr per sprinkler would seem to be the minimum minisprinkler application rate needed for frost protection. 10 g/hr is not enough. Dr. Robert J McNeil, Professor Emeritus, CalPolySLO, CA.

Minisprinklers (Bing.com)

Sprinklers for Frost Protection (Bing.com)

Furrow and Flood Irrigation for Frost Protection (Bing.com).

When installing an irrigation system for a new or existing crop, using micro sprinklers rather than trickle-drip irrigation is desirable. Surface irrigation (i.e. furrow or flood) is commonly used for frost protection in locations with adequate and inexpensive water supplies.

Furrow or flood irrigation may require 50 gpm/acre for frost protection and cheap and available water. Level ground is also usually needed.

See more at Frost Protection Principles https://ucanr.edu/sites/btfnp/files/165673.pdf

Furrow Irrigation (Bing.com)

Flood Irrigation (Bing.com)

Comparison of Furrow and Sprinklers (50 gal/min/acre) for Freezing Protection on 13 Cold Nights for Three Seasons With and Without Wind Machines. (Univ. of Calif. Cooper. Extension).

	With Wind Machine	**With Wind Machine**
Water Applied	Range	Mean
None	1.5-2.5 degrees F	2.0 degrees F
Furrow Center	2.5-4.5	3.5
Furrow Under Skirts	4.5-5.5	4.9
Low Head Sprinklers	1.5-6.0	5.5
	Without Wind Machine	**Without Wind Machine**
Furrow Center	1.5-2.5	1.8
Furrow Under Skirts	2.0-3.5	2.5
Low Head Sprinklers	0.5-4.5	4.0

Comparison of furrow or sprinklers for frost protection (50 gpm/acre) with and without a wind machine (see previous table).

Wind machines alone increased average temperature by 2 degrees F.

Center furrows increased average temperature by 1.8 F without a wind machine.

Center furrows increased average temperature by 3.5 F with a wind machine.

Furrows under skirts increased average temperature by 2.5 F without a wind machine.

Furrows under skirts increased average temperature by 4.9 F with a wind machine.

Low head sprinklers increased average temperature by 4 F without a wind machine.

Low head sprinklers increased average temperature by 5.5 F with a wind machine.

Frost and Freeze Protection Strategies, Texas. See Website Below:

https://aggie-horticulture.tamu.edu/wp-content/uploads/sites/13/2017/06/Frost-and-Freeze-Protection-Strategies.pdf

Monte L. Nesbitt

Extension Horticulture

College Station, Tx

Frost Protection In Orchards and Vineyards

https://www.irrigationtoolbox.com/ReferenceDocuments/BasicWaterManagement/f21_orchard_frost_protection.pdf See this website for more.

Table 5. Suggested starting temperatures for overtree sprinkling for frost protection based on wet bulb temperatures to reduce the potential for bud damage from "evaporative dip" to keep plant tissues above about about 30°F.

Wet Bulb Temperature		Starting Temperature	
°F	°C	°F	°C
≥26	≥ -3.3	34	1.1
24 to 25	-4.4 to -3.9	35	1.6
22 to 23	-5.6 to -5.0	36	2.2
20 to 21	-6.7 to -6.1	37	2.8
17 to 19	-8.3 to -7.2	38	3.3
15 to 16	-9.4 to -8.9	39	3.9

Undertree Sprinkling . Another commonly used frost protection method in Pacific Northwest orchards is the application of water through undertree sprinklers. Research and experience has shown that the success of undertree sprinkler systems (used both with and without wind machines) is influenced by the following factors. These are (in approximate order of importance): 1.) the height and strength of the temperature inversion; 2.) the level of protection is directly proportional to the amount (mass) of water applied and the temperature of the applied water; 3.) the volume of air flow moving into the orchard (advection) which can remove about half the heat; 4.) release of latent heat from the freezing of the applied water (small contribution); and, 5.) radiation heat fluxes from the soil. Other important, but less significant, parameters are the height and type of cover crop and water droplet sizes. The relative contribution of any one factor will vary with site and existing climatic conditions at the time, but the currently expected maximum amount of temperature increase (at 6 ft) is about 3°- 4°F using cold canal water in the spring (depending on inversion

strengths). Undertree systems are very compatible with wind machines and/or heaters (on borders) and the respective individual heat contributions appear to be additive up to a point limited by the resistance to heat transfer of the air. Many of the systems are being used in conjunction with wind machines. There are less risk, less disease problems and lower water requirements than overtree systems since the water does not come in contact with the buds.

Most of the systems use small (5/64"-3/32"), low-trajectory, (7°) sprinkler heads at 40-50 psi. Applications range from 0.08 to 0.12 in/hr (40-55 gpm/ac) or a little more than half of overtree requirements. Sprinklers are usually turned on around 32°F, or earlier if dew points are low, in order to raise the humidity as much as possible and prevent freezing of the risers and heads.

The level of protection is very dependent on the amount of water applied, up to a maximum of about 50 gpm/ac, and the areal extent of the freezing surface. Part of the heat from the freezing and the cooling of water is carried into the ground by infiltrating water, part goes into warming the air, and part into evaporation (which slightly increases the humidity). It is estimated that at least 75% of the heat is lost with conventional undertree systems. If the water applications are not adequate, total heat losses can approach 100%. "Misters" and "micro-sprinklers" should work well for undertree frost protection only if the application rates and coverage are adequate. Small droplets and "fogs" do not compensate for the lack of adequate water applications in undertree systems. The transfer of heat to the frosty buds is by radiation, convection and by any condensation which occurs on the coldest (radiating) plant tissues. The radiant heat and condensation (latent) heat have little effect on the thermometer, which may not accurately reflect the effective protection levels.

See more on this website including heaters, wind machines, helicopters, etc:

https://www.irrigationtoolbox.com/ReferenceDocuments/BasicWaterManagement/f21_orchard_frost_protection.pdf

Chemical Sprays for Frost Protection

Some copper sprays such as copper hydroxide materials have frost protection on their label. They may prevent ice crystals from forming by killing ice crystal nucleation bacteria such as *Pseudomonas syringae.* Experimental success with such sprays and antitranspirants was found by McNeil, Medders, and Guzman in 2003 at CalPolySLO. (COMPARISON OF FREEZING PROTECTANT SPRAYS APPLIED TO AVOCADO TREES, Proceedings V World Avocado Congress 2003).

Freeze Protectant Spray Experiment (McNeil et al, 2003)

Six freezing protectant products were sprayed at maximum label rates on one year old Hass avocado trees. Control trees were sprayed with water. Treatments were applied three times at monthly intervals, December 20, January 20, and February 20. Products tested were Copper Count-N®,Champ®, Frost Guard®, Frost Shield®, Anti Stress 550®, and Insulate®. Trees experienced one night of damaging temperatures with a duration of five and one-half hours at or below 1.1°C (30°F) and a minimum temperature of 2.3°C (27.9°F) on January 4. All of the products tested provided some level of freezing protection to mature leaves as compared to water-treated control trees, however there was no statistical difference between products.

Frost Protectant Spray Experiment (McNeil et al, 2003)

Two separate orchard areas were treated, one with additional freezing protection by a wind machine and the other with no wind machine. The experimental design for each orchard area was a randomized complete block with seven replications. Mature Hass avocado leaves freeze at 1.1°C (30°F) (McNeil, 2001). Freezing temperatures and subsequent leaf damage occurred on January 4, which was two weeks after the first treatment. The wind machine protected area experienced two hours at or below 1.1°C (30 °F) with a minimum temperature of 1.2°C (29 °F), while the area without a wind machine experienced five and one-half hours at or below 1.1°C (30 °F) with a minimum temperature of 2.3°C (27.9 °F).

One hundred mature leaves per tree were rated as to any freezing damage, slight damage (1-33%), moderate damage (33-66%), or severe damage (66-100%).

Frost Protectant Spray Experiment (McNeil et al, 2003)

All six freezing protectant products consistently reduced freezing damage of mature leaves below that of the water treated control trees except in one instance for all four categories of leaf freezing damage evaluated in both orchard areas, that with and that without a wind machine. Damage was reduced by approximately half for some of the treatments as compared to control trees. Data for four products (Anti Stress, Copper Count-N, Insulate, Champ) was statistically lower than the control for slightly damaged leaves and for all six products (including Frost Guard and Frost Shield) for moderately damaged leaves. Data was not statistically different between products. CONCLUSION: All of the freezing protectant products tested appeared to be able to provide some level of freezing protection to mature leaves of Hass avocado trees as compared to water treated control trees. Future studies failed to show differences. The first trial must have had good numbers of bacteria and was applied two weeks prior to freezing temperatures, time for the dead bacteria to decompose. Faber and Sachovich (1995) had no significant differences in similar trials on Hass avocado and Eureka lemon, only some treatment tendencies. They applied sprays only one week prior to freezing weather. Recommendations are to apply 10 days in advance. Our experiment was two weeks in advance, time for the dead bacteria to decompose, a reason for our success (McNeil et al, 2003). The frost protectant sprays are therefore recommended, especially the copper materials, known to kill ice-nucleating bacteria.

Frost Protectant Spray Experiment (McNeil et al, 2003)

Six freezing protectant products were sprayed at label rates on 1-year-old ` Hass' avocado trees. Control trees were sprayed with water. Treatments were applied three times at monthly intervals, 20 Dec., 20 Jan., and 20 Feb. The products tested were Copper Count-N, Champ, Frostguard, Frost Shield, Anti Stress 550, and Insulate. Two separate orchard areas were treated, one with additional freezing protection by a wind machine and the other with no wind machine. Freezing temperatures and subsequent leaf damage occurred on 4 Jan., which was 2 weeks after the first treatment. The wind machine protected area experienced 2 h at or below 30 °F, with a minimum temperature of 29 °F, while the area without a wind machine experienced 5.5 h at or below 30 °F with a minimum temperature of 27.9 °F. One hundred mature leaves per tree were rated as to any freezing damage, slight damage (1% to 33%), moderate damage (33% to 66%), or severe damage (66% to 100%). All six freezing protectant products consistently reduced the percentage of leaves with freezing damage below that of the water-treated control trees, except in one instance, for all four categories of leaf freezing damage evaluated in both orchard areas—that with and that without a wind machine. Damage was reduced by approximately half for some of the treatments as compared to control trees. Data for some or all freezing protectant products was statistically different (less) than the control in two freezing damage categories (slight and moderate) in the area without a wind machine, however, data was not statistically different between freezing protectant products.

Champ Formula 2 Flowable (From Label)

37.5 percent copper hydroxide.
Labeled for avocado.

FROST INJURY PROTECTION

Bacterial Ice Nucleation Inhibitor: Application of this product made to all crops listed on this label at rates and stages of growth indicated on this label just prior [10 days better to allow dead bacteria to decompose] to anticipated frost conditions will afford control of ice nucleating bacteria (Pseudomonas syringae, Erwina herbicola and Pseudomonas fluorescens) and may therefore provide protection against light frost. Use higher rates when bacterial infection is severe. Not recommended in those geographical areas where weather conditions favor severe frost. [2-4 degrees F protection possible.]

Crop Insurance for Freezing and Other Protection (https://ask.usda.gov/s/article/How-do-USDA-disaster-assistance-programs-work)

The USDA has crop insurance offices for avocados and other crops. Their office is called the Farm Service Agency. Insurance is available to cover from 50-75% of crop loss. Or pay for more coverage.

USDA's Farm Service Agency, Natural Resources Conservation Service, and Risk Management Agency offer a broad suite of programs available to producers to help recover losses from natural disasters. Disaster assistance programs and loans are available to help producers offset losses and get financing to help with recovery. Producers should visit farmers.gov, where they can use the Disaster Assistance Discovery Tool (https://www.farmers.gov/recover/disaster-tool) and the Disaster-at-a-Glance fact sheet (https://www.farmers.gov/sites/default/files/2020-04/FSA_DisasterAssistance_at_a_glance_brochure_.pdf) to learn more about program and loan options.

Crop updates must be reported annually.

I had 35% coverage for grapes, lemons, and avocados at CalPolySLO for $200 up to 2004.

Also read this website for the program: https://www.californiaavocadogrowers.com/sites/default/files/documents/Avocado-Insurance.pdf

California Code of Regulations. Avocado Freezing.

https://regulations.justia.com/states/california/title-3/division-3/chapter-1/subchapter-4/article-11/section-1408-7/

Freezing temperatures can cause fruit loss and tree damage in California's avocado growing regions. Avocados are considered damaged by freezing injury when there is bronze color on the outside surface of the skin or water-soaked discoloration of the flesh adjacent to the skin. Severe freezes can destroy individual avocado trees, particularly when temperatures fall below 30°F.

California Code of Regulations
Title 3 - Food and Agriculture
Division 3 - Economics
Chapter 1 - Fruit and Vegetable Standardization
Subchapter 4 - Fresh Fruits, Nuts and Vegetables
Article 11 - Avocados
Section 1408.7 - Avocados, Freezing Injury
Universal Citation: 3 CA Code of Regs 1408.7
Current through Register 2024 Notice Reg. No. 38, September 20, 2024

Notwithstanding the provisions of Section 1408.5, avocados shall be considered damaged by freezing injury when:
(a) There is any amount of bronze color on the outside surface of the skin; or
(b) There is any amount of water-soaked discoloration of the flesh adjacent to the skin as determined on the surface of a transverse cut made at least 1 inch from the stem end of the fruit; or (c) Any discoloration or desiccation of the flesh occurs on a transverse cut made at least 1 inch from either the stem or distal end of the fruit, or on either such cut surface if it covers an aggregate area of more than 1/2 inch in diameter; or (d) Ten or more vascular fiber bundles, which are as dark as the color guide established by the Director, appear on the surface of a transverse cut made at least 1 inch from the stem end of the fruit; or (e) There is any internal void as determined on the surface of a transverse cut made at least 1 inch from either the stem or distal end of the fruit.

1. Renumbering from section 1397 filed 1-21-75; effective thirtieth day thereafter (Register 75, No. 4). For prior history, see Register 57, No. 9.
2. Amendment filed 11-7-88; operative 11-7-88 (Register 88, No. 46).
3. Amendment of section and NOTE filed 9-16-92; operative 9-16-92 (Register 92, No. 38).
4. Editorial correction of subsection (a) (Register 2014, No. 10).

Note: Authority cited: Sections 14, 407 and 42684, Food and Agricultural Code. Reference: Sections 42941 and 44973, Food and Agricultural Code.

Freezing Damage Tolerances for Avocado Fruit Calif Agr Code (McNeil, 1997). May no longer apply. USDA regulations are currently (2024) for 10% fruit by count. See website below for latest information for 2024: https://regulations.justia.com/states/california/title-3/division-3/chapter-1/subchapter-4/article-11/section-1408-7/

% of Fruit, Flesh	% of Fruit by Count
20 %	15%

Chapter 6 Climate. References Cited

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OrchardRite.com

https://ucanr.edu/sites/Mendocino/files/17343.pdf

https://smallfruits.org/files/2019/06/SRSFC-Weather.pdf

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See more at Frost Protection Principles https://ucanr.edu/sites/btfnp/files/165673.pdf

Chapter 7. Soil Management and Weed Control.

The best type of soil for avocado trees is: (Bing.com)

Sandy [loam] soil that drains quickly, 3-4 feet or deeper, or clay loam soil 2-3 feet deep.

Rich, loamy, and well-draining soil with a pH between 5 and 7 (Some say 6-7, or 6-6.5).

Soil amended with compost or aged manure.

A mix of one-third organic material (such as pine bark), one-third coarse sand, and one-third perlite.

Limestone, sandy loam, and decomposed granite that encourage fruit growth.

(https://www.homefortheharvest.com/avocado-tree-soil/)

Avocado trees do best in well-draining soil with a pH of 6.0 to 7.0 (Some say 5-7, or 6-6.5) and plenty of organic matter. The best way to ensure your avocado tree has the right environment is to amend the soil with compost or aged manure before planting it. This will improve drainage and nutrient content and create an ideal habitat for your avocado tree's roots. Avocado trees thrive in well-draining soil, meaning that the soil allows excess water to drain away easily. These trees don't like to sit in puddles of water for long periods of time (the roots will suffocate). Avocados also benefit from slightly acidic to neutral soil and require consistent moisture without being waterlogged. The soil should feel like a wrung-out sponge, containing both water and air.

They prefer loamy or sandy soil rich in organic matter. Good drainage is crucial to prevent root rot, so avoid heavy clay soils or amend them with organic material and sand. Mulching around the base helps retain the right amount of moisture and boost soil health.

Organic matter helps retain moisture in the soil while providing essential nutrients like nitrogen, phosphorus, and potassium that are necessary for healthy growth. Adding aged manure or compost can help increase microbial activity which aids in breaking down organic material into usable forms of nutrition for plants. Additionally, adding organic matter can also help reduce compaction from heavy rains or watering cycles so that oxygen is able to reach the roots more easily which helps promote better root development over time.

pH level

Avocados prefer slightly acidic soils between 6-7 (Some say 5-7, or 6-6.5) on the pH scale but they are quite tolerant of alkaline soils as long as there’s adequate drainage available so their roots don’t become waterlogged or rot away due to lack of air circulation around them.

In nutrient-deficient soil, avocado trees generally need fertilizers that are high in nitrogen, phosphorus, and potassium to thrive. Slow-release fertilizers provide a steady stream of nutrients over time without burning the roots of the tree. They also help maintain an even pH level for optimal growth.

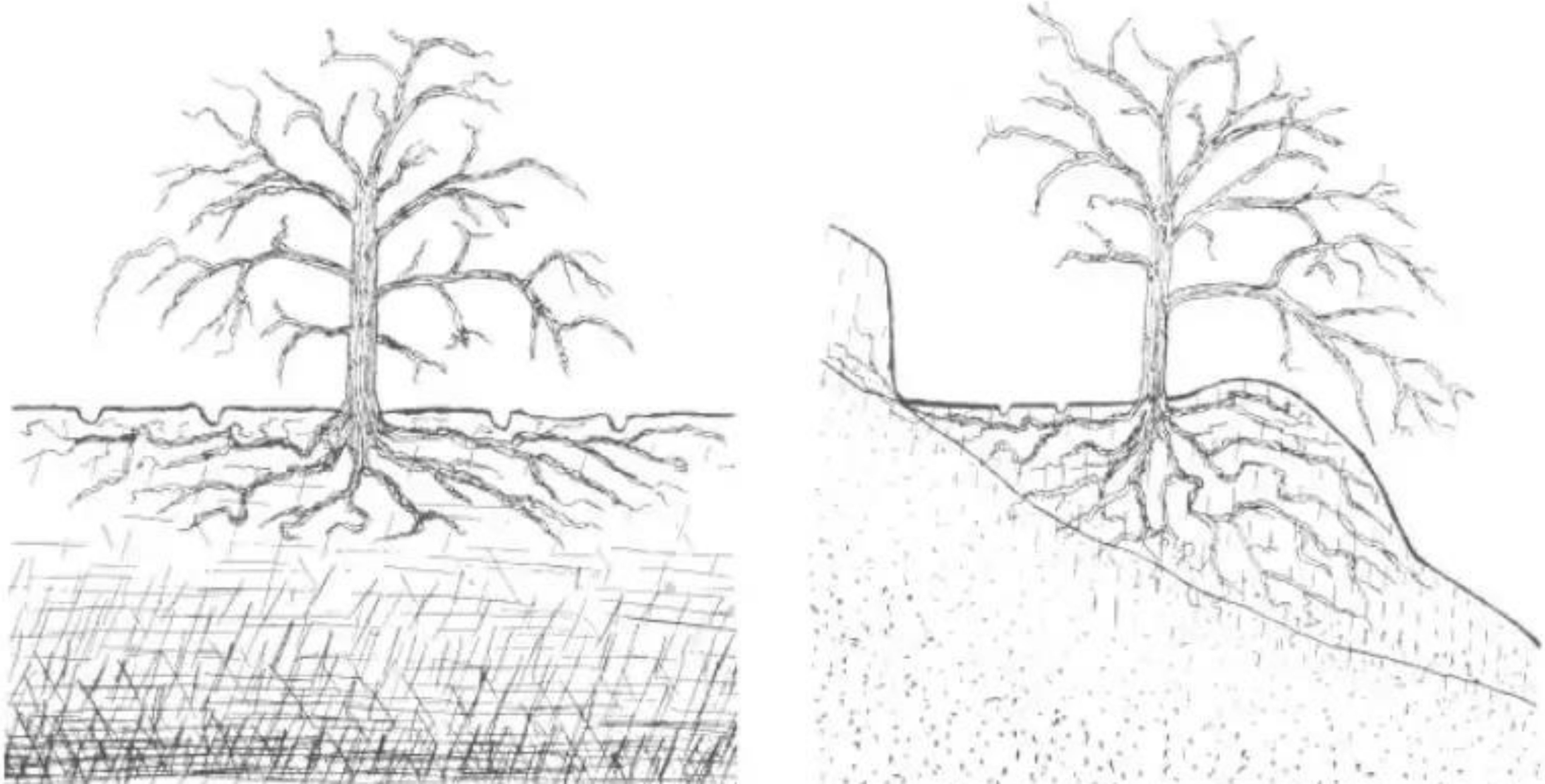
Mulching The application of clean organic material such as straw can be done around the tree in the area of the sprinkler pattern for erosion control since this area is not to be planted to a cover crop. Mulching 2-4 inches deep will reduce weed growth, conserve moisture and improve soil tilth. Do not incorporate the mulch into the soil.

Cover Crops Planted annual grasses or natural vegetation should be established on the contour between tree rows to control sheet erosion. This will replace the Critical Area Planting in the long term. The types of equipment used and the cultural operations performed should maintain a population of planted and/or desirable resident species not including any noxious weeds that provides at least 60 percent ground cover during the erosive period. Plant height shall be controlled by mowing. As the trees grow and the canopy shades the cover crop it is slowly eliminated. It should not be allowed to grow around the sprinkler as this will disrupt the spray pattern and result in poor distribution to the root zone.

Cover Crop Between Avocado Rows on a Slope for Erosion Control (Bing.com)

Avocado Terraces for better soil depth on the outer edge of the terraces and erosion control, and to allow vehicle access. (Bing.com).

Avocado Terraces on the right can increase topsoil depth on the outer edge. Plant on the outer edge of terraces where soil is deeper. Tree on the right should be planted further to the right where soil is deeper and to leave 10 feet for tractors/sprayers on the terrace. (Bing.com).



Berms for Avocados. Deeper soil. Better drainage. Greater production.

(https://gregalder.com/yardposts/planting-avocados-in-poor-soil)

Making berms for avocados with a road grader at CalPolySLO.

In Southern California, soils should have free drainage for at least 3 feet in depth. This means that, if possible, there should not be any clay layers, hardpan layers or solid rock layers in areas where trees are planted. Most hillsides have rock in the subsoil, but the rock is usually cracked or fissured allowing free drainage. Some slopes, however, have solid, un-cracked rock just inches below the soil surface and the water-logged areas just above the rock have been blamed for the rapid spread of root rot in some groves.

South African Avocado Growers' Association Yearbook. 2003. 26:106-112. Avocado rootstocks: What do we know; are we doing enough research?

ROOTSTOCK EFFECTS OF THE THREE RACES. Although there are differences within each race ecotype, in broad terms the following effects have been noted (Ben-Yaacov & Michelson, 1995): Salinity: West Indian most tolerant; Mexican least tolerant (reduced productivity). Calcareous and alkaline soils: Guatemalan most sensitive to lime-induced chlorosis; West Indian most tolerant. Poorly aerated soil: Variable responses, but Mexican more tolerant than West Indian. Dothiorella and Verticillium wilts: Guatemalan more sensitive than Mexican. Cold: Mexican most tolerant; West Indian least. Heat: West Indian most tolerant; Guatemalan least.

On a worldwide basis, Mexican rootstocks appear to dominate, including the clonal Duke 7. This is mainly because California set the pace, and being concerned with cold winters, selected Mexican germplasm. Later, when Phytophthora root rot tolerance was sought, Mexican types were again the most selected. This is in spite of sometimes serious soil salinity problems, which led to selection mainly from West Indian germplasm in Israel. Nowhere was Guatemalan germplasm widely used, although South Africa used Edranol seedlings before Duke 7 became prominent. In Australia however, the predominantly Guatemalan (but with some West Indian genes) Velvick has proven to be an excellent rootstock in the humid subtropics. It imparts vigour, productivity and good fruit quality to the scion (including improved boron uptake), and is tolerant of Phytopthora root rot (Whiley, 2002).

Soils for avocados. (McNeil, 2001)

Good soil drainage. Soils that do not drain well due to soil compaction or clay layers may cause roots to die of asphyxiation. Root rot caused by the fungus Phytophthora cinnamomi is much worse in poorly drained soils. As a rule of thumb, if an 18 inch deep hole is dug and filled with water, and water is still in the hole the following day, then this is not a good site for avocados. Sandy loam soils are usually considered to be good for avocados, but only if the subsoil has good drainage. Clay soils are not recommended for avocados. When replanting a grove that had root rot and/or poor drainage, mounding [or ridging] is usually recommended in order to improve drainage. After building the mounds, the entire root ball is planted in the mound with the bottom of the root ball just above the surface of the native soil. A mound is constructed by scraping the surrounding soil into a mound about 6-7 feet in diameter, usually about 20 inches high. If the ground is flat enough, a scraper attached to a tractor pushing the soil to one side can create long, continuous mounds [ridges].

To prepare soil for an avocado tree, it is important to use a well-draining soil mix. Start by digging a hole twice as wide and just as deep as the root ball of your avocado tree. Amend the soil with compost or aged manure to add organic matter and nutrients. Mix in some sand if you have heavy clay soils to improve drainage. Once planted, water deeply until established and continue regular watering throughout the growing season. Mulch around the base of your tree to help retain moisture and reduce weeds. Organic fertilizers such as composted manure or fish emulsion can be used to give avocado trees the essential nutrients they need. Composted manure is rich in nitrogen and other minerals that will help keep your tree healthy and strong. Fish emulsion is made from ground-up fish parts and provides a great source of nitrogen, phosphorous, potassium, calcium, magnesium, iron, and zinc which are all beneficial for avocados. It’s important to remember when using any type of fertilizer that you should only apply it once every two months during the growing season (spring through fall). Applying too much can burn the roots or cause nutrient deficiencies so be sure to follow instructions carefully. Also, make sure you water your avocado tree after applying any kind of fertilizer so it has time to absorb into the soil before evaporating away due to sun exposure or windy conditions outside.

Soil Management and Weed Control

Ideal Orchard Soils. Ideal avocado orchard soils are those that have been proven to be successful for a particular scion variety/rootstock combination. Local experience is the best information source.

Well-drained and Aerated.

Growth and production will be best if the soil has good drainage of excess rainfall or irrigation water. Extended periods of soil saturation will deny oxygen to the tree roots such that they will be weakened or even asphyxiated (drowned). A weakened root system will inhibit tree growth, production, and fruit size. Oxygen is necessary for respiration of roots so that they may remain alive and grow. Trees that are dormant in relatively cold winter climates such as the San Joaquin valley of California can withstand a saturated soil condition longer than less dormant trees in milder winter climates such as southern California or Florida.

Roots are more dormant (thus more asphyxiation resistant) in colder winter climates where the soil temperature is lower in winter than in milder winter regions.

Factors that impede soil drainage and aeration are primarily hardpan and denser subsoil layers especially if they are within a few feet of the soil surface. These dense layers will impede water drainage such that the soil remains saturated for extended periods of time such that tree roots are damaged. Soils that are too heavy such as clay soils also have poor drainage characteristics.

Soil management or preparation techniques that can improve soil drainage are ripping (chiseling or subsoiling), backhoeing, ridging, terracing, installing tile drains, incorporation of organic matter, and applying gypsum. Each may be useful only in certain soil situations.

Backhoeing. Backhoeing is a permanent, but expensive solution to poor drainage caused by denser subsoil layers. Each individual tree planting spot is backhoed at least four or five feet deep such that the denser subsoil layer is broken up and mixed with the well-drained top soil. The soil then will have good drainage at least to the depth of backhoeing. Fruit trees have been observed to grow and produce very well in backhoed soil.

Ridging. Ridging is appropriate for shallow orchard soils and/or those that have poor drainage because of underlying hardpan or denser subsoils. It consists of making berms of soil within each proposed orchard row by scraping the topsoil from between rows using a large road scraper. The soil in the tree rows (on the ridges or berms) is then deeper and has better drainage. Berms should have topsoil at least three or four feet deep (berm height plus the natural topsoil depth). Deeper is better for best drainage and tree performance. Trees will perform much better in ridged soil than in shallow poorly drained soil.

Terracing.

Terracing is suitable for orchards to be planted on hillsides that have shallow and/or poorly drained soils. Small bulldozers are used to create terraces (level areas) on the contour of hillsides. They are graded to a 1% slope in the direction that one desires collected rainwater to flow into ditches or drains. They also should slope slightly downward into the hillside so rainwater does not run over their edges and cause erosion. Terrace spacing might be 25 feet on steep hillsides, with the actual terrace 10-15 feet wide and banks between terraces about 10-15 feet wide. Terrace spacing and bank diameter would be wider on less steep slopes.

The primary soil management advantage of terraces is the creation of deep well-drained soil on the outer terrace edge and banks between terraces. This deep soil, which could be several feet in depth, provides a

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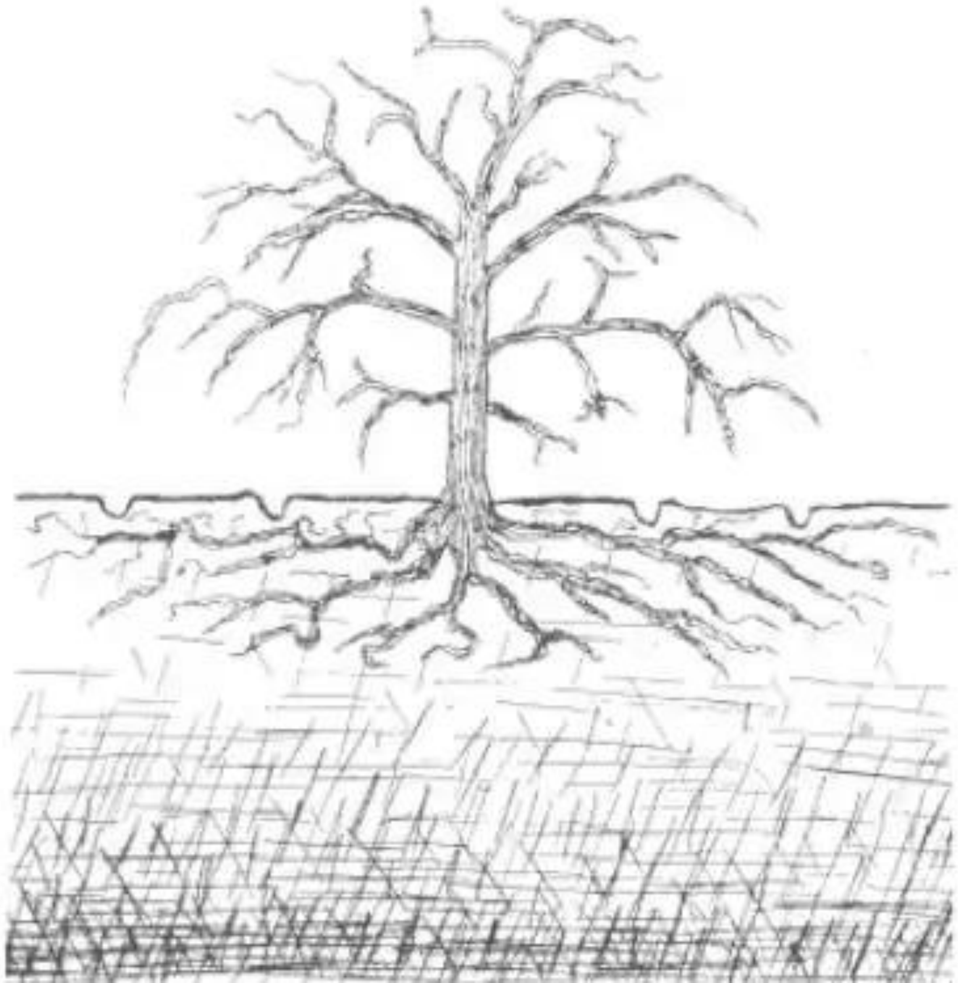
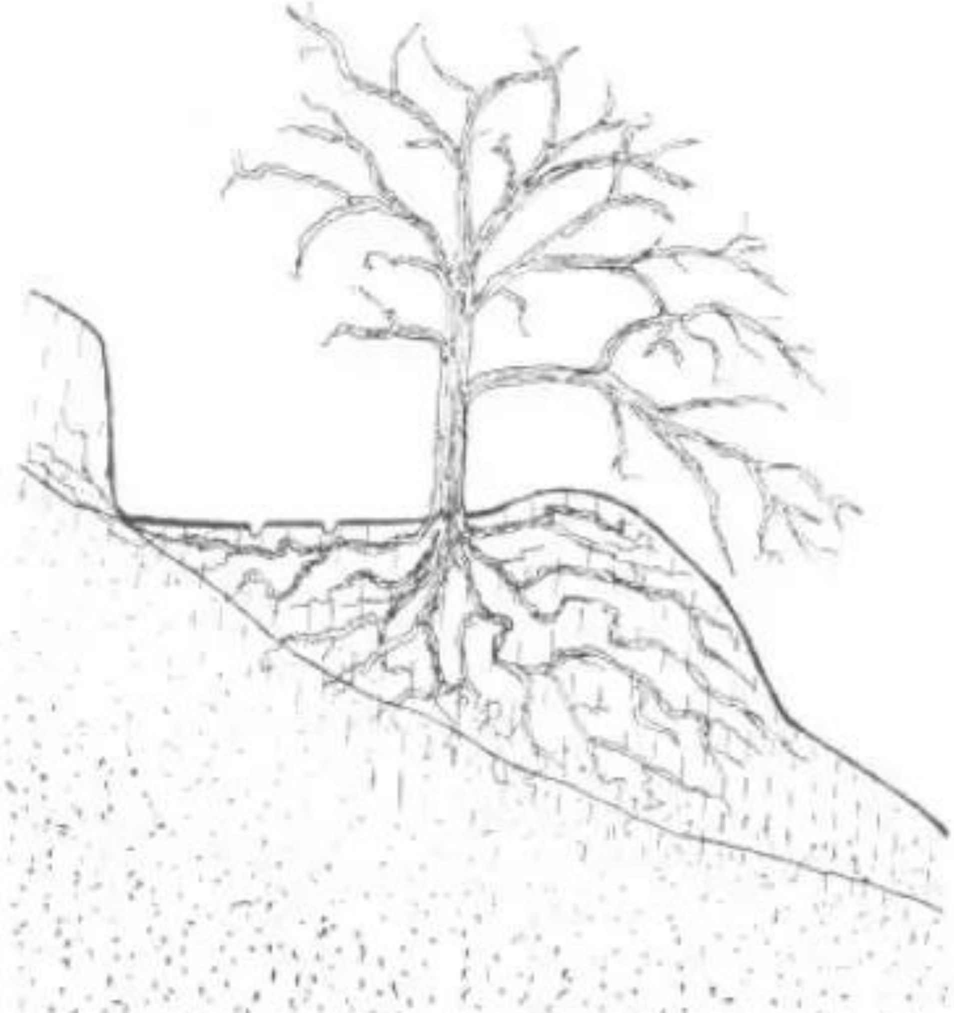
increase topsoil depth on the outer edge. Plant on the outer edge of terraces where soil is deeper. Tree on the right should be planted further to the right where soil is deeper and to leave 10 feet for tractors/sprayers on the terrace. (Bing.com).





deep well-drained medium for tree roots. Tree growth and production will be excellent. Trees can be planted either on the outer edge of the terraces or on the terrace banks. Additional advantages of terracing are erosion control (by collection and drainage of rainwater) and to allow easier hillside access for harvesting and spraying. Erosion can be controlled on the terrace banks by use of a winter cover crop (natural or planted) for the California winter rainy season. Organic Matter. Incorporation of organic matter such as well-composted manure or other composts or by growing or disking in a cover crop or weeds can help soil drainage and aeration by providing more pore space in the soil. Manure and other compost materials (yard waste) must be well-composted so that weed seeds and pathogens have been killed by high composting temperatures. This may have to be practiced on an annual basis for continuous benefit. Manures or composts must be applied at extremely heavy rates (40 tons/acre) to significantly improve soil drainage (Sanden, 1997). Precautions should be taken not to use compost that has a high soil pH which might make the soil pH too high for the crop such as for acid-loving crops like highbush blueberry. Some leaf compost may have a high soil pH.

Tile Drains. Tile drains can be installed to help with soil drainage on soil that overlies hardpan or denser soil layers. The drains consist of porous pipe installed at the depth of the impervious layer and at such a spacing to provide good drainage. Water drains into the pipe and runs out of their ends into other pipes, drains, or ditches. This is an expensive but effective drainage method. It has been used in California desert areas to provide good soil drainage so that excess salinity does not build up in the soil by use of relatively saline irrigation water. This can be cumbersome and expensive.

Winter cereal grains such as rye, barley, or oats are good winter cover crops to improve soil structure, water infiltration and drainage (Peacock, 1997). They produce large quantities of organic matter and have a fibrous root system that may even grow into compacted soil. Nutrients provided by the organic matter (especially nitrogen) must be figured into the orchard fertilization/nutrition program. An additional benefit of improving organic matter content of the soil is the nutrient holding and releasing capability.

(cation exchange capacity) of organic matter.

Gypsum. Gypsum (calcium sulfate) is useful on soils of low calcium content to help open up pore spaces and allow for better surface water penetration and drainage. Low calcium soils will crust on the surface and also have poor internal drainage. Gypsum can be applied during the irrigation season in the areas wetted by surface irrigation or applied to all the orchard soil prior to the winter rainy season.

It can be applied in dry form to soil surfaces or injected in liquid form through low volume irrigation systems. How much gypsum to apply can be determined by commercial soil analysis laboratories by analyzing soil samples for their gypsum requirement. The estimated amount of rainfall or irrigation may also determine how much or how often gypsum must be applied. Gypsum will not affect the soil pH. Two other important aspects of an ideal orchard soil are good moisture-holding capacity (not too coarse) and good nutrient-holding capacity.

Moisture-holding Capacity. Optimum soil moisture must be constantly available for trees to grow and produce well. Water is needed for the plant not only as a nutrient in photosynthesis and to take up dissolved minerals but also to cool the plant by loss of water vapor from its leaves (transpiration).

Soils that may not always hold enough water to carry trees through hot spells are those that are too coarse such as sands.

Nutrient-holding Capacity. Mineral elements supplied in optimum and constant supply to trees, particularly during the warm growing season, will allow for best growth and production. Components of the soil that will hold and release these nutrients (cation exchange capacity) are clay particles and organic matter. Loam soils (sandy loam, silt loam, clay loam) usually have adequate amounts of clay and/or organic matter for good nutrient holding and releasing capacity. Coarse soils such as sands have little or no nutrient holding capacity. Mineral elements, especially nitrogen, will leach through sands very easily. Fertilizer applications need to be more frequent on sandy soils to have a more constant supply of nutrients. Nutrient-holding capacity of soils can be improved by incorporation of organic matter.

Soil pH. A factor that affects the mineral element availability to plants is the soil pH. The optimum soil pH for avocado trees in general is from 5 to 7.0. Below or above this pH range deficiencies of mineral elements will occur that can decrease growth and production. Micronutrient elements such as zinc are especially deficient at high soil pH's in California. Within
this pH range optimum availability of mineral elements will occur making for best growth and production. The soil pH can be lowered (if too high) by application of soil sulfur or raised (if too low) by application of ground limestone (calcium carbonate) in certain amounts depending on how much the pH needs to be modified. These applications can be expensive.
Alternative methods of mineral element (fertilizer) application, such as foliar sprays of micronutrients (zinc, manganese, copper, boron), may be utilized to avoid having to modify the soil pH. Such sprays are commonly used in California, especially on citrus trees.

Salinity. Salinity is the presence of soluble salts of various elements in the soil or water. Too high a salinity can reduce avocado tree production and be toxic to the tree. The threshold salinity level in a saturated soil extract is an electrical conductivity (Ece) of 1.7 millisiemens per centimeter (mS/cm)(Stromberg, 1980). The old term for mS/cm was millimhos per centimeter (mmhos/cm). 1.7 mS/cm equates to 1190 ppm total soluble salts since every unit of Ece is equal to 700 ppm soluble salts. At this threshold level or less, no yield decreases can be expected, but yields will be depressed by 15.9% for each Ece unit (mS/cm) above the threshold (Stromberg, 1980). Symptoms of general high soluble salt toxicity to trees consists of leaf browning(drying) and drop. Fruit drop may also occur. A few deep leaching irrigations at intervals may be necessary to correct the salt buildup. Allow excess water to drain out of the soil between successive irrigations. Continuous successive irrigations of saturated soil would move water mainly through larger pore spaces and not thoroughly leach all of the soil. Avocado rootstocks that have soil salinity tolerance are of the West Indian race used in Israel but not California.

Individual Toxic Elements in Soil. Individual elements that may be toxic to trees if soil levels are too high are sodium (Na), boron (B), and chloride (Cl). Soil Na levels of 5 to 10% exchangeable sodium can cause leaf burn (Branson, 1987) in fruit trees and possibly defoliation. Structural deterioration of soils can occur if exchangeable Na levels are generally above 15%, 10% for fine textured soils, 20% for coarse-textured soils. Soil problems caused are poor aeration, poor water penetration, and difficult seedling emergence. Correction of high Na levels in the soil may require a gypsum application.

The soil's gypsum requirement would need to be analyzed by a laboratory to determine how much gypsum to apply. The boron tolerance threshold in soils is 0.5 to 0.75 ppm (Branson, 1987)(Stromberg, 1980). Concentrations above these threshold levels will cause injury such as leaf tip and marginal chlorosis followed by leaf scorch. Boron toxicity often results from use of high boron irrigation water, but also may be found in saline soils. Some high boron soil and water areas in California are the west sides

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Symptoms of chloride toxicity are varying degrees of leaf tip burn.

Soil Depth. The minimum soil depth for good growth and production of avocado trees should be about 2 feet on heavy textured soils(clay loam), 3 feet on medium soils(silt loam), and 4 feet on light soils(sandy loam).

Loams are Best. The best soils for optimum growth and production of avocado trees are loams. A loam is a soil that is composed of all three weathered rock particles (sand, silt, and clay) in certain percentages such that it has both good aeration and drainage and good nutrient holding and releasing capacity (cation exchange capacity). The percentages of sand, silt, and clay particles for a sandy loam, silt loam, and clay loam are listed in the table below:

Sandy loam	silt loam	clay loam	Percent of sand, silt, clay, respectively.
60	25	15	Sandy loam
28	54	18	Silt loam
25	45	30	Clay loam

Webster's Third International Dictionary (1981) defines a loam as a "A fertile and humus-rich soil consisting of a friable mixture containing from 7 to 27% clay, 28-50% silt, and less than 52% sand."

Soil Fumigation. Chemical fumigation of avocado orchard soil needs to be practiced primarily prior to replanting old orchard soil or soil on which the previous but different crop was a host for a pest of avocado. Virgin (previously uncropped) soil does not need preplant fumigation unless there is a natural pest population that affects avocado, nor is fumigation needed if the previous crop did not harbor avocado pests.

Soil on which avocado was previously grown will require preplant fumigation for Phytophthora foot rot and root rot organisms that may have built up on the old tree roots. These pests, being at a relatively high population level, could easily attack the roots of newly planted trees and weaken them severely. Replanting with a Phytophthora tolerant rootstock is also advised in addition to fumigation.

Virgin soil which has a natural pest population affecting avocados may need preplant fumigation. An example is root rot caused by the natural oak-root fungus (Armillaria mellea) hosted by oak and sycamore trees in California.

Crop rotation is a useful alternative if a grower does not want to deal with the expense of preplant fumigation. An example would be the planting of avocados in old citrus soil. The avocados will grow well since they are not affected by the same soil borne pests of citrus. Conversely, citrus can be planted and grow well in old avocado soil since they are not affected by the soil borne pests of avocado such as avocado root rot (Phytophthora cinnamomi).

Preplant chemical soil fumigants for Phytophthora foot rot and root rot are metam sodium (Vapam), methyl bromide, and chloropicrin (Ohr and Menge, 1996).

Cultivation and Weed Control

Cultivation (Tillage). The primary reason to cultivate orchards (such as with tractor drawn disks or rototillers) is to control weeds. Other uses may be to prepare the soil for planting trees or cover crop, prepare for irrigation (furrows or leveling and borders for flooding), and ripping to break up a compacted plowsole layer. Frequent cultivation (disking, rototilling) such as for weed control is detrimental to the soil because it decreases soil aeration (and drainage) and compacts the soil by forming a hard plowsole layer at the frequent cultivation depth.

Cultivation of mature avocado orchards (such as for weed control) is not recommended for two primary reasons: (1) It will destroy roots in the cultivated layer near the surface of the soil. Much of the avocado root system, especially the small fibrous feeder roots, are located very close to the soil surface. These are easily destroyed by cultivation. Cultivation of newly planted orchards may be done because tree roots have not yet grown out into the cultivated area. (2) Cultivation will make the orchard 1 or 2 degrees F colder on frosty nights as compared to bare, firm, moist uncultivated soil. The cultivated surface layer would insulate the soil such that it does not warm up as much during the daytime thus would have less stored heat to release to and warm the orchard air on cold nights.

Hoeing. Hoeing of weeds may be economical and effective if there are sparse numbers of weeds in the orchard or close to young trees where herbicide might harm or be absorbed by green bark, suckers, or shallow roots of young trees.

Mowing. Mowing with rotary or flail mowers powered by the tractor power take off may be used on fairly level ground to control cover crop or weed growth. Mowing should be practiced before these plants go to seed to avoid increased weed problems. Annual cover crops could be allowed to go to seed if one would like them to naturally reseed themselves. Some cover crops can successfully reseed themselves every year (Miller et al, 1989).

Weeds that have grown too large to be economically and effectively controlled by herbicides may have to be mowed and then later sprayed with herbicide. Cover crops or weeds on steep hillsides or banks between terraces may have to be cut with gasoline powered weed wackers to avoid fire hazard during the dry season.

Non-cultivation (Nontillage, clean culture). 100% non-cultivation is the most commonly used soil management and weed control method in California avocado orchards particularly on level ground. Weeds are controlled on 100% of the soil surface by use of herbicides. This method is utilized for the one primary reason that the orchard will be warmer than with any other soil management method on cold nights. The bare firm soil when moist 12 inches deep will collect and store the most heat during the daytime such that it will be released to and warm the orchard air on cold nights. Bare, firm moist soil will make the orchard air 3 degrees F. warmer than cover cropped or weedy soil, and 1 to 2 degrees F. warmer than cultivated soil during cold winter nights. Cover crop, weeds, and cultivation shade or insulate the soil such that it does not absorb as much heat during the daytime.

Other advantages of non-cultivation (clean culture) compared to cultivation are savings in labor, better soil structure, avoidance of shallow root damage, firmer sooner after rain or irrigation, and less erosion. Other advantages compared to cover crop or weed cover are savings in mowing labor and fewer rodent, snail and slug problems. Disadvantages of noncultivation are the initial weed control (herbicide) cost may be high and the soil surface may silt or crust over lessening water penetration, particularly on soils of low calcium content. Water penetration might be improved by a surface application of organic matter or gypsum. Some insect or disease problems could be greater in orchards with non-cultivated compared to cultivated soil. Insect life cycle stages that overwinter in the soil plus diseased ground fruit would not be destroyed by noncultivation as they would by cultivation. Additional control measures or sanitation (cleaning up ground fruit) may be necessary.

Cover crops. A cover crop is some type of herbaceous vegetation of either a planted species or natural weeds allowed to grow in the orchard soil the purpose usually being to improve soil fertility and organic matter and/or to control erosion and improve water penetration and drainage. Cover crops can be grown for either the winter or continuously. For ease of management (mowing or disking in) cover crops are usually grown between but not within the orchard rows.

The use of winter or continuous cover crops in California avocado orchards has been limited by the possibility that it will make the orchard 3 degrees F. colder during a freezing winter night as compared to a noncultivated (bare, firm, moist) soil. Freezing damage to the fruit and trees could be much more severe with a cover crop present. Planting the winter cover crop one or two months later (December 1 or January 1 instead of November 1) will lessen the decrease in winter freezing temperature (Otremba and McNeil, 1997).

There has been renewed interest in cover crops for avocado orchards in recent years to gain some of their uses and advantages which are improvement of soil organic matter, return nutrients to the soil, improve water penetration, control erosion, allow orchard operations soon after rain or irrigation, lessen wind erosion such as with light sandy soils, and provide a possible habitat for beneficial insects.

Cover crops can potentially aid with insect control by hosting beneficial predacious insects such as ladybugs and lacewings and parasitic insects such as syrphid flies and wasps (Long et al, 1998). A recent study (Long et al, 1998) demonstrated that lady beetles, lacewings, syrphid flies, and parasitic wasps fed on the nectar or pollen of borders of flowering insectary plants around farms. It was also shown that syrphid flies, parasitic wasps, and lacewings fed on an annual insectary mix of flowering cover crops in an almond orchard and that some of each beneficial insect moved 6 feet high in the tree canopy and 100 feet away from the cover crop within the orchard.

The benefits on pest insect pest populations needs to be evaluated. Dust can be controlled with cover crops which will help control mites. Be wary of cover crops that can host damaging insects. An example is the fava bean which attracts lady bugs, but also hosts several species of aphids (Miller et al, 1989). More research is needed as to which cover crops, if any, will help control insect pests by providing a habitat for beneficial insects. Contact the University of California Farm Advisors in your county for any recent recommendations on cover crop use in avocado orchards that they may have.

Disadvantages of cover crops are the management that may be needed such as soil preparation, planting, irrigation, fertilization, mowing, and disking in; increased rodent and snail problems compared to cultivation or clean culture, fire hazard during the dry season (mowing would be necessary to lessen the hazard), competition with the trees for water and nutrients (additional amounts may be needed), and the orchard will be colder on freezing nights with a winter cover crop. The orchard will be 3 degrees F. colder with a winter cover crop as compared to bare, firm, moist (noncultivated) soil, or 1 or 2 degrees F. colder than a cultivated soil. The latter disadvantage can be lessened somewhat by late planting of the cover crop so that it is not as tall and dense during the potential cold winter or by mowing the cover crop very short prior to cold spells. Otremba and McNeil (1997) in a California coastal valley demonstrated that later planting dates, December 1 and January 1, of a barley winter cover crop would lower the air temperature only by only 1.8 degrees and .8 degrees F. less than the early planting date November 1, 3 degrees colder.

Other Cover Crop Advantages and Disadvantages. Summer cover crops such as summer Sudan grass have been shown to reduce dust, sunburn, and heat in table grape vineyards (Miller et al, 1989). Some cover crop species can suppress damaging nematode populations, while other cover crops may increase nematode populations. Some cover crops (and weeds) may act as a host for viruses or virus like diseases and/or their insect vectors.

Possible Cover Crops

An excellent comprehensive reference on cover crops is the University of California publication 21471, Cover Crops for California Agriculture by Miller et al, 1989. This is the latest edition.

Continuous (Permanent) Cover Crops. Continuous cover crops grow year-round in the orchard. They are usually a perennial species such as perennial ryegrass. Natural weed cover could also be utilized. Mowing should be frequent enough to prevent seed production to avoid additional weed problems in the tree rows.

Winter Cover Crops. Winter cover crops are planted in the fall. Cereals such as rye, barley, or oats are good to improve soil structure and drainage because they have a fibrous root system. Annual ryegrass, Zorro fescue, or Blando brome are good for erosion control because they establish quickly. Winter legumes (such as vetches, clovers, medics, bell beans, and field peas) are used to improve soil fertility (especially nitrogen). Their roots will fix nitrogen from the air especially if the seed is mixed with the appropriate nitrogen-fixing bacteria (Rhizobium) species.

Various cover crop species are available alone or in mixtures from seed suppliers. Winter cover crops are either cultivated into the soil or mowed very short in the spring. The nutrient content (especially nitrogen) that cover crops return to the soil would need to be taken into account as part of the avocado orchard fertilization program. Leaf and soil analyses are the best ways to monitor cover crop effects on tree nutrition. Winter legumes increase nitrogen. Winter cereals and grasses incorporated in March or April have been shown to usually have no effect on nitrogen levels in vineyards. Winter grasses not incorporated until June or July, permanent sods, and summer grasses can lower grapevine nitrogen levels (Peacock, 1994). The effects of cover crops on avocado tree nitrogen levels needs to be researched in California growing areas.

Chemical Weed Control

Chemical control of weeds by use of herbicides is the principal method of controlling weeds in California avocado orchards. On level ground without much erosion hazard herbicides are applied to all of the soil surface to control weeds because this will make the orchard the warmest on freezing nights in winter. Cover crop or weeds would make the orchard 3 degrees F colder on such nights. Cultivation would make it 1 to 2 degrees colder. On hillsides or sloping ground cover crops may be grown between the orchard rows for erosion control thus chemical weed control would be confined to within the tree row.

Tank Mixes of Different Herbicides. No individual herbicide will control all weed species. One should try to choose an herbicide with a broad spectrum of weed toxicity, especially for pre-emergent herbicides, so that additional pre-emergents or foliar applications of contact or systemic chemicals will not be often needed. Sometimes two or more herbicides may be applied from the same spray tank to save the labor of separate applications. Often the recommended tank mix of two or more herbicides is on the product labels. If the mix is not on the product labels one needs to investigate the chemical compatibility of the products in question.

Compatibility charts may be available in pesticide/herbicide manuals. Mixing a small amount of each chemical in a bucket of water (at recommended dilutions) and looking for precipitates (indicating incompatibility) could be tried as a last resort. Incompatible chemicals need to be applied separately to avoid clogging filters and nozzles and to work effectively. Examples of tank mixes are the following:

(1) Two pre-emergent herbicides such as Goal (for non-bearing citrus only) plus Surflan. Goal primarily controls annual broadleaved weeds while Surflan controls mostly annual grasses. Together they will control most

annual broadleaved weeds and most annual grasses. (2) A pre-emergent herbicide plus a contact herbicide. Simazine (a pre- emergent) will control emergence of most annual grasses and annual broadleaved weeds but has no contact effect. If existing annual weeds are present at the time simazine (or another pre-emergent) needs to be applied, paraquat (a contact herbicide) could also be applied in the tank mix to kill the existing weeds. (3) A pre-emergent herbicide plus a systemic herbicide. Simazine (a pre-emergent herbicide) plus Roundup Ultra (a systemic herbicide). If existing annual and perennial grasses and annual and perennial broad- leafed weeds are present at the time simazine (or another pre-emergent) needs to be applied, Roundup Ultra could also be applied in the tank mix to kill the existing weeds. (4) Two systemic herbicides such as Roundup Ultra plus 2,4-D when each is used alone only partially control clover, cheeseweed, filaree and field bindweed. When used together better control of these weeds should be attained. Roundup partially controls mustard and does not control goosefoot and lambsquarters. 2,4-D will control all three of these weeds. **Mulching as an Alternative to Herbicides and/or Cover Crops.** A mulch is a layer of plant residue or other materials that occur naturally (such as leaf litter) or are applied to the soil surface (such as composted manures, composted yard waste, sawdust, wood chips, straw, shredded prunings, or other crop residue). Straw is not highly recommended due to its fire hazard. Benefits of mulches are moisture conservation, temperature reduction, prevention of surface compaction or crusting, control of erosion, improvement of soil structure, and control of weeds (Opitz, 1974). Well-composted mulch materials such as composted manures and composted yard waste should be relatively free of pathogens, insects, and viable weed seeds because of the high temperatures of the composting process. They may also provide some nutrients such as nitrogen. Raw mulches may decrease soil nitrogen levels because nitrogen is needed by bacteria that break down organic material. Additional nitrogen fertilizer may have to be supplied to the citrus trees mulched with raw organic materials (Opitz, 1974).

Disadvantages of mulches may be the cost of the material, the labor in applying it (which may be done annually), additional nitrogen fertilizer may be needed for raw mulches, possible pest (pathogens, insects, weed seeds) introduction by raw or incompletely composted mulches (especially yard waste or manures), and colder orchard temperatures by 2 or 3 degrees F compared to bare firm moist soil (clean culture) during the frost season. High pH mulches should be avoided such as some leaf mulches or composts. High pH could negatively affect the nutrition of the crop especially acid loving crops.

Mulching materials have been relatively unavailable in large quantities and expensive in past years. More recently, composted yard waste and possibly other organic waste materials have become more available from public and private sources. The inducement for this increased recycling of yard waste was the passing of AB 939 by the California legislature in 1990 which required that the volume of waste into landfills be reduced by 50% by the year 2000 (Sakovich, 1997).

Research in Ventura county by University of California personnel has shown that the use of an adequate depth of mulches in citrus orchards can provide good weed control comparable to that of herbicide application (Sakovich, 1997). A mixed source, chipped urban yard waste was applied at three depths, 1,3, and 6 inches in a 6 feet wide band within tree rows, but not closer than 2 feet from the trunk to avoid gummosis (foot rot). Mulch was reapplied yearly in amounts required to maintain the original depths which was about 1 inch per year since about that amount decomposed each year.

Irrigation was by drip the first year and by minisprinkler the last three years of the four years of the trial up until 1997. All three depths of mulch helped control weeds however the 3 and 6 inch depths were better than the 1 inch depth. One application of a 6 to 8 inch depth of mulch every three years was recommended to save the inconvenience and labor of annual applications.

Established perennial weeds were found to be able to emerge through deep layers of the mulch. Herbicides plus mulching were recommended for their control. Wild oats were found at a greater density in the mulched areas than in unmulched plots. Future information to be gained from the research were to be the effects of the mulch treatments on citrus tree nutrition, soil moisture, and pests such as snails, ants, nematodes, and phytophthora.

Comparison of Clean Culture, Disking, and Mowing as to Yield, Fruit Size and Gross Income of Citrus (Lemons).

A three year study of this topic was conducted in Arizona by University of Arizona personnel Glenn Wright and Bill McCloskey (Sumner, 1996).

Comparisons were made between 7 to 9 year old lemon trees having clean culture (weed control with pre-emergence and post-emergence herbicides), conventional disking, and mechanical mowing. Chemical mowing with low herbicide rates was also attempted but was abandoned after one year due to poor weed control. Fruit yields per acre were higher in all three years for trees under clean culture than those where weeds were managed by disking or mowing. Disking reduced yields by an average of 13.7% for the three seasons. Mowing reduced yields by an average of 16.7% for the three seasons. Trees under clean culture produced more fruit of the larger sizes than trees under disking or mowing practices for three out of four harvests studied. Trees under clean culture yielded the highest gross income per acre for each year of the study. Disking reduced gross income by an average of $313 per acre for the three seasons. Mowing reduced income by $386 per acre

for the three seasons. Similar results as to yields and fruit size were found in California with Washington navel orange (Jones et al, 1961). Fruit quality (higher Brix-acid ratio and thinner peels) was improved in this study by nontillage as compared to winter cover crop. It appears, as expected, that weed control by clean culture can produce higher yields and larger fruit sizes. Net income (profits) need to be determined by factoring in costs of herbicides, herbicide application, labor, and labor and equipment costs for disking and mowing. Why are yields and fruit sizes reduced by disking or mowing?

Remember the disadvantages of disking: destruction of shallow avocado roots to the depth of disking and reduction in soil structure (drainage and aeration).

Both are capable of reducing yields and fruit size. What are the disadvantages of mowing (allowing weeds to grow in and between tree rows but managing them by mowing?;competition with the trees by the weeds for food (mineral elements, fertilizer) and water. These are resources that the trees need for good production and fruit size. If weeds or cover crop are allowed to grow in avocado orchards more water and fertilizer will be needed. Soil moisture monitoring and leaf and soil analysis should indicate the degree of these greater needs.

Avocado / Agriculture: Pest Management Guidelines / UC Statewide IPM Program (UC IPM) (ucanr.edu) **Avocados.**

(Https://ipm.ucanr.edu/agriculture/avocado/#gsc.tab=0)

Common name	Amount per acre	REI‡	PHI‡	
	(Example trade name)		(hours)	(days)

Avocado Herbicide Tables. **Not all registered pesticides are listed. The following are listed alphabetically. When choosing a pesticide, consider information relating to** environmental impact**,** resistance management**, the pesticide's properties, and application timing. Tank mixes may be necessary to achieve desired control; see** Susceptibility of Weeds to Herbicide Control **for information on specific weed control. Always read the label of the product being used.**

See herbicide website for avocados: https://ipm.ucanr.edu/agriculture/avocado/herbicide-treatment-table/#gsc.tab=0

See tables for susceptibility of weeds to herbicides. Next six pages. Key is on next page and seventh page.

C	= control	P	= partial control	N	= no control	—	= no information

CAR	= carfentrazone (Shark)	ORY	= oryzalin (Surflan)
FLA	= fluazifop-p-butyl (Fusilade DX)	OXY	= oxyfluorfen (Goal, GoalTender)
FLU	= flumioxazin (Chateau)	PAR	= paraquat (Gramoxone)
GLY	= glyphosate (Roundup, Touchdown etc.)	SET	= sethoxydim (Poast)
ISO	= isoxaben (Gallery)	SIM	= simazine (Princep)
NOR	= norflurazon (Solicam)		

1 Considered to be a ground water contaminant and requires a use permit within Ground Water Protection Areas.

2 Contact with spray or drift can severely damage avocado.

3 For use on nonbearing trees only.

4 Some populations of rigid ryegrass, horseweed, and hairy fleabane) are resistant to glyphosate.

	PREEMERGENCE							POSTEMERGENCE				
	FLU[3]	ISO[3]	NOR[1]	ORY	OXY	SIM[1]		CAR[2]	FLA[3]	GLY[2]	PAR[2]	SET[3]
ANNUAL WEEDS												
Grasses												
barley, hare (wild barley)	N	N	C	C	N	C		N	N	C	P	P
barnyardgrass	C	N	P	C	P	P		N	C	C	P	C
bluegrass, annual	C	N	C	C	P	C		N	N	C	P	N
crabgrasses	N	N	P	C	N	N		N	C	C	C	C
foxtail, yellow	C	N	C	C	C	C		N	C	C	C	C
lovegrasses (stinkweeds)	C	N	P	C	C	C		N	N	C	P	—
oats, wild	N	N	P	C	P	C		N	C	C	P	C
ryegrass	N	N	C	C	N	P		N	C	C[4]	P	C
sandbur, longspine	N	N	P	P	N	C		N	N	C	P	C
sprangletop	N	N	P	C	N	N		N	N	C	N	C
witchgrass	N	N	C	C	N	C		N	C	C	P	C

	FLU[3]	ISO[3]	NOR[1]	ORY	OXY	SIM[1]	CAR[2]	FLA[3]	GLY[2]	PAR[2]	SET[3]
Broadleaves											
cocklebur	C	—	C	N	C	C	N	N	C	C	N
fleabane, hairy	C	C	C	N	C	C	P	N	C[4]	P	N
goosefoot	N	C	C	C	C	C	N	N	C	C	N
groundsel, common	C	C	P	N	C	P	N	N	C	C	N
horseweed (mare's tail)	C	C	C	N	C	C	P	N	C[4]	P	N
knotweed	N	C	P	C	P	C	N	N	P	P	N
lambsquarters	C	C	P	C	C	C	C	N	C	C	N
lettuce, prickly	C	—	P	N	C	C	C	N	C	C	N
mallow, little (cheeseweed, malva)	C	C	P	P	C	P	C	N	P	N	N
mustards	C	C	P	N	P	C	N	N	C	C	N

	PREEMERGENCE						POSTEMERGENCE				
	FLU[3]	ISO[3]	NOR[1]	ORY	OXY	SIM[1]	CAR[2]	FLA[3]	GLY[2]	PAR[2]	SET[3]
nettle, burning	N	C	C	P	C	C	N	N	N	P	N
nightshade, black	C	C	C	N	C	C	C	N	C	C	N
nightshade, hairy	C	C	C	N	C	C	C	N	C	C	N
pigweed	C	C	P	C	C	C	C	N	C	C	N
puncturevine	C	C	C	P	C	P	N	N	C	C	N
purslane	C	C	P	C	C	C	N	N	P	C	N
sowthistle	N	C	P	N	C	C	C	N	C	P	N
spurge, prostrate	N	C	P	C	P	N	N	N	C	C	N
starthistle, yellow	N	N	—	N	C	C	N	N	C	C	N
thistle, Russian	C	C	C	P	P	C	N	N	C	C	N
velvetleaf	C	C	—	N	—	—	C	N	P	C	N

	PREEMERGENCE						POSTEMERGENCE				
	FLU[3]	ISO[3]	NOR[1]	ORY	OXY	SIM[1]	CAR[2]	FLA[3]	GLY[2]	PAR[2]	SET[3]
PERENNIALS											
Seedling											
bermudagrass	N	N	C	C	N	P	N	C	C	N	C
bindweed, field	P	C	N	P	N	C	N	N	C	P	N
dallisgrass	N	N	N	C	N	C	N	N	C	N	C
johnsongrass	C	N	C	C	N	C	N	C	C	N	C

	PREEMERGENCE						POSTEMERGENCE				
	FLU[3]	ISO[3]	NOR[1]	ORY	OXY	SIM[1]	CAR[2]	FLA[3]	GLY[2]	PAR[2]	SET[3]
Established											
bermudagrass	N	N	P	N	N	N	N	P	C	—	P
bindweed, field	P	C	N	N	N	N	N	N	P	N	N
dallisgrass	N	N	N	N	N	N	N	N	C	N	—
fescue	N	—	C	N	—	—	N	—	C	—	—
johnsongrass	C	N	P	N	N	N	N	C	C	N	C
nutsedge, purple	N	N	P	N	N	N	N	N	P	N	N
nutsedge, yellow	N	N	P	N	N	N	N	N	P	N	N

C	= control	P	= partial control	N	= no control	—	= no information

CAR	= carfentrazone (Shark)	ORY	= oryzalin (Surflan)
FLA	= fluazifop-p-butyl (Fusilade DX)	OXY	= oxyfluorfen (Goal, GoalTender)
FLU	= flumioxazin (Chateau)	PAR	= paraquat (Gramoxone)
GLY	= glyphosate (Roundup, Touchdown etc.)	SET	= sethoxydim (Poast)
ISO	= isoxaben (Gallery)	SIM	= simazine (Princep)
NOR	= norflurazon (Solicam)		

[1] Considered to be a ground water contaminant and requires a use permit within Ground Water Protection Areas.

[2] Contact with spray or drift can severely damage avocado.

[3] For use on nonbearing trees only.

[4] Some populations of rigid ryegrass, horseweed, and hairy fleabane) are resistant to glyphosate.

SITE PREPARATION – BEFORE PLANTING
Preemergence (before weeds emerge)

A.	**NORFLURAZON**			
	(Solicam DF)	**Label rates**	**12**	**60**
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 12			
	COMMENTS: Rate depends on soil texture (see label). Do not apply to the soil under young trees (trees less than about 3 years old). Apply to soil as a directed spray from fall to early spring. If no rainfall occurs within 4 weeks, incorporate with sprinkler irrigation. Can suppress yellow nutsedge or bermudagrass when used year after year. Remove existing weeds (e.g., with cultivation, hand-weeding, or a postemergence herbicide) because it has no postemergence activity. Avoid higher rates on sandy or gravelly soils to reduce risk of injury to trees. Considered to be a ground water contaminant and requires a use permit within Ground Water Protection Areas. Do not use in the Coachella Valley. Apply in 20 to 100 gal water/acre. Residual period: 6 to 12 months.			

B.	OXYFLUORFEN	1.25–2 lb a.i.		
	(Goal 2XL)	5–8 pts	24	30
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14			
	COMMENTS: Has pre- and some postemergence activity. Do not mechanically disturb the soil after application or poor residual weed control may result. Apply in a minimum of 20 gallons of water per acre. Do not apply between bud swell and final harvest or when fruit are present as injury may occur. Residual period: 4 to 10 months.			

C.	ORYZALIN	2–6 lb a.i.		
	(Surflan)	2–6 qts	24	NA
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3			
	COMMENTS: Apply to the soil surface in 20 to 60 gal water/acre. If rain does not occur within 21 days after application, sprinkle irrigate with 0.5 to 2 inches of water. May be combined with a postemergence herbicide if weeds are present. The higher rates give the longest soil residual. Usually used at 4 lb a.i./acre. Chemigation with oryzalin is possible; see label for instructions. Residual period: 4 to 10 months.			

Precautions to reduce avocado crop injury risk: (For SIMAZINE)

1. Apply only to groves that have been established for 12 months or more.
2. Avoid use on sand, sandy loam, or loamy sand soil.
3. Immediately following application, limit irrigation to 1/2 inch.

D.	SIMAZINE*	2–4 lb a.i.		
	(Princep 4L)	2–4 qt	12	NA
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 5			
	COMMENTS: Do not apply to the soil under avocado trees. Make one application per year, or split the application between fall and spring. Simazine is frequently used in combination with other preemergence herbicides. Use the high rate for heavy soils and the low rate for lighter soils. Do not use on gravel, sand, or loamy sand soils. Limit first irrigation after application to 0.5 inch. Considered to be a ground water contaminant and requires a use permit within Ground Water Protection Areas. Residual period: 8 to 12 months.			

CROP USE DIRECTIONS

AVOCADO

Apply Princep 4L to the grove floor avoiding contact with fruit, foliage, stems or trunk. Refer to **Table 1** for a list of weeds controlled or partially controlled. Refer to **Table 2** for a list of potential tank mixtures.

Crop	Rate[1] (qt/A)	Application Timing	Restrictions
Avocado	2 - 4	Following final grove preparation *(See "Precautions" for grove establishment interval before application)*	• Apply to avocados in California and Florida only. • Do not apply more than 4 qt/A (4 lb ai/A) per calendar year. • Do not make more than one application per calendar year. • Applications made by mechanically pressurized handguns are restricted to spot treatment only.

[1]Rates are based on a broadcast treatment acre. For band applications, reduce the broadcast rate of Princep 4L and water per acre in proportion to area actually sprayed.

Precautions to reduce avocado crop injury risk:

1. Apply only to groves that have been established for 12 months or more.
2. Avoid use on sand, sandy loam, or loamy sand soil.
3. Immediately following application, limit irrigation to 1/2 inch.

Postemergence (established weeds)

A. CARFENTRAZONE 0.024–0.31 lb a.i.

(Shark EW) 2.0 fl oz 12 3

WSSA MODE-OF-ACTION GROUP NUMBER1: 14

COMMENTS: For best activity, apply when weeds are still actively growing, less than 4 inches tall or rosettes less than 3 inches wide. Provides control of emerged annual broadleaves, but has no preemergence activity. A nonionic surfactant or crop oil concentrate or methylated seed oil is required. Can be mixed with other herbicides that have pre- or post-emergence activity for broader spectrum weed control. Can be applied anytime during the season. Apply in a minimum of 20 gallons of water per acre. Do not allow contact with desirable fruit, foliage, bloom, or bark, use hooded sprayers during application.

B.	FLUAZIFOP-P-BUTYL	0.125–0.375 lb a.i.		
	(Fusilade DX)	16–24 fl oz	12	NA
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 1			
	COMMENTS: For use on nonbearing trees only. Apply to actively growing grasses when they are 2 to 8 inches in height. Add a crop oil concentrate or a nonionic surfactant according to the label for the amount of water (5–40 gal/acre) added. For bermudagrass apply to 4- to 8-inch runners; for johnsongrass apply before boot stage. Do not apply to grasses, which are stressed due to moisture, temperature, low soil fertility, mechanical, or chemical injury. Do not apply more than 72 fl oz/acre per season.			

C.	GLYPHOSATE	0.7–3.7 lb a.e.		
	(Roundup)	11 fl oz–3.3 qt	See label	See label
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 9			
	COMMENTS: Apply with a controlled applicator, low pressure flat fan nozzles, or with drift-reducing nozzles. For annual weed control use 10 to 40 gal water/acre with 1 lb/acre of glyphosate. Using the lower range of water (10-20 gal water/acre) with 1 lb/acre of glyphosate is generally more effective. Ammonium sulfate can also be added (1 to 2% by weight or 8.5 to 17 lbs per 100 gallon of water) to the spray solution to improve control in areas with hard water. It is important to add the ammonium sulfate to the water before adding the herbicide. Apply to young annuals or vigorously growing flowering perennial weeds. Some perennials require the high label rate for control. May be used on young weeds in strip that will be the tree row, followed by planting into the dead weeds. Weeds should not be cultivated for 7 to 14 days after treatment to obtain maximum control. New weeds usually do not establish for a month or more, because of the no-till effect. Residual period: less than 1 month.			

D.	PARAQUAT*	0.50 lb a.i.		
	(Gramoxone SL2.0)	2.5–4.0 pts	24	—
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 22			
	COMMENTS: Best control of annual weeds when they are in the two- to four-leaf stage. Less effective against perennials that will regrow (bermudagrass, dallisgrass, johnsongrass, and bindweed). Older weeds require higher herbicide rates. Apply in a minimum of 20 gallons of water per acre. Use 0.5% nonionic surfactant. Do not allow contact with desirable fruit, foliage, blooms, or bark, use hooded sprayers during application. Do not apply more than 4 times a year.			

E.	SETHOXYDIM	0.28–0.47 lb a.i.		
	(Poast)	1.5–2.5 pt	12	365
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 1			
	COMMENTS: For use on nonbearing trees only. Apply to young annual or perennial grasses. Repeat applications will be required for the control of perennial grasses. Add 2 pt crop oil concentrate to the spray solution. Do not apply to grass that is stressed or poor control may result. Residual period: less than 1 month.			

AFTER PLANTING – NONBEARING TREES

Premergence (before weeds emerge)

A.	FLUMIOXAZIN	0.191–0.383 lb a.i.		
	(Chateau)	6–12 oz	12	1 year
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14			
	COMMENTS: For use on nonbearing trees only. Do not apply to trees established less than one year unless protected from spray contact. Best control is achieved when irrigation or rainfall follows within 21 days of application. It will not provide adequate control of emerged weeds unless tankmixed with a postemergence herbicide. Do not apply to row middles (area between berms).			

E.	ISOXABEN	0.66–0.9975 lb a.i.		
	(Gallery 75 dry flowable)	0.66–1.33 lb	12	1 year
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 21			
	COMMENTS: For use on nonbearing trees only. Wait until soil has settled around transplant to apply. Treatments are most effective when adequate rainfall or irrigation is received within 21 days after application for incorporation. Will not control grasses or sedges.			

C.	NORFLURAZON			
	(Solicam DF)	Label rates	12	60
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 12			
	COMMENTS: Rate depends on soil texture (see label). Do not apply to the soil under young trees (trees less than about 3 years old). Apply to soil as a directed spray from fall to early spring. If no rainfall occurs within 4 weeks, incorporate with sprinkler irrigation. Can suppress yellow nutsedge or bermudagrass when used year after year. Remove existing weeds with cultivation or a postemergence herbicide, because it has no postemergence activity. Avoid higher rates on sandy or gravelly soils to reduce risk of injury to trees. Considered to be a ground water contaminant and requires a use permit within Ground Water Protection Areas. Apply in 20 to 100 gal water/acre. Residual period: 6 to 12 months.			

D.	ORYZALIN	2–6 lb a.i.		
	(Surflan)	2–6 qt	24	NA
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3			
	COMMENTS: Apply to the soil surface in 20 to 60 gal water/acre. If rain does not occur within 21 days after application, sprinkle irrigate with 0.5 to 2 inches water. May be combined with a postemergence herbicide if weeds are present. The higher rates give the longest soil residual. Usually used at 4 lb a.i./acre. Chemigation with oryzalin is possible, see label for instructions. Residual period: 4 to 10 months. Can be tank-mixed with glyphosate.			

Postemergence (established weeds)

A.	CARFENTRAZONE	0.024–0.31 lb a.i.		
	(Shark EW)	2.0 fl oz	12	3
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14			
	COMMENTS: For best activity, apply when weeds are still actively growing, less than 4 inches tall or rosettes less than 3 inches wide. Provides control of emerged annual broadleaves, but has no preemergence activity. A nonionic surfactant or crop oil concentrate or methylated seed oil is required. Can be mixed with other herbicides that have pre- or post-emergence activity for broader spectrum weed control. Can be applied anytime during the season. Apply in a minimum of 20 gallons of water per acre. Do not allow contact with desirable fruit, foliage, bloom, or bark, use hooded sprayers during application.			

B.	FLUAZIFOP-P-BUTYL	0.125–0.375 lb a.i.		
	(Fusilade DX)	See Label	12	NA
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 1			
	COMMENTS: For use on nonbearing trees only. Apply to actively growing grasses when they are 2 to 8 inches in height. Add a crop oil concentrate or a nonionic surfactant according to the label for the amount of water (5–40 gal/acre) added. For bermudagrass apply to 4- to 8-inch runners; for johnsongrass apply before boot stage. Do not apply to grasses which are stressed due to moisture, temperature, low soil fertility, mechanical, or chemical injury. Do not apply more than 72 fl oz/acre per season.			

C.	GLYPHOSATE	0.7–3.7 lb a.e.		
	(Roundup)	11 fl oz–3.3 qt	See label	See label
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 9			
	COMMENTS: Apply with a controlled applicator, low pressure flat fan nozzles, or with drift-reducing nozzles. Contact with spray or drift can severely damage avocado. For annual weed control use 10 to 40 gal water/acre with 1 lb/acre of glyphosate. Using the lower range of water (10–20 gal water/acre) with 1 lb/acre of glyphosate is generally more effective. Ammonium sulfate can also be added (1 to 2% by weight or 8.5 to 17 lbs per 100 gallon of water) to the spray solution to improve control in areas with hard water. It is important to add the ammonium sulfate to the water before adding the herbicide. Apply to young annuals or vigorously growing flowering perennial weeds. Some perennial weeds require the high label rate for control. May be used on young weeds in strip that will be the tree row, followed by planting into the dead weeds. Weeds should not be cultivated for 7 to 14 days after treatment to obtain maximum control. New weeds usually do not establish for a month or more, because of the no-till effect. Can be tank-mixed with oryzalin.			

D.	PARAQUAT*	0.50 lb a.i.		
	(Gramoxone SL2.0)	2.5–4.0 pts	24	—
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 22			
	COMMENTS: Best control of annual weeds when they are in the two- to four-leaf stage. Less effective against perennials that will regrow (bermudagrass, dallisgrass, johnsongrass and bindweed). Older weeds require higher herbicide rates Apply in a minimum of 20 gallons of water per acre. Use 0.5% nonionic surfactant. Do not allow contact with desirable fruit, foliage, blooms, or bark, use hooded sprayers during application. Do not apply more than 4 times a year.			

E.	SETHOXYDIM	0.28–0.47 lb a.i.		
	(Poast)	1.5–2.5 pt	12	365
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 1			
	COMMENTS: For use on nonbearing trees only. Apply to young annual or perennial grasses. Repeat applications will be required for the control of perennial grasses. Add 2 pt crop oil concentrate to the spray solution. Do not apply to grass that is stressed or poor control may result. Residual period: less than 1 month.			

ESTABLISHED TREES

Preemergence (before weeds emerge)

A. NORFLURAZON

(Solicam DF)	Label rates	12	60

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 12

COMMENTS: Rate depends on soil texture (see label). Do not apply to the soil under young trees (trees less than about 3 years old). Apply to soil as a directed spray from fall to early spring. If no rainfall occurs within 4 weeks, incorporate with sprinkler irrigation. Can suppress yellow nutsedge or bermudagrass when used year after year. Remove existing weeds (e.g., with cultivation, hand-weeding, or a postemergence herbicide) because it has no postemergence activity. Avoid higher rates on sandy or gravelly soils to reduce risk of injury to trees. Considered to be a ground water contaminant and requires a use permit within Ground Water Protection Areas. Do not use in the Coachella Valley. Apply in 20 to 100 gal water/acre. Residual period: 6 to 12 months.

B.	ORYZALIN	2–6 lb a.i.		
	(Surflan)	2–6 qts	24	NA
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3			
	COMMENTS: Apply to the soil surface in 20 to 60 gal water/acre. If rain does not occur within 21 days after application, sprinkle irrigate with 0.5 to 2 inches water. May be combined with a postemergence herbicide if weeds are present. The higher rates give the longest soil residual. Usually used at 4 lb a.i./acre. Chemigation with oryzalin is possible; see label for instructions. Residual period: 4 to 10 months.			

C.	OXYFLUORFEN	1.25–2 lb a.i.		
	(Goal 2XL)	5–8 pts	24	30
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14			
	COMMENTS: Has pre- and some postemergence activity. Do not mechanically disturb the soil after application or poor residual weed control may result. Apply in a minimum of 20 gallons of water per acre. Do not apply between bud swell and final harvest or when fruit are present as injury may occur. Residual period: 4 to 10 months.			

D.	SIMAZINE*	2–4 lb a.i.		
	(Princep 4L)	2–4 qt	12	NA
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 5			
	COMMENTS: Do not apply to the soil under avocado trees. Make one application per year, or split the application between fall and spring. Simazine is frequently used in combination with other preemergence herbicides. Use the high rate for heavy soils and the low rate for lighter soils. Do not use on gravel, sand, or loamy sand soils. Limit first irrigation after application to 0.5 inch. Considered to be a ground water contaminant and requires a use permit within Ground Water Protection Areas. Residual period: 8 to 12 months.			

Postemergence (after weeds emerge)

A.	CARFENTRAZONE	0.024–0.31 lb a.i.		
	(Shark EW)	2.0 fl oz	12	3
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14			
	COMMENTS: For best activity, apply when weeds are still actively growing, less than 4 inches tall or rosettes less than 3 inches wide. Provides control of emerged annual broadleaves, but has no preemergence activity. A nonionic surfactant or crop oil concentrate or methylated seed oil is required. Can be mixed with other herbicides that have pre- or post-emergence activity for broader spectrum weed control. Can be applied anytime during the season. Apply in a minimum of 20 gallons of water per acre. Do not allow contact with desirable fruit, foliage, bloom, or bark, use hooded sprayers during application.			

C.	OXYFLUORFEN	1.25–2 lb a.i.		
	(Goal 2XL)	5–8 pts	24	30
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14			
	COMMENTS: Has pre- and some postemergence activity. Herbicide can be used on weed-free soil to prevent germination of a wide variety of weeds or it can be applied to existing weeds at seedling stage especially with a tank mix partner to increase the variety of weeds controlled and/or the length of residual control. Do not mechanically disturb the soil after application or poor residual weed control may result. Apply in a minimum of 20 gallons of water per acre. Do not apply between bud swell and final harvest or when fruit are present as injury may occur. Residual period: 4 to 10 months.			

B.	GLYPHOSATE	0.7–3.7 lb a.e.		
	(Roundup)	11 fl oz–3.3 qt	See label	See label
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 9			
	COMMENTS: Apply with a controlled applicator or with low pressure flat fan nozzles. Contact with spray or drift can severely damage avocado. For annual weed control use 10 to 40 gal water/acre with 1 lb/acre of glyphosate. Using the lower range of water (10 to 20 gal water/acre) with 1 lb/acre of glyphosate is generally more effective. Ammonium sulfate can also be added (1 to 2% by weight or 8.5 to 17 lbs per 100 gallon of water) to the spray solution to improve control in areas with hard water. It is important to add the ammonium sulfate to the water before adding the herbicide. Apply to young annuals or vigorously growing flowering perennial weeds. Some perennial weeds require the high label rate for control. May be used on young weeds in strip that will be the tree row, followed by planting into the dead weeds. Weeds should not be cultivated for 7 to 14 days after treatment to obtain maximum control. New weeds usually do not establish for a month or more, because of the no-till effect. Can be tank-mixed with oryzalin.			

D.	PARAQUAT*	0.50 lb a.i.		
	(Gramoxone SL2.0)	2.5–4.0 pts	24	—
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 22			
	COMMENTS: Best control of annual weeds when they are in the two- to four-leaf stage. Less effective against perennials that will regrow (bermudagrass, dallisgrass, johnsongrass and bindweed). Older weeds require higher herbicide rates Apply in a minimum of 20 gallons of water per acre. Use 0.5% nonionic surfactant. Do not allow contact with desirable fruit, foliage, bloom, or bark, use hooded sprayers during application. Do not apply more than 4 times a year.			

E.	SETHOXYDIM	0.28–0.47 lb a.i.		
	(Poast)	1.5–2.5 pt	12	365
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 1			
	COMMENTS: For use on nonbearing trees only. Apply to young annual or perennial grasses. Repeat applications will be required for the control of perennial grasses. Add 2 pt crop oil concentrate to the spray solution. Do not apply to grass that is stressed or poor control may result. Residual period: less than 1 month.			

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

*** Permit required from county agricultural commissioner for purchase or use.**

NA Not applicable.

1 Group numbers are assigned by the Weed Science Society of America (WSSA) according to different modes of action. Although weeds may exhibit multiple resistance across many groups, mode of action numbers are useful in planning mixtures or rotations of herbicides with different modes of action.

https://ipm.ucanr.edu/agriculture/avocado/herbicide-treatment-table/#gsc.tab=0

See the website above for:

Common and scientific names of weeds.

Integrated weed management.

Special weed problems.

Susceptibility of weeds to herbicide control.

Herbicide treatment table.

CalPolySLO Weed Control

Herbicides used for avocado weed control at CalPolySLO were Simazine (Princep) for preemergent weed control after trees were established for one year. Roundup was used for existing weeds. Tank mixes of Simazine and Roundup were often also used.

Herbicide sprays were applied by hand wands or boom sprayers. Areas covered were all of the avocado orchard soil (clean culture) on flat land or orchard row strips or terraces, not terrace banks on hillsides.

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Chapter 8. Irrigation Principles for Avocados

(https://www.agric.wa.gov.au/spring/growing-avocados-irrigation-principles?page=0%2C3)

Water quality. Salinity. The avocado tree is considered to be highly sensitive to salt and particularly chloride ions. There are some differences between the various races of avocado — avocados evolved in three different regions and are grouped accordingly into Mexican, Guatemalan and West Indian races. The Mexican race being the most sensitive, followed by the Guatemalan with the West Indian race being the least sensitive.

One simple and relatively cheap method of determining water quality in terms of total salt, is to carry out an electrical conductivity test (EC) using a solubridge device usually provided in microSeimens per centimetre (µS/cm), this figure can be converted to provide an approximate determination of Total Dissolved Solids (TDS) often given in parts per million (ppm). In many locations in the South-West of Western Australia, EC is a fair representation of the levels of the potentially harmful ions sodium and chloride. However, this is not always the case, so it can be of value to get a complete analysis of your water. This will provide accurate levels of sodium and particularly chloride ions. The following information assumes that the bulk of the TDS is sodium and chloride ions and therefore the EC reading is a fair representation.

Salinity

Preferably, irrigation water for avocados should have an EC of less than 500µS/cm (approximately 320 ppm), ideally less than 300µS/cm (190ppm). Poorer quality water of up to about 700µS/cm (450ppm) can be used, and is used by some growers, but management practices must be employed to reduce the impact on tree health and therefore fruit yield and quality. Depending on the severity of the salt levels, various strategies such as the use of more tolerant rootstocks, salt leaching, pulse irrigation and the application of gypsum may be used. At levels higher than 700µS/cm EC, consideration should be given to the suitability of the water for avocado production. It can be done, but it is likely that yield and fruit quality will suffer regardless of your strategies.

Salinity

The danger with salty irrigation water is that we aim to waste as little water as possible by only applying what the tree uses. The water is used by the tree and also evaporates from the soil surface, leaving behind much of the salts that were in the irrigation water. This starts to cause a significant build-up of salts within the root zone. This can lead to excessive levels of chlorides being taken up by the tree, rates higher than 0.25% in the leaves are considered toxic. Leaching can be used to try and reduce these built up levels of salt in the soil. This is achieved by using extended irrigations that apply sufficient water to the soil to result in saturation of the soil to a point beyond the root zone. The idea is that it will take the salts with the water front to a point beyond the reach of the roots. The frequency of leaching is dependent on water quality, the higher the TSS content, the more frequent you will need to leach. But avoid leaching any more than is necessary as, this is not only wasteful, but will push required plant nutrients beyond the root zone along with the salts.

Salinity

Leaching is not an exact science and a level of experimentation will be required to determine the best length of irrigation and how frequently you should apply them. Growers with salty water have reported that doing a heavy irrigation once a week or from 'time to time' are useful in removing salts.

The best way to leach if total salts are at a toxic level (3.4 ec) is to give three successive deep irrigations spaced out every other day to allow leaching to occur. Do not irrigate continuously with the three deep irrigations. Water will flow through large pore spaces and not leach.

Choice of rootstock is important when using salty water. Research in Chile has identified Nabal as a salt tolerant rootstock. Australian research shows that Nabal, Velvick and the relatively new SHSR-03 are good rootstocks in areas with saline water with cumulative three year yields of 120.8 kg per tree for Nabal, 119.1 kg per tree for SHSR-03, and 128.7 kg per tree for Velvick. These rootstocks have Guatemalan and West Indian parentage. For full details of the research see the final report of AV08000 on the Avocados Australia Best Practice Resource.

Iron

Iron can be a significant issue for many avocado growers, particularly those using under-ground water resources. Iron concentrations of greater than 1 milligram per litre (mg/L) should be treated otherwise irrigation blockages are likely to be experienced. At this concentration the iron in the water oxidises upon contact with air and forms precipitates. Evidence of iron precipitating is the red stain often seen on sprinklers and tree trunks. Bacteria in water supplies can also lead to iron precipitating at lower concentrations. The iron precipitate can result in emitter blockage on its own and is mostly a problem for growers using drippers and micro-sprays, though low volume mini-sprinklers can sometimes be affected. The iron and bacteria combination can result in bacterial slime which causes greater issues. The slime grows as a result of the bacteria oxidising the soluble iron and is a great problem for many growers, causing blockages in even the largest of sprinkler emitters.

Iron is most commonly treated by aeration in settling tanks to oxidise the iron and cause it to precipitate followed by quality filtration. If iron created blockages occur your system will need to be cleaned by either scouring or acid treatment.

Sediment/particles

Depending on your system, both inorganic and organic sediment can find its way into your irrigation water. If these sediments are larger than your emitters then they can block them resulting in inefficient delivery of water to your trees. The only way to remove sediment is by filtration, ensure your filtration unit is suitable to remove any sediment larger than what can readily flow through your emitters and can handle the flow volume required. Filtration systems should be situated after any aeration systems to oxidise soluble iron and any fertigation systems. Filtration is an integral part of any irrigation system and should be designed by your irrigation engineer

Fertigation

Fertigation is the delivery of fertilisers, or plant nutrients, to your trees via your irrigation system. Many avocado growers have set up fertigation systems as part of their irrigation systems. This requires specialised equipment and careful design.

Frost mitigation

Under tree mini-sprinklers can be used to help reduce the impact of mild frost events (see 'Growing avocados – frost' for more information on frost). Water by nature is more than 0°C, so by distributing this under trees you are providing warmth to the surface. Also, as water freezes it gives off heat, so by providing water to freeze, you are generating heat. However, water cannot flow when it is frozen, so any under-tree irrigation systems must be started before the temperature gets to a point where the water freezes in the pipes or emitters. Most growers have these automated with temperature sensors and operate short bursts of irrigation through the orchard until the temperature rises again. The temperature sensor must be located at the coldest point of your orchard.

Excess irrigation

We have emphasised the point of avoiding moisture stress and that avocado trees require a plentiful supply of irrigation and this needs to be applied at regular intervals. It is equally important to highlight that the avocado tree is also highly susceptible to water logging. Avocado trees are reported to start to show signs of root damage after just 24 hours of water logged soil. This is due to a lack of oxygen in the soil when it is saturated. The heavier your soil (the higher the clay content), the greater the likelihood you have of having extended periods of saturated soil. This is due to the slower infiltration rate of heavier soils resulting in the water taking longer to drain away. The other major danger of excess irrigation is that such conditions can be highly favourable to the development and spread of Phytophthora cinnamomi, or die back. This fungal like water-mould thrives in moist, warm soil, plus trees that are stressed as a result of water logging are much more susceptible to attack. Therefore, it is important to let the soil dry to your chosen refill point rather than irrigating too frequently.

Irrigation and the environment

Water is a limited commodity, so we should be aiming to waste as little as possible. Careful irrigation has less impact on the environment. Over watering is not only wasteful, but expensive due to increasing power cost for pumping and can impact on the environment. Excess leaching combined with fertilising can result in sub soil acidification and also ground water pollution in extreme cases.

Acknowledgement

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Avocado Irrigation. Soil Depth for Avocado Trees.

(http://avocadosource.com/Journals/SAAGA/SAAGA_1990/SAAGA_1990_PG_8-10.pdf)

Depth of avocado roots should be the first consideration for irrigation.

According to Nel (1983), a soil suitable for avocado production should possess the following characteristics: — Clay content of between 20 and 40%. — Well-drained. — No compacted, clayey or patchy layers. — Soil depth > 2 m. — pH around 6.0-6.5. (http://avocadosource.com/Journals/SAAGA/SAAGA_1990/SAAGA_1990_PG_8-10.pdf)

The effective root depth of avocado trees is about 100-200 mm above a restrictive layer or abrupt change in soil texture and structure. Avocado trees have deep taproots that can reach 2 to 3 feet into the soil. The deeper, vertical roots specialize in accessing deeper water tables and stored nutrients. The root system of an avocado tree is very important because it helps to support the tree during growth and harvest. (Bing.com)

Irrigation Depth

Irrigation depth for avocado trees should be 2 feet, sometimes 3 feet. 2 feet on heavy soils, 3 feet on lighter soils. Soil moisture sampling should be to these depths. Most sampling should be one foot and two feet. Shallow depth is one foot. Deep depth is two feet. Using soil augers or tensiometers. Insert two tensiometers in each block, one at 12 inches, another at 24 inches.

When the 12 inch deep soil indicates dryness, irrigate 12 inches deep. When the 24 inch deep soil also indicates dryness, irrigate 24 inches deep. Every so often irrigate 36 inches deep. Include a leaching fraction.

How much water to apply? See table below.

This depends on the water holding capacity of the soil described in the next table. Irrigation should be when 30-50 % of the available soil water has been depleted. Sandy loams hold 1.0 to 1.8 inches per foot of soil. Silt loams hold 1.8 to 2.4 inches per foot of soil. Clay loams hold 2-2.6 Inches per foot of soil. A leaching fraction must also be applied.

Apply half of the available water (inches) to go to the depth required. A silt loam would require about half of 2 inches of available water per foot of soil depth. One foot deep would require 1 inch of applied water. Two feet deep would require 2 inches of applied water. Half of 4 inches of available water.

Apply one inch of water and see how deep it goes in your soil. Use a probe (rod with handle) or auger to see how deep it goes. A probe moves easily through moist soil. Meets resistance in drier soil.

Available Water and Infiltration Rates for Different Soil Textures (McNeil, 2001)

Soil Texture	Available Water (inches per foot)	Infiltration Rate (Inches per hour)
COARSE SAND	0.4-0.8	5.0-10.0
FINE SAND	0.8-1.2	2.0-5.0
SANDY LOAM	1.0-1.8	0.5-4.0
LOAM	1.7-2.3	0.25-2.0
SILT LOAM	1.8-2.4	0.20-1.5
CLAY LOAM	2.0-2.6	0.05-0.50
SILTY CLAY LOAM	2.2-2.8	0.05-0.25
CLAY	2.4-3.0	0.005-0.05

Choose the application rate of your irrigation system to match up with your soils infiltration rate. A 20 g/hr minisprinkler applies .21 in/hr at a 20x20 feet spacing. This would infiltrate on a silt loam soil. A 10 gal/hr minisprinkler applies .105 in/hr at a 20x20 feet spacing. This would infiltrate on a clay loam soil. See previous table.

Calculation of a Sprinkler Application Rate

Formula: 96.3 x gpm/sprinkler spacing = application rate in/hr.

Example: Dragline sprinklers: 1 GPM, 20 X 20 feet spacing.

96.3 x 1 gpm / 20 x 20 = 96.3 / 400 = .24 in/hr.

If 2 in of water needed. 2 in / .24 in/hr = 8.33 hours to apply 2 inches of water.

Methods of Irrigation

Old methods were furrow or flood irrigation on level soil. 50 gpm per acre might be needed. Or high volume sprinklers. Newer methods are drip and minisprinklers.

Design of Irrigation Methods

Have an irrigation sales company design your irrigation system, especially for drip, minisprinklers, or high volume sprinklers. Supply your irrigation lines with 2 inch pvc pipe in case you need more volume for frost protection.

Also have a knowledgable company design your furrow or flood irrigation system.

Fruit Growers Supply company designs irrigation systems:

https://fruitgrowers.com/ And Fruit Growers Supply IRRIGATION DESIGN, REPAIRS, MAINTENANCE AND INSTALLATION.

Also design can be found at CalPolySLO website:

www.ITRC.org (CalPolySLO)

Furrow Irrigation (Bing.com)

Flood Irrigation (Bing.com)

Furrow irrigation systems (fig. 4) carry water in furrows rather than flooding the entire area between tree rows. Most often, two or more furrows per tree row are used. The amount of irrigation water applied may be determined by the following formula.

inches applied = [1.6 × furrow inflow rate (gpm) × number of furrows per tree row × irrigation set time (min)] ÷ [tree row length (ft) × tree row spacing (ft)]

Furrow Irrigation Systems
https://ucanr.edu/sites/btfnp/files/165618.pdf#:~:text=Evapotranspiration%20information

Designing Furrow Irrigation for Orchards

https://www.irrigationtoolbox.com/NEH/Part652_NationalIrrigationGuide/ch6.pdf

Water Flows from a Standpipe to Furrow Irrigate an Orchard (Bing.com)

Border Irrigation (Flood)

https://ucanr.edu/sites/btfnp/files/165618.pdf#:~:text=Evapotranspiration%20information

Border irrigation systems flood the area between tree rows (fig. 3). The amount of irrigation water applied may be determined by the following formula.

inches applied = [1.6 × flow to border (gpm) × irrigation set time (min)] ÷ [tree row length (ft) × tree row spacing (ft)]

Figure 3. Orchard border irrigation. *Photo:* Lawrence J. Schwankl.

Flood Irrigation Design for Orchards (Almonds)(Bing.com)

https://www.agrivi.com/blog/agronomy/modern-management-of-centennial-flood-irrigation/

Sprinkler Irrigation Systems

The application rates of sprinkler irrigation systems are most often provided in inches per hour, which is compatible with evapotranspiration data. If you do not know the sprinkler application rate in an orchard, see the companion water management publication *Soil Intake Rates and Application Rates in Sprinkler-Irrigated Orchards* (Publication 8216).

Or use the formula 96.3 x gph / product of sprinkler spacing in feet = inches per hour application rate.

Example: For 10 g/hr minisprinkler.
1.6 x 10 gph / 20 x 20 ft = 16/400 = .04 in/hr
20 g/hr minisprinkler would be 1.6 x 20 gph / 20 x 20 ft = 32 / 400 = .08 in/hr

Microirrigation Systems

The application rate of microirrigation system emitters (drip emitters and microsprinklers) is usually measured in gallons per hour (gph). To convert an application rate in gallons per hour to inches per hour, use the following formula.

application rate (in/hr) = [1.6 × discharge from emission devices per tree (gph)] ÷ [tree row spacing (ft) × tree spacing within row (ft)]

Avocado Irrigation Methods

https://ripenavocados.com/guides/best-irrigation-systems-for-avocado-tree/

Drip irrigation is the best method for watering avocado trees because it conserves water and doesn't require much labor. Micro irrigation systems are also effective, but they can be expensive to set up and maintain.

Filtration is necessary to avoid clogging. See plugging hazards in the next table (McNeil, 2001).

Microirrigation Plugging Hazards	Burt, 1995	Bucks and Nayayama, 1980	Schwankl et al, 1996
Potential Problem	Hazard: Low	Moderate	Severe
PHYSICAL;			
Suspended solids	<than 50 ppm	50-100 ppm	>100 ppm
CHEMICAL:			
pH	<7	7.0-8.0.	>8.0
TOTAL DISSOLVED SOLIDS (SALTS)	<500 PPM	500-2000 PPM	>2000 PPM
BICARBONATE HARDNESS (PPM CACO3)	<150 PPM	150-300 PPM	>300 PPM
ALKALINITY (PPM CACO3)	<100 PPM	100-200 PPM	>200 PPM
HYDROGEN SULFIDE	<0.2 PPM	0.2-2.0 PPM	> 2.O PPM0
MANGANESE	<0.1 PPM	0.1 – 1.0 PPM	>1.0 PPM
IRON	<0.1 PPM	0.1-1.0 PPM	>1.0 PPM
BIOLOGICAL			
BACTERIAL POPULATIONS	<2642/GALLON	2642-13,210/GAL.	>13,210/GAL
	<10,000/LITER	10,000-50,00LITER	>50,000/LITER

FILTRATION (SOLIDS REMOVAL)
(Burt, 2016)

Water sources for drip/micro irrigation include municipal water, reservoirs, rivers, canals, and groundwater. Solids contaminants include inorganic material such as sand, silt, and clay; aquatic growth such as algae and fish; and trash such as plastic bottles, tumbleweeds, weed seeds, and rags. Reasons for removal of solids include:

- Pump wear. Sand and other abrasive inorganic materials can cause serious wear on pump impellers and bowls, which results in reduced pumping plant efficiencies and less water delivered by the pumps.
- Emitter plugging. Drip/micro irrigation systems have much smaller outlets, ranging from about 0.01"-0.07" *(0.03 cm-0.18 cm)* in diameter. A rule of thumb in the drip/micro irrigation industry is that all particles greater than 1/10th the diameter of the emission holes must be removed from the water to prevent emitter plugging by "bridging" (see Figure 115). Therefore, drip filtration must remove particles down to the 0.001"-0.007" *(0.003 cm-0.018 cm)* diameter size. For microsprayers with large and simple orifices, removal of particles $1/7^{th}$ the orifice diameter is generally considered sufficient for plugging (but not for wear).

Types of Filters (Burt, 2016)

Sand separators use the centrifugal action of spinning water to remove sand an
are very effective if they are sized properly and the flow rates remain relatively
constant. Models are made to fit either before or after pumps.

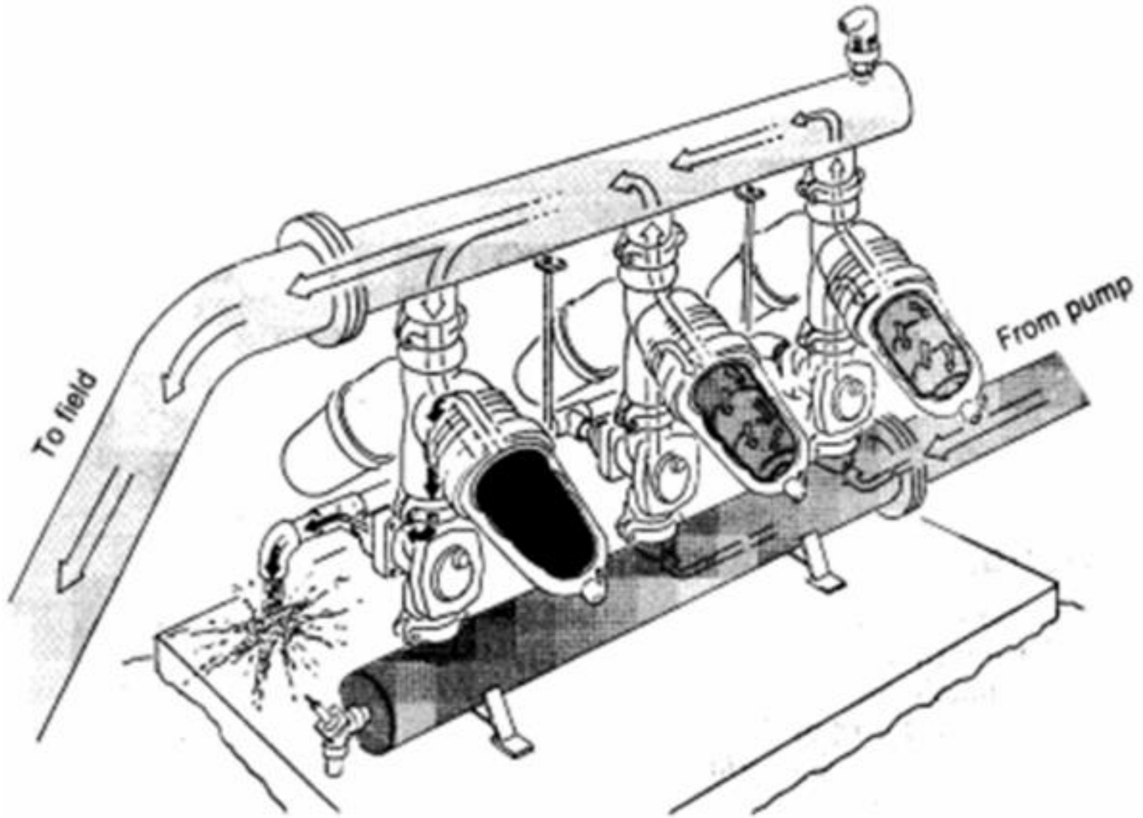
Media Tanks

Media tanks utilize high flow rates passing through sand tanks to remove large volumes of organic and inorganic contaminates. The sand is sized to provide the required degree of filtration and it is retained in the tank by an underdrain at the tank bottom. The tanks backflush one at a time. Rugged automatic controllers determine backflushing cycles based on time elapsed or pressure differentials across the tanks.

Tubular screens provide low-capacity, emergency filtration. They are used as backups to primary filtration devices, or in very clean water situations.

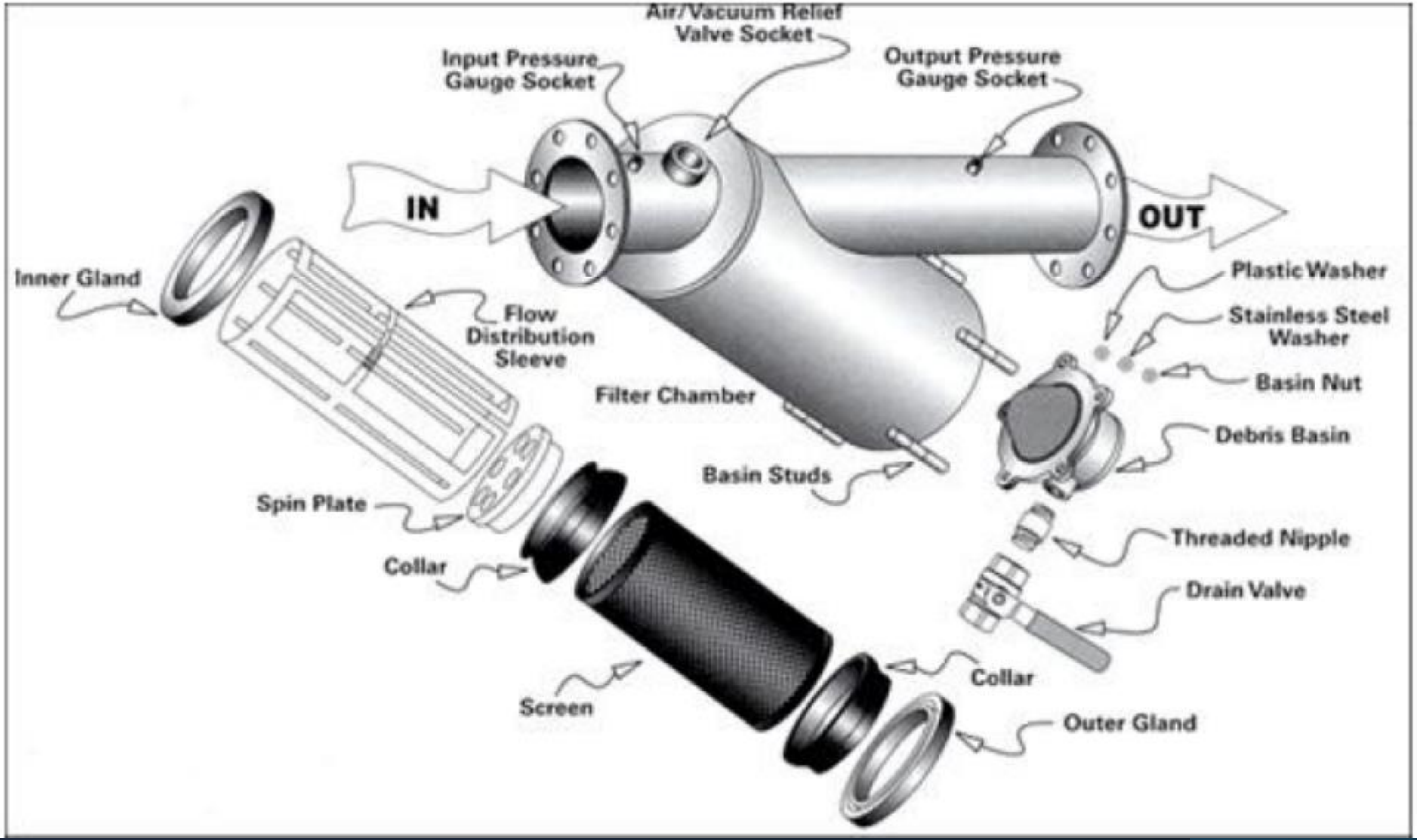
Gravity overflow screens provide high-capacity, primary filtration. They are typically self-cleaning. Water cascades onto a very tight, fine mesh screen. Contaminates are washed to the edge of the screen, and the clean water passes through the screen fabric to a lower chamber where it is picked up by a booster pump and delivered to the drip system.

Disc filters are a hybrid between a media tank and a tubular screen. They can be thought of as a stack of circular disks; each disk has a cross-hatch pattern of grooves of the appropriate depth to provide the required filtration. Water must pass between the disks; the grooves allow water to pass, but they retain the solids. These filters, especially the ones with automatic backflush features, are relatively new in the U.S. drip markets.



Rotary cleaning tubular screen filters must be automated to frequently clean off the small filtration surface area.

<u>Hybrid screens</u> combine some spinning action of the water with an internal screen. The spinning action is intended to continually clean the inside of the screen (on the upstream side). These screens generally require a constant flushing/drain discharge of 5-10 GPM, and a 5-8 psi pressure differential.



Using a Tensiometer

A tensiometer is one of the best ways to measure soil moisture. It consists of a water-filled tube with a pressure gauge at the top and a porous clay cup at the bottom. The tensiometer measures the amount of energy a plant needs to extract water from the soil.

Fill the tube with water and place it in a bucket overnight. Use a portable vacuum pump to draw air bubbles out of the clay cup and have water fill the clay.

Place tensiometers about 2-3 feet away from the sprinkler in the wetted area of the root zone, at the dripline.

Use an auger or other tool to create a hole for the tensiometer.

Pour a cup of water into the hole and place the tensiometer at the correct depth. Do not pound on the tensiometer — the clay cup is fragile.

Pack loose soil around the tensiometer and tamp it down.

Run the irrigation system to help settle the soil around the tensiometer.

Checking Soil Moisture in Avocado Groves

https://www.californiaavocadogrowers.com/cultural-management-library/checking-soil-moisture-avocado-groves

Avocado trees are heavy users of water but they have a shallow feeder root system located primarily in the top six - twelve inches of soil that are prone to drying out. Monitoring soil moisture in avocado groves is important.

Soil moisture can be checked by hand for a general assessment. To do so, gather a sample about 8 – 16 inches deep in the root zone area and form a ball of soil. If the soil has about 50% of available water remaining, the level needing irrigation, it will form as follows:

Coarse soil will form a ball that does not hold its shape and it will appear almost dry.

Loamy soil will form a ball and have a dark color.

Clay soil will be slightly sticky and form a good ball.

The next page has soil moisture testing by sight and feel (Cooney and Pehrson, 1955).

Recognition of soil moisture levels require experience and observation. Some of the characteristics more easily recognized are listed in the following table.

SOIL'S TEXTURAL APPEARANCE

Moisture Level	Loamy Sand, Sandy Loam (Coarse Soils)	Loam, Silt Loam (Medium Soils)	Clay Loam, Clay (Fine Soils)
No available soil moisture. Plants wilt. Irrigation required.	Dry, loose, clods easily crushed and will flow through fingers. No stain or smear on fingers	Crumbly, dry, powdery. Will barely maintain shape. Clods break down easily. May leave smear or stain when worked with hands or fingers.	Hard, firm baked, cracked. Usually too stiff or tough to work or ribbon* by squeezing between thumb and forefinger. May leave slight smear or stain.
Moisture is available but level is low. Irrigation desirable.	Appears dry; may tend to make a cast when squeezed in hand, but seldom will hold together.	May form a weak cast** or ball** under pressure, but will still be crumbly. Color is pale with no obvious moisture.	Pliable, forms a cast or ball; will ribbon but usually breaks or is crumbly. May leave a slight smear or stain.
Moisture is available. Level is high. Irrigation not required.	Color is darkened with obvious moisture. Soil forms weak ball or cast under pressure. Slight finger stain, but no ribbon when squeezed through thumb and forefinger.	Color is darkened from obvious moisture. Forms a ball or cast. Works easily, clods are soft with mellow feel. Will stain finger and have slick feel when squeezed.	Color is darkened with obvious moisture. Forms a good ball or cast. Ribbons easily, has slick feel. Leaves stain or smear on fingers.
Soil moisture level following an irrigation	Appears and feels moist. Color is darkened. Forms cast or ball. Will not ribbon but will show smear stain, leave wet outline on hand.	Appears and feels moist. Color is darkened. Has a smooth, mellow feel. Forms ball and will ribbon when squeezed Stains and smears. Leaves wet outline on hand.	Color is darkened. Appears moist, may feel sticky. Ribbons cut easily, smears and stains hand. Leaves wet outline. Forms good cast or ball.

*Ribbon is formed by squeezing and working soil between thumb and forefinger.

**Cast or ball is formed by squeezing soil in hand.

*** Reprinted from Avocado Irrigation, Leaflet 50, 1955 by J.J. Coony and J.E. Pehrson, Calif. Agr. Exp. Sta. Ext. Service.

SOIL'S TEXTURAL APPEARANCE

Moisture Level	Loamy Sand, Sandy Loam (Coarse Soils)	Loam, Silt Loam (Medium Soils)	Clay Loam, Clay (Fine Soils)
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Moisture is available but level is low. Irrigation desirable. **Slightly Moist**	Appears dry; may tend to make a cast when squeezed in hand, but seldom will hold together.	May form a weak cast** or ball** under pressure, but will still be crumbly. Color is pale with no obvious moisture.	Pliable, forms a cast or ball; will ribbon but usually breaks or is crumbly. May leave a slight smear or stain.
Moisture is available. Level is high. Irrigation not required. **MOIST**	Color is darkened with obvious moisture. Soil forms weak ball or cast under pressure. Slight finger stain, but no ribbon when squeezed through thumb and forefinger.	Color is darkened from obvious moisture. Forms a ball or cast. Works easily, clods are soft with mellow feel. Will stain finger and have slick feel when squeezed.	Color is darkened with obvious moisture. Forms a good ball or cast. Ribbons easily, has slick feel. Leaves stain or smear on fingers.
Soil moisture level following an irrigation **WET**	Appears and feels moist. Color is darkened. Forms cast or ball. Will not ribbon but will show smear stain, leave wet outline on hand.	Appears and feels moist. Color is darkened. Has a smooth, mellow feel. Forms ball and will ribbon when squeezed Stains and smears. Leaves wet outline on hand.	Color is darkened. Appears moist, may feel sticky. Ribbons cut easily, smears and stains hand. Leaves wet outline. Forms good cast or ball.

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*** Reprinted from Avocado Irrigation, Leaflet 50, 1955 by J.J. Coony and J.E. pehrson, Calif. Agr. Exp. Sta. Ext. Service.

Soil Sampling for Irrigation.

Irrigate when soil is still slightly moist.

Soil samples can be made with an auger or with tensiometers. Sampling depth for avocado trees is 12 -24 inches, the two depths for which tensiometers are recommended. Make an auger sample 12 inches deep. Irrigate 12 inches deep if the soil is slightly moist at that depth. Irrigate 24 inches deep if the soil is also slightly moist at that depth.

Dryness for tensiometer readings would be 20-30 centibars for drip irrigation 6-12 inches away from drippers, 30-40 centibars for minisprinkler irrigation 2-3 feet from sprinklers. 40-50 centibars for high volume irrigation methods (sprinklers, furrow, or flood irrigation), 2-3 feet from sprinklers in the dripline, in the dripline for furrow and flood irrigation.

Irrometer Tensiometer Readings

https://irrometer.com/basics.htmls **General Guidelines**

0-10 Centibars = Saturated soil

10-30 Centibars = Soil is adequately wet (except coarse sands, which are drying)

30-60 Centibars = Usual range for irrigation (most soils)

60-100 Centibars = Usual range for irrigation in heavy clay

100-200 Centibars = Soil is becoming dangerously dry- proceed with caution!

Tensiometer Readings for Avocados

https://www.avocadosource.com/papers/research_articles/goodallgeorge1986.pdf

For high volume sprinklers, the 1-foot readings (12 inches) can rise to 40-50 before scheduling an irrigation. For low volume (mini or micro) sprinklers, 30-40 centibars is recommended. For drip (or trickle) systems, the critical range is 20-30 centibars.

Irrometer (Tensiometer) Placement Depths

Recommended Placement Depths for Avocado Trees are

12 inches shallow.

24 inches deep.

and 36 inches extra depth.

Avocado Irrigation. Tensiometer Placement.

https://irrometer.com/pdf/ext/Avocado-San_Diego_Farm_Advisor.pdf

https://www.avocadosource.com/papers/research_articles/goodallgeorge1986.pdf

A reading should be made daily to determine whether or not the instruments are operating properly. Once it is known that the instruments are functioning, readings need be made only two or three times a week. It is preferable to read the gauge at the same time each day, early morning being the best.

Tensiometers should be placed in pairs, a 12-inch and a 24-inch, with sufficient stations in the orchard to get a good representation of the soil drying characteristics.

For high volume sprinkler systems with full surface soil wetting, locate the tensiometers just inside the dripline (outer edge of foliage) on the southwest side of the tree. For low volume (mini or micro) sprinklers. placement should be about 2-3 feet away from the sprinkler.

In the case of drip irrigation, tensiometers are placed laterally within 6-12 inches of an emitter, located just inside the drip line on the southwest side of the tree.

Other Soil Moisture Measuring Devices (McNeil, 2001)

Other soil moisture measuring devices are Gypsum Blocks, Water Marks, Neutron Probes, Thermal Dissipation Sensors, Radio Frequency Sensors, Pressure Bombs, and Infrared Thermometers. They may be expensive. See Goldhamer and Snyder (1989) for more information about these instruments.

Goldhamer, D. A. and R. L. Snyder (editors). 1989. Irrigation Scheduling A Guide for Efficient On Farm Water Management, Publication 21454. University of California, Division of Agriculture and Natural Resources.

Irrigation Methods for Avocados

New avocado plantings are usually started with drip irrigation, a very efficient method. One dripper per tree is positioned on the trunk. Usually a one gal/hr dripper is used at first. Determine the depth of irrigation for your soil by trial and error. Apply one gallon when the soil is slightly dry at 12 inches. Check the soil penetration depth. It took 4 gallons (4 hours) to penetrate one foot (12 inches) deep on a clay loam soil at CalPolySLO. 8 gallons (8 hours) to penetrate two feet (24 inches) deep. Additional drippers were added as trees got larger. Eventually three per tree three feet apart.

Finally minisprinklers were added, one per tree, 20 feet apart. 10 gph minisprinklers were used because of the slow infiltration rate of the clay loam soil.

Testing infiltration rate of the minisprinkers

The infiltration depth of the 10 gph minisprinklers was tested by trial and error. They were operated for 12 hours when the soil was slightly moist 12 inches deep. Then the penetration depth was observed. The water penetrated 6 inches deep after 12 hours. Future irrigations were operated for 24 hours to penetrate 12 inches deep, 48 hours to penetrate 24 inches deep. Plus a leaching fraction.

The Leaching Fraction to Apply

An extra percentage of water needs to be applied at each irrigation to prevent salt buildup in the soil which can reduce yield. Calculate the leaching fraction with the following formula LR = ECw/(5ECe – ECw) LR = leaching requirement, ECw = salinity of applied water, ECe = salinity of the soil.

According to the tables in the Western Fertilizer Handbook, a soil extract EC of 1.3 is the threshold before yield reduction begins in avocado. If district water with an ECw of 0.9 was being applied, and the soil ECe was 1.3, the equation for leaching requirement would be as follows:

LR = 0.9/(5 x 1.3 – 0.9)

LR = 0.9/6.5 – 0.9

LR = 0.16 or 16%

Irrigation Scheduling (After Bender et al 2015)

Knowing when to water does not tell a person how much to water. The estimate of “how much to water” can be done by using CIMIS (California Irrigation Management Information System), a system of weather stations that measure evapotranspiration (ETo) of eight-inch tall grass. A crop coefficient of 0.7 is preferred for avocado trees.

CIMIS gives a fairly accurate water usage based on weather. If the available water holding capacity of the soil is known, and water is re-supplied to the soil when 30% - 50% of the moisture is depleted, irrigation scheduling can be fairly accurate.

Evapotranspiration values (www.ITRC.org) **have been developed for this section using the method outlined in Food and Agriculture Organization Irrigation and Drainage Publication No. 56.**

Irrigated agricultural crops in California were modeled on a daily basis for 13 ETo Zones that have been established by the California Dept. of Water Resources (DWR). These include the major irrigated agricultural areas in California. California Department of Water Resources ETo Zone Map separates California into 18 zones. For this project only 13 zones were looked at in determining ETc. The other zones had very little irrigated agriculture, which was grouped into the closest ETo zone.

Although the ETc values were computed for four major soil types, the tables presented here represent average values of all four soil types.

The evapotranspiration values are dependent upon assumptions of crop growth stage length, planting and harvest dates, irrigation scheduling, pre-irrigation dates, leaching irrigations, and other parameters that are crop and management specific. Information was obtained from University of California Crop Calendars, Irrigation and Water District crop calendars, ITRC staff experience, literature searches, and farmer interviews that were conducted by ITRC in spring 2000.

It is important to note that the total annual ETc values in ITRC tables include evaporation during non-growing periods which can be considerable in wet years. As most published estimates of crop ET are based only on the growing season, you will find that ITRC values can be higher than many other published values. (www.ITRC.org)

The small vegetables crop category is based primarily on lettuce in most regions. It assumes lettuce has been double cropped. Drip irrigation on small vegetables in the coastal regions assumed sprinkler irrigation for pre- and early season irrigations (3 irrigations total) and surface drip irrigation for the remainder of the irrigation season (about six irrigations of about an 8 hour duration each).

Water stress was taken into account for the scheduling of appropriate crops, such as processing tomatoes and wine grapes.

Note: The difference between the ET values in the water balance section and the ET values in the scheduling and design section is that the ETc values for a water balance must recognize that fields are not blanketed by pristine conditions. Studies in California by the ITRC have concluded that about 10% of acreage in California suffers from bare spots and/or decreased vigor. Bare spots and decreased vigor causes include, but are not limited to, salinity, non-uniformity of irrigation, under-irrigation on parts of the field, disease, poor initial crop stands, farm implement damage, and pest damage. Obviously, transpiration is lower on bare/weak spots than in the rest of the field. However, because bare spots are irrigated with the same frequency as the rest of the field, evaporation from these regions is higher than in the rest of the field. The net result is an overall reduction in actual field crop ET of 7-8%. This will vary by crop because of the difference in growing season and cover. The details are in the CALFED/ARI Evaporation Study Report. (www.ITRC.org)

>> Link to CIMIS data

>> Evapotranspiration main

Instructions on using CIMIS.

Go to the www.ITRC.org website. Click on Evapotranspiration data. Select data type: Irrigation scheduling and design. Select irrigation method. Drip/microspray, or surface, or sprinkler. Select relative precipitation year: 1997 typical year. Select Eto zone on map. Click on map on website to enlarge it and select Eto zone number. Download California Evapotranspiration Data either PDF or Excel. The monthly evapotranspiration table will display. Find the grass Eto for your month and the avocado Etc for your month. Then do the calculations: ET = Eto (for grass) x crop coefficient. Crop coefficient for avocados is .7. ET in inches will be the daily ET rate. See example on next page. Minus precipitation. Plus add leaching fraction. LR = ECw/(5ECe – ECw) LR = leaching requirement, ECw = salinity of applied water, ECe = salinity of the soil. See a previous page.

How are crop coefficients used to estimate crop ET? Estimating the daily ET rate of your crop is very simple. Multiply the ETo for that day by the crop coefficient for that day.

EXAMPLE: Your avocado crop has a crop coefficient of .7 for June 15. The CIMIS ETo value for the closest weather station for June 15 is 5.79 inches.

ET = ETo x crop coefficient

ET = 5.79 inches x .7 for avocados.

ET = 4.05 inches. Daily ET rate. Minus .22 for precipitation.

Plus leaching fraction. See a previous page for leaching fraction formula.

Go to www.ITRC.org website for this map. Click on your zone number.

ETc Table for Irrigation Scheduling and Design
Zone 4 Monthly Evapotranspiration
Drip/Micro Irrigation Typical Year
IRRIGATION TRAINING AND RESEARCH CENTER, California Polytechnic State University, San Luis Obispo
Table does not include adjustments for bare spots and reduced vigor

	1997 (Typical Year)						
	January inches	February inches	March inches	April inches	May inches	June inches	July inches
Precipitation	6.21	0.29	0.34	0.3	0.49	0.22	0.07
Grass Reference ETo	1.53	2.43	3.44	4.82	5.74	5.79	5.92
Apple, Pear, Cherry, Plum and Prune	1.72	0.65	0.64	1.14	2.91	4.48	5.13
Apples, Plums, Cherries etc w/covercrop	1.79	2.61	2.97	4.01	4.99	5.07	5.16
Peach, Nectarine and Apricots	1.72	0.65	0.74	1.37	2.97	4.37	4.81
Immature Peaches, Nectarines, etc	1.73	0.65	0.54	0.83	1.78	2.39	2.54
Walnuts	1.72	0.65	0.51	1.26	2.62	4.03	5.77
Misc. Deciduous	1.72	0.65	0.35	0.92	1.95	3.59	4.82
Cotton	1.75	0.65	0.88	0.72	1.72	4.69	6.2
Misc. field crops	1.75	0.65	1.33	1.45	2.38	5.49	5.57
Small Vegetables	1.78	2.19	3.62	2.69	3.46	5.58	1.31
Tomatoes and Peppers	1.75	0.65	1.1	0.89	3.27	6.11	5.79
Melons, Squash, and Cucumbers	1.75	0.65	0.35	0.3	1.25	0.84	3.24
Onions and Garlic	1.79	2.13	3.12	4.33	4.28	1.33	0.06
Strawberries	1.75	0.65	1.33	1.45	2.38	5.49	5.57
Flowers, Nursery and Christmas Tree	1.72	0.65	0.35	0.92	1.95	3.59	4.82
Citrus (no ground cover)	1.79	2.38	2.6	3.33	3.88	3.58	3.51
Immature Citrus	1.78	1.47	1.39	1.86	2.17	1.89	1.84
Avocado	1.72	0.65	0.35	0.92	1.95	3.59	4.82
Misc Subtropical	1.72	0.65	0.35	0.92	1.95	3.59	4.82

	August inches	September inches	October inches	November inches	December inches	Annual inches
Precipitation	0.31	0.43	0.65	4.92	4.29	18.52
Grass Reference ETo	5.7	4.78	3.58	1.56	1.74	47.04
Apple, Pear, Cherry, Plum and Prune	4.99	4.25	3.06	1.04	1.62	31.64
Apples, Plums, Cherries etc w/covercrop	5.13	4.34	3.37	1.49	2.09	43.01
Peach, Nectarine and Apricots	4.74	4.04	2.87	1.07	1.62	30.96
Immature Peaches, Nectarines, etc	2.73	2.33	1.87	1.09	1.62	20.11
Walnuts	5.45	4.71	3.16	1.45	1.61	32.95
Misc. Deciduous	4.97	4.17	3.08	1.13	1.62	28.97
Cotton	5.84	2.15	0.65	1.05	1.63	27.92
Misc. field crops	2.33	0.4	0.63	1.05	1.63	24.65
Small Vegetables	0.31	0.4	0.63	1.05	1.69	24.72
Tomatoes and Peppers	1.12	0.4	0.63	1.05	1.63	24.39
Melons, Squash, and Cucumbers	4.49	1.83	0.63	1.05	1.63	18
Onions and Garlic	0.3	0.4	0.63	1.61	1.79	21.77
Strawberries	2.33	0.4	0.63	1.05	1.63	24.65
Flowers, Nursery and Christmas Tree	4.97	4.17	3.08	1.13	1.62	28.97
Citrus (no ground cover)	3.58	3.14	2.71	1.45	2.04	33.99
Immature Citrus	1.92	1.8	1.69	1.25	1.89	20.95
Avocado	4.97	4.17	3.08	1.13	1.62	28.97
Misc Subtropical	4.97	4.17	3.08	1.13	1.62	28.97

How are crop coefficients used to estimate crop ET?

Estimating the daily ET rate of your crop is very simple. Multiply the ETo for that day by the crop coefficient for that day.

EXAMPLE: Your avocado crop has a crop coefficient of .7 for June 15. The CIMIS ETo value for the closest weather station for June 15 is 5.79 inches.

ET = ETo x crop coefficient

ET = 5.79 inches x .7   for avocados.

ET = 4.05 inches. Daily ET rate. Minus .22 for precipitation.

Plus leaching fraction. See a previous page for leaching fraction formula.

The Water Budget Irrigation Scheduling System (Bender et al 2015)

In the previous sections in this chapter, we have suggested that the best method to schedule irrigations is to use CIMIS to determine "how much" water the trees are using, and to use a tensiometer or soil probe to determine "when" to water. A variation of this method is to use CIMIS to determine daily water use in inches, and to schedule irrigations when the water use (evapotranspiration) equals 30% - 50% moisture loss in the soil. Attempts have been made to water soils knowing what the moisture holding capacity of the soil in question. For instance, if a sandy loam soil holds 1 inch of water per foot of soil, the soil is 2 feet deep, and the grower wants to water when the moisture is 50% depleted, then the irrigation would commence when 1 inch of water has been removed from the soil. How does the grower know when 1 inch of water has been removed? The grower checks the CIMIS data each day and when the Etc totals 1 inch, the irrigation water is turned on and runs long enough to supply 1 inch of water, plus a leaching fraction. In this example, if CIMIS indicates an ETc of 0.2 inches per day, then there should be irrigation every 5 days (5 days x 0.2 inches ETc = 1.0 inch water plus 10% for leaching). A key to

The water budget irrigation scheduling system-continued.

using this method is to correct for the surface area of wetted soil under the tree. For example, ETc gives you the amount of water used by the tree in that 400 sq ft (20’ x 20’ spacing). If you wet the entire orchard floor with your sprinkler and you apply 1 inch of water (plus 10%), you have applied the correct amount. If your mini-sprinkler wets only 50% of the surface area, and you apply 1 inch of water, you have given the tree only ½ of its water requirement. Therefore, you would have to apply 2 inches of water in this area to supply the correct amount of water to the tree. Using a computer to keep track of daily ETc, the grower can determine irrigation frequency in a particular soil, but there should always be a tensiometer to validate the irrigation frequency. However, the accuracy using this system is variable, probably due to the variability in soils and rock content in the soils (rocks do not absorb water). If a grower would like to experiment with this system, Table 5 is useful as it indicates the available water holding capacity of different types of soils.

Available Water and Infiltration Rates for Different Soil Textures (McNeil, 2001)

Soil Texture	Available Water (inches per foot)	Infiltration Rate (Inches per hour)
COARSE SAND	0.4-0.8	5.0-10.0
FINE SAND	0.8-1.2	2.0-5.0
SANDY LOAM	1.0-1.8	0.5-4.0
LOAM	1.7-2.3	0.25-2.0
SILT LOAM	1.8-2.4	0.20-1.5
CLAY LOAM	2.0-2.6	0.05-0.50
SILTY CLAY LOAM	2.2-2.8	0.05-0.25
CLAY	2.4-3.0	0.005-0.05

CIMIS. (https://cimis.water.ca.gov/)

The California Irrigation Management Information System (CIMIS) is a program unit in the Water Use and Efficiency Branch, Division of Regional Assistance, California Department of Water Resources (DWR) that manages a network of over 145 automated weather stations in California. CIMIS was developed in 1982 by DWR and the University of California, Davis (UC Davis). It was designed to assist irrigators in managing their water resources more efficiently. Efficient use of water resources benefits Californians by saving water, energy, and money.

Go to the websites below to learn how to use CIMIS.

www.avocadosource.com

https://cimis.water.ca.gov/

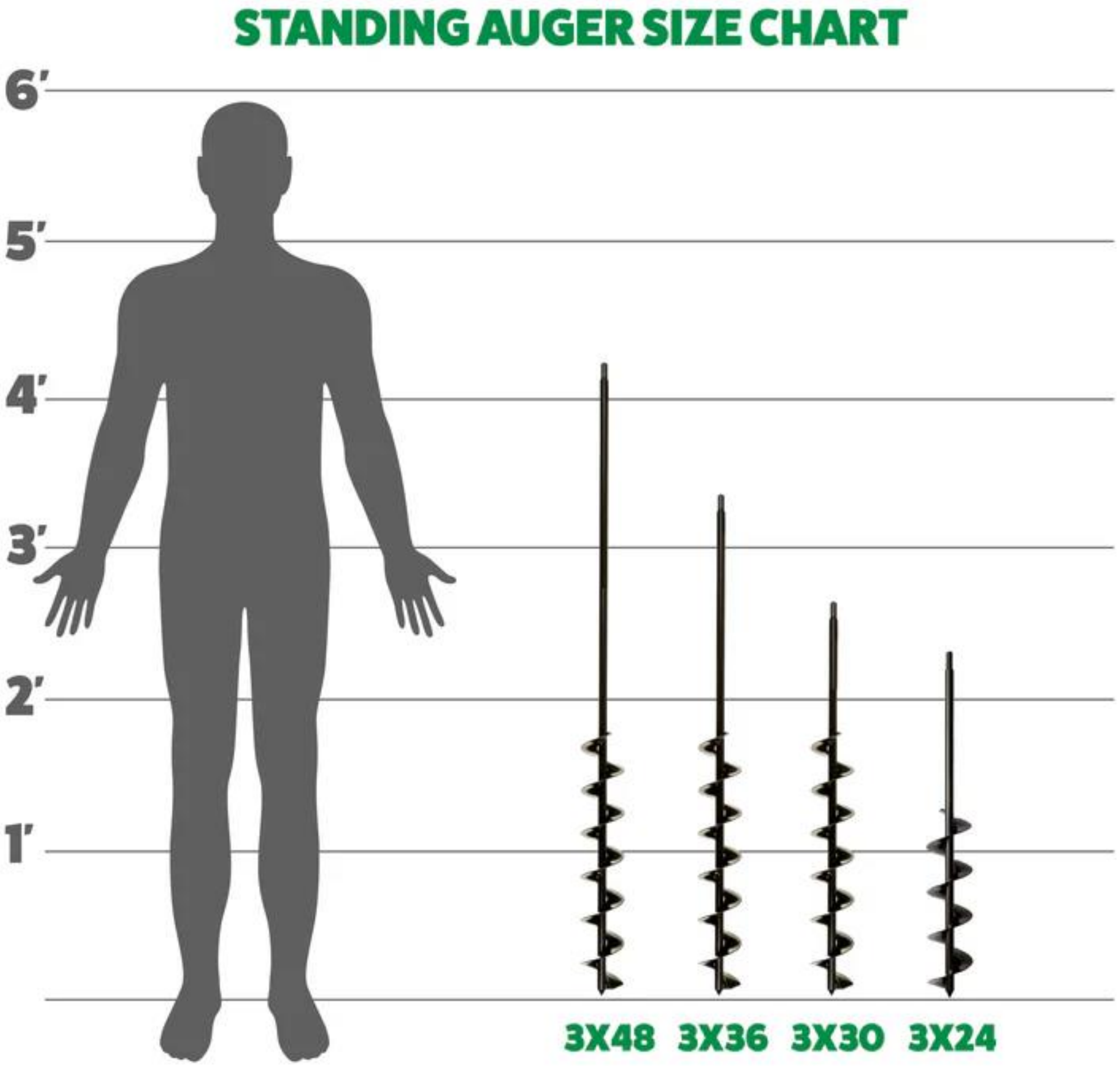
Or www.ITRC.org (CalPolySLO Recommended)

Shortcomings of using CIMIS for irrigation scheduling.

CIMIS only predicts approximately when and how much irrigation is needed. The most accurate way to determine irrigation frequency and depth is by use of soil moisture monitoring with soil auger samples or tensiometer readings. Get them at farm supply companies.

Dr. Robert J McNeil, Professor Emeritus, CalPolySLO (Personal Comment).

Soil augers (will have handles on top). (https://powerplanter.com/collections/gardening-augers/products/lauras-edition-3-x-36)



Design of Orchard Irrigation Methods

Have an irrigation sales company design your irrigation system, especially for drip, minisprinklers, or high volume sprinklers. Supply your minisprinkler irrigation lines with 2 inch pvc pipe in case you need more volume for frost protection if you have enough water.

Also have a knowledgable company design your furrow or flood irrigation system.

See the Utah State University website for orchard irrigation design information:

https://intermountainfruit.org/orchard-irrigation/

And Colorado State University website for microirrigation design:

https://extension.colostate.edu/topic-areas/agriculture/micro-sprinkler-irrigation-for-orchards-4-703/

The FAO has a complete irrigation design manual on their website:

https://www.fao.org/4/ai596e/ai596e.pdf

Fruit Growers Supply company designs irrigation systems:

https://fruitgrowers.com/ And Fruit Growers Supply IRRIGATION DESIGN, REPAIRS, MAINTENANCE AND INSTALLATION.

www.ITRC.org (CalPolySLO)

Farm Supply Company, San Luis Obispo, CA 93407.

Or other irrigation supply companies.

Go to www.ITRC.org website at CalPolySLO.

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Fertirrigación

Dr. Charles M. Burt
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Water Quality (Bender et al 2015)

Water quality has always been a concern in avocado production in Southern California and will be more important as growers are forced to use more ground water and reclaimed sewage water for irrigation. Avocado is one of the most sensitive of the tree crops in California to total dissolved solids (TDS, or total salts). The chloride ion, usually a major component in the salinity spectrum, is specifically toxic to avocado, causing the familiar "tip-burn". Sodium can also enter the roots and has been shown to accumulate in the roots, trunk and branches, possibly to toxic levels.

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Yield Reduction with Salinity (Bender et al 2015)

Ayers (1977) suggested that a 10% reduction in yield would be expected to occur when TDS in the irrigation water reached 760 ppm (ECw = 1.2) assuming a leaching fraction of 10%. A yield reduction of 25% would be expected to occur when TDS reaches 1088 ppm (ECw = 1.7) assuming a leaching fraction of 14% , and a yield reduction of 50% would be expected when TDS reaches 1536 ppm (ECw = 2.4), assuming a leaching fraction of 20%. Oster et.al (2007) calculated that yield would be reduced if the EC of the soil water increased above 0.7.

Rootstocks and Salinity (Bender et al 2015). The Mexican race of avocado is used primarily for rootstocks in California, but it is the most sensitive of the three races to salinity. The West Indian race is more tolerant, and certain selections may show improved tolerance over those used right now. The upper threshold of chloride in the soil extract is reported to be 5 meq/L for Mexican rootstocks, but 8 meq/L for West Indian rootstocks (Anon. 1990), or 180 ppm chloride for West Indian, 145 ppm chloride for Guatemalan, and 110 ppm for Mexican rootstocks (Maas 1984, Westcott and Ayers 1984). A rootstock salinity trial was conducted in San Diego County by Crowley and Arpaia using West Indian selections from Israel versus Mexican selections from California and South Africa. The West Indians appeared to be doing better than the Mexican selections, but they were hurt badly by a freeze in January, 2007 (one of the reasons we don’t use West Indians in California). The trees were brought back and harvested in 2010 (Bender et al 2010). Surprisingly, Dusa, one of the selections from South Africa, did the best, and several selections from Israel (West Indian selections VC 801, VC 218 and VC 207) did very well with the saline water (EC of 2.5). There is a possibility that, in the future, we may be able to use more saline water in conjunction with an improved rootstock for avocado.

Dominant Ions (Bender et al 2015)

It is important to note the dominant anion in the water when evaluating salinity. For a water with bicarbonate as the dominant anion, the salinity hazard is much lower than if the dominant anion were chloride. Thus, waters with the same TDS could perform significantly different depending on the types of anions. When chloride and sodium exceed 100 ppm in the water, or when boron exceeds 1 ppm, there should be an alerted concern for ensuring adequate leaching of the root zone to prevent accumulation of these ions.

Water Supply (Bender et al 2015)

Most low-flow systems require relatively frequent applications of water during peak demand periods. With drip systems it may be as frequent as once a day. In some areas water is delivered by the irrigation district on a basis that may cause difficulty in following an "on demand" frequency. In this case it is necessary to work out an agreement with the agency supplying water. If the infrastructure will not allow frequent deliveries, a pond or tank system should be installed to provide a reservoir. If not, a well should be considered. In Southern California, water supply to groves was cut-back by many of the water districts in the drought years in the early 1990's. Given that we live in a desert with most of our district water being delivered from the Colorado River, it would seem that our groves may be in peril in the future, especially if California enters a prolonged drought. Many growers have invested in wells (not always very productive and often saline), but a well may serve as a good back up in case of water cutback.

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Chapter 9. Avocado Tree Fertilization

(https://www.avocadosource.com/papers/research_articles/goodallgeorge1978.pdf)

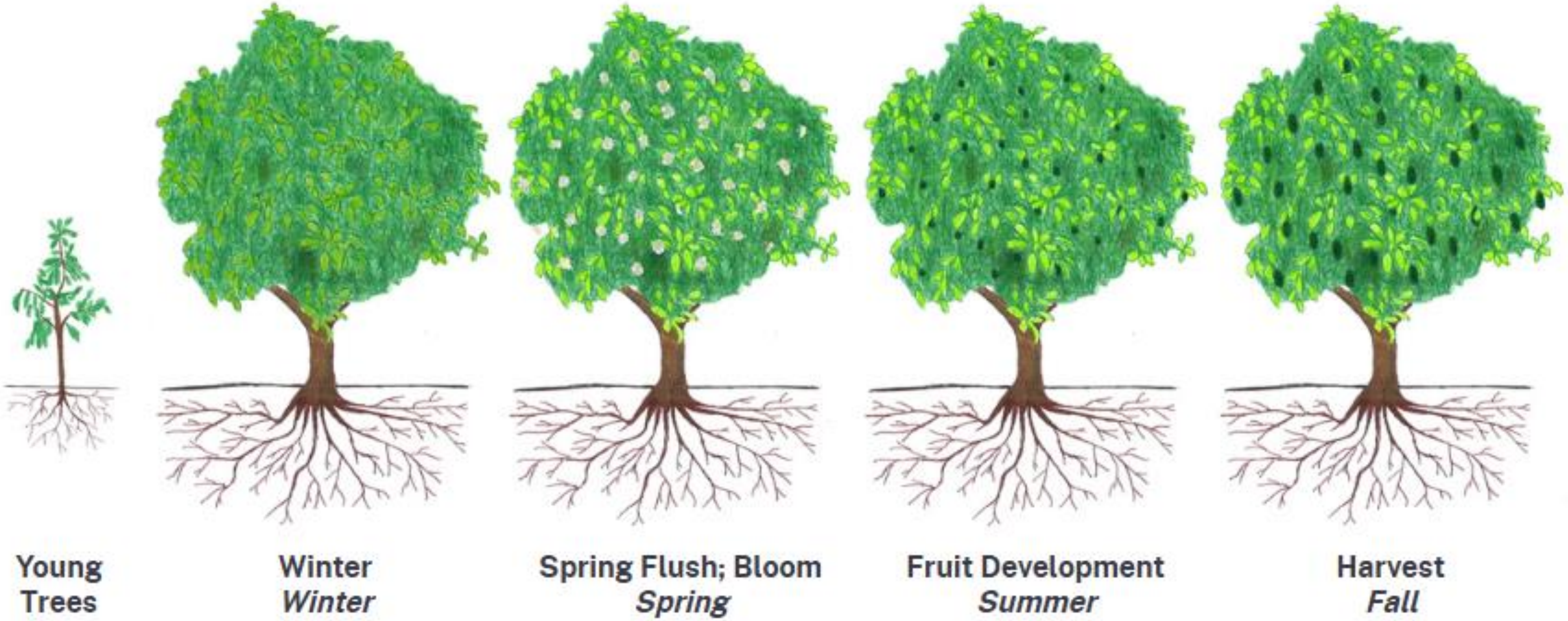
Avocado trees need proper nutrition to grow and produce a crop of fruit. California soils usually supply enough phosphorus and potassium macroelements but nitrogen needs to be supplied by fertilization. Potassium may also be needed in areas with serpentine soils high in magnesium which competes with potassium such as on the central coast in San Luis Obispo county.

The only micronutrient that usually is needed is zinc applied by foliar sprays. Iron chlorosis occurs occasionally.

https://www.cdfa.ca.gov/is/ffldrs/frep/FertilizationGuidelines/Avocado.html

Avocado

The Fertilization guidelines can also be found on the UC Davis Nutrient Management website.



Foliar Nitrogen

Mature avocado leaves are inefficient at taking up urea because of their thick, waxy cuticle [N4,N30]. However, foliar N application to flowers and young leaves has potential to increase yields and fruit size. Jaganath and Lovatt [N17] applied low-biuret urea (20% N, 0.1% biuret) to an 11-year old orchard of non-deficient 'Hass' avocado trees at a rate of 50 - 54 lbs urea/acre at the "cauliflower" stage of inflorescence. This resulted in an increased cumulative 3-year yield of large fruits compared with a control [N17].

Foliar urea applications are best made when spring flush leaves are about 1/2 to 2/3 fully expanded [N27].

Since high-N trees are less at risk from freeze damage, a spray of 2% urea prior to an anticipated freeze may be useful [N20].

See https://www.cdfa.ca.gov/is/ffldrs/frep/FertilizationGuidelines/Avocado.html for complete avocado nutrition/fertilization information.

Soil Applied Nitrogen

Application Rate Nitrogen application rate recommendations based on early studies range from about 1 to 2 lbs N/tree, which corresponds to 145-290 lbs N/acre in a 145 tree/acre orchard [N6]. However, with better irrigation efficiency and the ability to "spoon-feed" N to avocado trees at crucial growth stages, optimal N application rates can be significantly reduced [N13] (See Table). Rates based on avocado fruit removal and the Avocado Fertilization Model. Avocados remove about 2.5- 3.5 lbs N/1000 lbs of harvested fruit [N1,N4,N19,N20,N31]. An online fruit removal calculator for 'Hass' avocado can be found here. However, avocados tend to alternate bear, and the fruit can remain on the tree 15-18 months after bloom, meaning that two crops of different sizes and at different stages are often on the tree at once. Applying N based on an average yield, or the yield of the previous year's crop, may overstimulate vegetative growth in "off" years and provide insufficient N in "on" years [N20,N25]. In addition, the N required for canopy growth depends on the crop load as well as the size and age of the trees [N31,N32].

To address this complexity, Richard Rosecrance and Carol Lovatt recently [N32] developed an avocado fertilization model (accessible online here) which uses data from California research trials to determine avocado N requirement based on user-reported tree age, N status, canopy size, and yield expectations for both the new and maturing crop. The model integrates this information with weather data, irrigation volume and estimated N from non-fertilizer sources to give N application rate and timing suggestions.

The annual N application rates suggested in the table below need to be adjusted for the previous year's crop remaining on the tree, as well as N from the soil, cover crops, organic fertilizers, and irrigation water, and excess or deficient leaf N concentrations. The model provides a detailed breakdown of N application rates and times.

Annual N application rates to avocados fertigated via low volume irrigation. Assumes a non-deficient orchard with a density of 145 trees/acre and a canopy diameter of 20 ft. Expected yield does not include yield from the maturing (previous year's) crop.

N rate versus Yield

Expected yield (lbs/acre)	N application (lbs N/acre)
3,000	47
6,000	56
9,000	64
12,000	72
15,000	81
18,000	89

Nitrate in Irrigation Water

When well water is used for irrigation, it may contribute a significant amount of N [N12]. Well water samples should be taken after the pump has been run for several hours, to make sure that the water sampled is representative of what the orchard will receive [N29]. Nitrate in well water can be calculated as the ppm of nitrate-N x 2.72 = lbs N applied in one acre foot of water. For example, a test value of 7 ppm nitrate-N in an orchard receiving 4 acre-feet of water per year would mean that 76 lbs N/acre are added annually with the irrigation water. If the concentration of nitrate rather than nitrate-N is given, multiply by 0.614 rather than 2.72. To estimate N credits, only the nitrate-N in the water taken up by the trees, which corresponds to the evapotranspiration (ET) rate, should be counted [N29].

Mode of Application

Fertigation

Fertigation is the preferred method for applying N [N4]. The fertilizer should be injected into the irrigation system in the middle third of the irrigation set. For example, in an 18-hour irrigation set, fertilizer is injected from hour 6 through hour 12. This prevents urea and nitrate from moving below the root zone but still ensures that the N is distributed well in the wetting zone and does not remain in the irrigation system [N13]. If an avocado orchard is leached for salinity control, N fertilizer should be applied towards the end of the irrigation set, followed by enough water to clear out the lines and leach the fertilizer into the top eight inches of soil [N4].

Granular fertilizer

Urea and ammonium may be lost through ammonia volatilization, especially when applied to the surface of dry and alkaline soils [N5]. Since fertilizers cannot practically be mechanically incorporated in a mature avocado orchard without damaging the shallow root system [N20], granular fertilizers are broadcast evenly over the wetting zone before an irrigation is scheduled or rain is expected [N16].

Fertilizer Type

A number of mineral N fertilizers are available to growers. Mineral fertilizers contain N in the form of urea, ammonium, nitrate or a mixture of these. These N forms behave differently in the environment. Nitrate is mobile in the soil and can easily be leached below the root zone with irrigation water or rain. Urea is also relatively mobile and is generally quickly converted to ammonium. Ammonium is less mobile, but is generally converted quickly to nitrate by soil microorganisms in warm and moist soils, unless they are water saturated. This process, nitrification, can lower soil pH. The acidifying effect is especially strong when ammonium fertilizers are applied by drip systems as they are concentrated in a small soil volume [N35]. Ammonium sulfate, a strong acidifier, is not used when avocados are grown on acidic soils such as those found on hillsides in San Diego County [N4]. Calcium nitrate, which neutralizes acidity, is a good choice for these soils [N4]. Consult your local farm advisor about appropriate fertilizers for your area.

Triple 15 (15-15-15), ammonium nitrate and urea are commonly used granular fertilizers [N4]. But applying only ammonium nitrate may be adequate if soil P and K are ok.

Time of Application

A traditional recommendation is that N be fertigated once a month in equal doses over the course of the growing season [N4]. This reduces the risk of nitrate leaching into the groundwater. However, adding more N just before periods of high uptake may increase yields and fruit size [N22]. Avocado trees take up most of their nutrients between full bloom and autumn, and during the following spring [N32]. Very little N is taken up in winter. On-year trees take up more N than off-year trees [N31]. An efficient fertilization program is to apply most N in spring just after full bloom and in mid- to late summer and to adjust fertilizer application rates to crop load (i.e. more applied during "on" years) [N31].

If fertilizer is not applied in irrigation water, about 2/3 of the annual rate may be applied 4-6 weeks prior to bloom, with the remaining third applied in June or split between June and September [N4].

Special considerations

In order to avoid winter flushing, which can lead to frost damage, Ben Faber [N14] recommends that along the coast in Southern California, no N be applied between October 1st and March 1st. Consult your local farm advisor for the appropriate timing for your area.

Extra N in April may help reduce alternate bearing [N22]. When the tree has set a heavy crop, an extra N application in August can help protect the fruit from sunburn by stimulating new vegetative growth. This is especially a good idea on trees affected by persea mite, which causes leaf drop [N15].

Trees that have been damaged by fire or frost shouldn't be fertilized until new growth begins to push, which can take 3 to 6 months [N9].

Foliar Phosphorus. **Targeted applications of foliar P to avocado flowers may increase yields, especially in "off" years. Mature 'Hass' avocado trees in a commercial orchard in Ventura County were sprayed with potassium phosphite (0-28-26; 1.6 lbs P2O5/acre; 1.6 lbs K2O/acre) in March, at the 'cauliflower' stage of inflorescence development, and yields were tracked for three years. Foliar phosphite significantly increased the yield of large fruits in the off-year, and tended to increase the total yield and number of large fruits per tree in each year for three crop years. Yields for the three years were increased by an average of 38.8 lbs of fruit per tree compared to a control in which potassium phosphate was applied to the soil [P16]. Phosphite is better absorbed into avocado tissues than phosphate [P17], and foliar sprays of potassium phosphite are also used to help control Phytophthera root rot [P18]. However, phosphite fertilizers have the potential to be toxic to plant tissues and so should be used with care [P17].**

P Fertilization of Young Trees

There are no University of California recommendations for fertilizer P to young avocado trees, and P fertilization is not common.

Soil Applied Phosphorus

There are currently no University of California recommendations for P fertilization of avocado orchards. Soil and leaf analyses can be used to monitor the P status of an orchard over the years to ensure that P availability is adequate (See Soil P Test and Leaf P Analysis).

K Fertilization of Young Trees

For young nonbearing trees, the Avocado Fertilization Model suggests the following application rates.

K application rate to young non-bearing avocado. Assumes a tree density of 145 trees/acre and no organic amendments.

Leaf K range (%)	K application (lbs K2O/acre)
<0.55	40
0.55-0.7	20
0.75-0.85	10
0.85 or above	0

When trees begin to bear, K fertilizer may be applied to replace the K removed with the fruits. See Soil Applied K for more details.

Foliar Potassium

There is evidence that avocado leaves can take up K; however, soil applications may be more effective. Limaco Sing and McNeil [K11] found that when 'Hass' avocados growing on a K-limited California soil were sprayed with a 3.6% potassium nitrate solution (30 lbs KNO_3/100 gallons water) at about 261 gallons/acre, leaf K concentration increased compared with an unfertilized control. However, banded K_2SO_4 [5-10 lb/tree] gave similar results and was more cost effective. Leaf burn may occur at concentrations exceeding 30 lbs KNO_3/100 gallons water of foliar sprays [K11].

Soil Applied Potassium

Avocado K requirements are under-researched in California. A large amount of K is removed in the fruits, and the little research which exists suggests that potassium fertilization is required for good yields in the long term [K2]. Leaf and soil analyses should be used to monitor the K status of an orchard and to plan K applications (See Soil K Test and Tissue K Analysis).

Soil applied K2SO4 is effective at 5-10 lb/tree banded around the dripline if soil is high in Mg which competes with K uptake (Sing and McNeil, 1992).

Application Rate of K

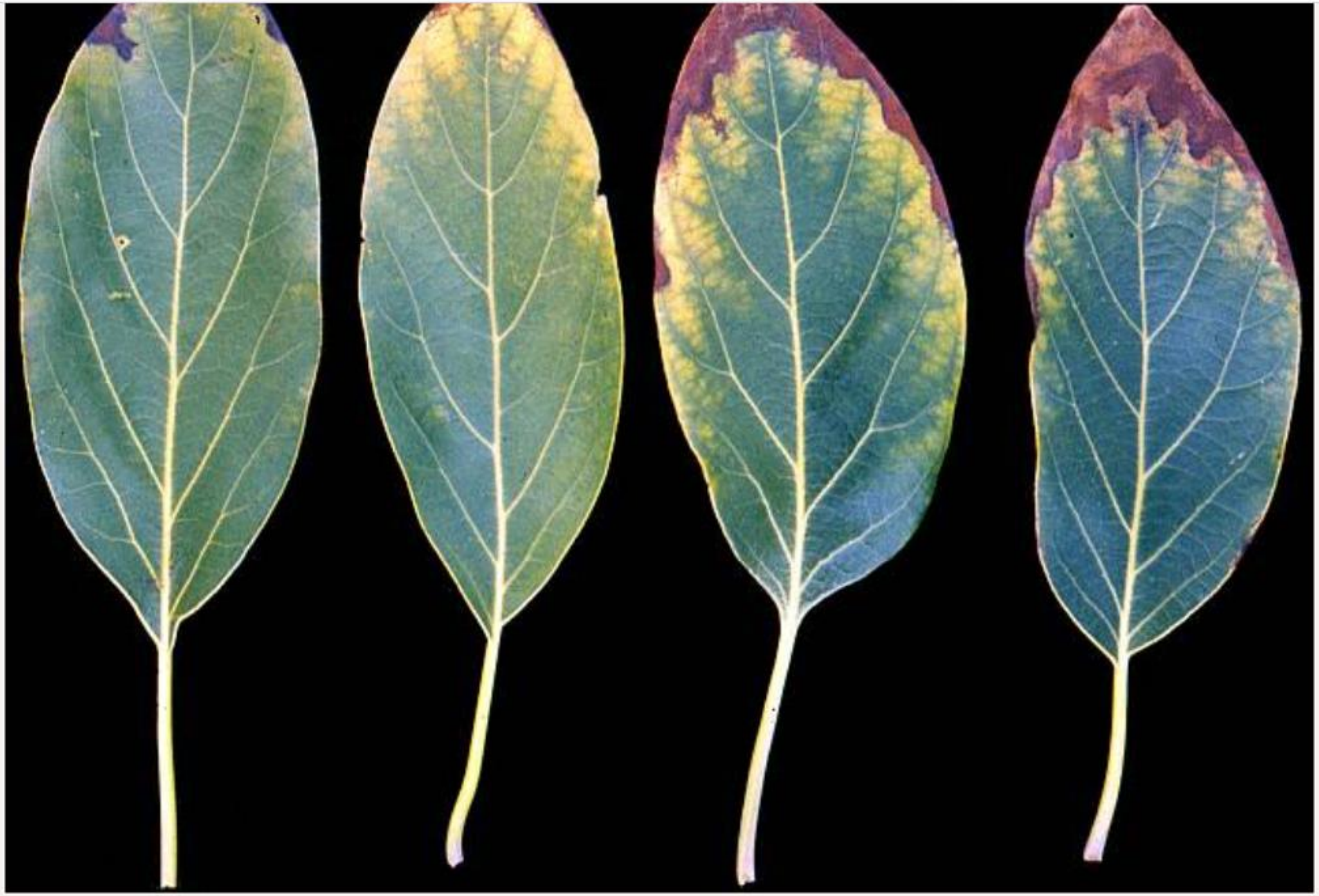
Fertilizer rates may be based on crop removal. Avocados remove about 7.2-8.4 lbs of K_2O (6-7 lbs of K) for each 1,000 lbs of harvested fruit [K1,K2,K10,K17]. An online fruit removal calculator for 'Hass' avocado can be found here. For example, replacing K removed with 10,000 lbs of fruit would require about 144-168 lbs K_2SO_4 (0-0-50). This rate may be adjusted based on leaf tissue and soil analyses. A higher rate is applied to deficient trees. However, while a large amount of K is removed with the avocados at harvest, avocados do not reliably respond to K fertilization. It appears that once a minimum requirement is met additional K does not increase yield or fruit size [K10].

Composts and manures also contribute some K, which should be deducted from the total rate. If two crops are on the tree, both should be fertilized. An online K fertilization model can be accessed here.

Fertilizer Type

Potassium sulfate, potassium chloride, potassium thiosulfate and potassium nitrate are common materials. Fact sheets of the most common fertilizers can be found on the web site of the International Plant Nutrition Institute.

Potassium chloride (KCl) should be used with caution, especially on saline soils or where irrigation water is high in chloride [K10]. A leaf Cl- concentration of 0.25-0.50 ppm indicates Cl - toxicity [K9], and KCl should not be used.



Cl^- toxicity on 'Hass' avocado. Photo by Bob Platt, courtesy of Avocado Source.

Time of Application

Since K does not usually leach from the soil and doesn't stimulate winter flushes, timing of application is generally not thought to be important [K5]. However, an experiment by Lovatt [K13] found that P and K applied in July and August improved fruit yield and number of fruits per tree in a mature commercial Hass orchard in Ventura County more than when applied in April, November, or in all four months. July is a time of rapid N and K uptake by last year's crop, and dropping of some of the current year's fruit ("June drop"), as well as the development of the summer vegetative flush. In August the current fruits grow exponentially, mature fruits abscise and next year's inflorescences are initiated [K13].

Avocado is sensitive to chloride. If potassium chloride (KCl) fertilizer is used, applying KCl in the wetter months of the year is a good strategy, since Cl- is more mobile than K in soil and can be leached out by winter rains in a normal winter [K6].

Zn Fertilization of Young Trees.

In young trees, Zn is usually fertigated as liquid zinc sulfate ($ZnSO_4$; 12% Zn). It may also be banded as dry fertilizer ($ZnSO_4$; 36% Zn) or applied foliarly (See Foliar Zn). Bender [Zn1] recommends the following rates to correct deficiency in young avocado trees. The higher rates should be used with more severe deficiencies. Recommended fertigated zinc sulfate (12%) application rates to young trees. "Low" and "High" rates represent 10 and 50 lbs Zn/acre to mature trees in a 145 tree/acre orchard, respectively [Zn1].

Tree age (years)	"Low" application (gal ZnSO4/acre)	"High" application (gal ZnSO4/acre)
2	1.0	5.2
3	1.5	7.5
4	2.2	11.2
5	3.0	14.9
6	3.8	18.7
7	4.5	22.5
8	5.2	26.2
9	5.9	30.0
10	7.4	37.6
Mature	10.4	52.5

If solid $ZnSO_4$ is used, a rate of 0.7 lbs fertilizer/tree is recommended in the second year, 1 lb fertilizer/tree in the third, and an additional 0.5 lbs for each subsequent year until maturity. A single application of dry fertilizer can correct the deficiency for 3 to 5 years. Additional applications should not be made unless leaf Zn is low. When Zn is banded it is a good idea to test an application rate on a few trees first, since too much Zn may injure trees and the correct amount depends on soil type [Zn9]. [Foliar sprays may be preferred.]

Foliar Zinc

Most foliar-applied Zn remains in the sprayed leaves and is not translocated to the rest of the tree [Zn4,Zn5]. Unless the only concern is correcting deficiency in the outer canopy, soil application is more effective. If foliar application is used, it is best done on new leaf tissue [Zn5]. A spray of 3-4 lbs/acre $ZnSO_4$ (1 lb $ZnSO_4$ /100 gallons water) is recommended for young trees, and 6-8 lbs for mature orchards [Zn9].

See references at the CDFA website:

https://www.cdfa.ca.gov/is/ffldrs/frep/FertilizationGuidelines/Avocado.html

When to apply nitrogen fertilizer?

Nitrogen fertilizer should be applied on the soil over the root area in January or February and then moved into the root zone by rain or sprinkler, furrow, or flood irrigation. If no rain occurs a urea foliar spray might be considered. Embleton and Jones and others found no response to foliar sprays of urea on avocado trees in the field. But effective on citrus.

See: https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=7889

If nitrogen is applied in the irrigation water, apply most of the nitrogen early in the irrigation season.

Success with Foliar Urea Sprays

Jaganath and Lovatt (1996) applied low-biuret urea (20% N, 0.1% biuret) to an 11-year old orchard of non-deficient 'Hass' avocado trees at a rate of 50 - 54 lbs urea/acre at the "cauliflower" stage of inflorescence. This resulted in an increased cumulative 3-year yield of large fruits compared with a control.

Foliar urea applications are best made when spring flush leaves are about 1/2 to 2/3 fully expanded (Lovatt and Whitney, 2001).

Since high-N trees are less at risk from freeze damage, a spray of 2% urea prior to an anticipated freeze may be useful (Lahav et al 2013).

Leaf Analysis

The best way to monitor elemental nutrient levels in avocado trees is through leaf analysis. Leaf samples are taken between August to October each year. 30-40 leaves are taken of mature leaves in the middle of a shoot from nonflushing, nonflowering, nonfruiting stems. Then mailed to a testing lab. All elements should be tested initially. Future tests should be only for those elements that may need to be applied such as nitrogen, potassium, iron and zinc. Test all orchard blocks separately.

Standards are presented in the following table. If the level is low or deficient then apply or increase the fertilizer for the element. If it is adequate then apply the same amount of fertilizer. If it is high then decrease the amount of fertilizer. Do nothing if the soil has adequate amounts of the element.

Soil analysis can be practiced to diagnose soil problems such as pH, salinity, high sodium or chlorine, if necessary.

Avocado Leaf Analysis Standards

IN MATURE Leaves between August and October in California.

(B. W. Lee, Farm Advisor, Ventura County, Univ of Ca Coop Ext. 1980)

Tentative Guide for Avocado Trees Ranges					
Element		**Unit**	**Deficient Less than**	**Adequate**	**Excess More than**
Nitrogen	(N)	%	1.6	1.8-2.4	2.8
Phosphorus	(P)	%	0.05	0.08-0.25	0.3
Potassium	(K)	%	0.35	0.75-.02	3.0
Calcium	(Ca)	%	0.5	1.0-3.0	4.0
Magnesium	(Mg)	%	0.15	0.25-0.80	1.0
Sulfur	(S)	%	0.5	0.20-0.60	1.0
Boron	(B)	ppm	10-20	20-100	100-250
Iron	(Fe)	ppm	20-40	50-200	?
Manganese	(Mn)	ppm	10-15	30-500	1000
Zinc	(Zn)	ppm	1-20	30-150	300
Cooper	(Cu)	ppm	2-3	5-15	25
Molybdenum	(Mo)	ppm	0.01	0.05-1.0	?
Chloride	(Cl)	%	?	?	0.25-0.50
Sodium	(Na)	%	--	--	0.25-0.50
Lithium	(Li)	ppm	--	--	50-75

ppm = parts per

Ranges of Elements in Avocado Leaves

https://www.avocadosource.com/papers/research_articles/goodallgeorge1978.pdf

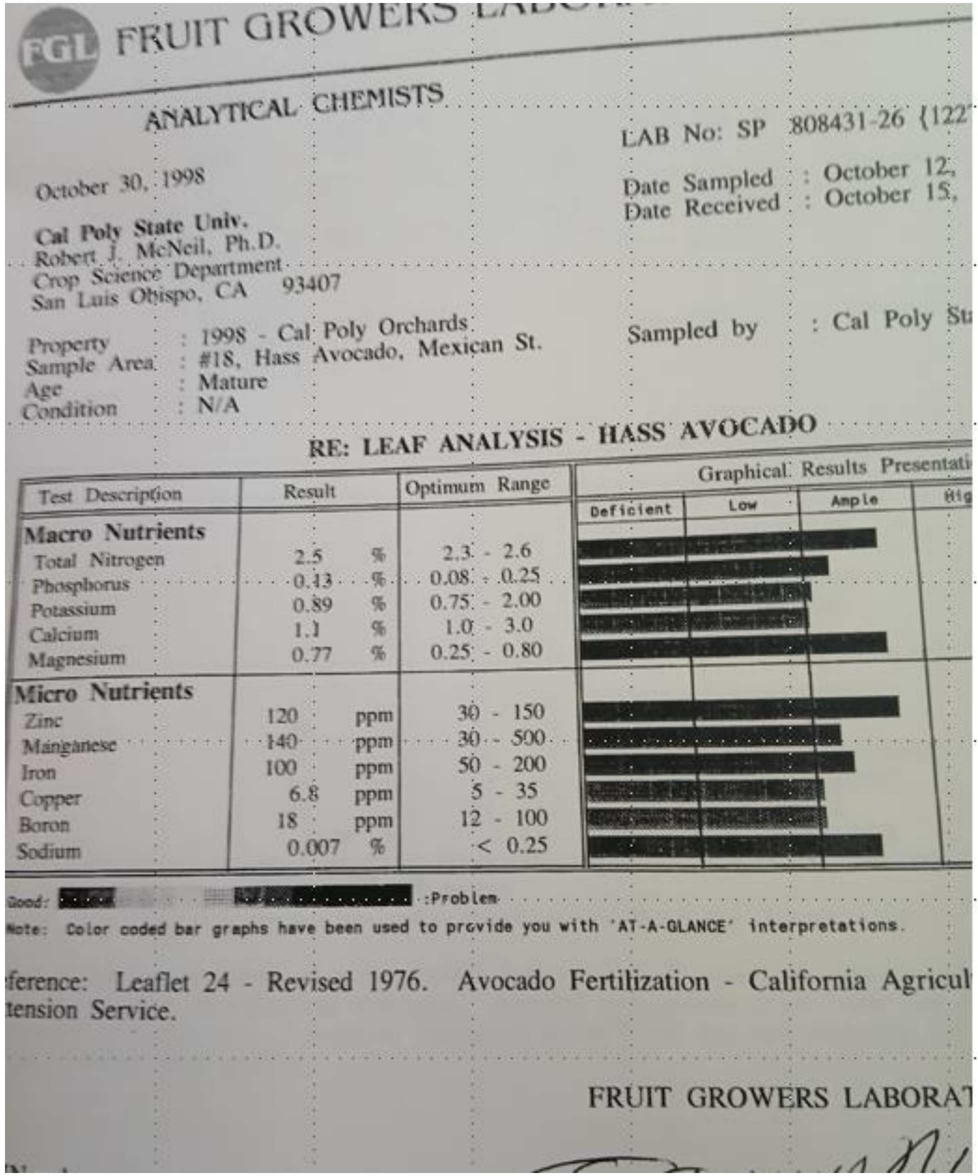
			Ranges for mature trees*		
Element		Unit	Deficient: less than	Adequate	Excess: more than
Nitrogen	(N)	%	1.6	1.6 –2.0	2.0†
Phosphorus	(P)	%	0.05	0.08–0.25	0.3
Potassium	(K)	%	0.35	0.75–2.0	3.0
Calcium	(Ca)	%	0.5	1.0 –3.0	4.0
Magnesium	(Mg)	%	0.15	0.25–0.80	1.0
Sulfur	(S)	%	0.05	0.20–0.60	1.0
Boron	(B)	ppm‡	10–20	50–100	100–250
Iron	(Fe)	ppm	20–40	50–200	?
Manganese	(Mn)	ppm	10–15	30–500	1,000
Zinc	(Zn)	ppm	10–20	30–150	300
Copper	(Cu)	ppm	2–3	5–15	25
Molybdenum	(Mo)	ppm	0.01	0.05–1.0	?
Chloride	(Cl)	%	?	?	0.25–0.50
Sodium	(Na)	%	–	–	0.25–0.50
Lithium	(Li)	ppm	–	–	50–75

Based on analysis of the most recently expanded and matured, healthy, terminal leaves from non-flushing and nonfruiting terminals sampled during mid-August to mid-October. (These are normally leaves from the spring growth cycle.) Values expressed on a dry-matter basis.

Values above 2 percent N will not increase yield in most varieties; however, a reduction in yield of the Fuerte variety may occur above that level.

ppm, parts per million.

Hass Avocado Leaf Analysis results example. All elements are ample. Only increase or decrease fertilizer if low, deficient or high.



FGL FRUIT GROWERS

ANALYTICAL CHEMISTS

LAB No: SP 808431-26 (122

October 30, 1998

Date Sampled : October 12,
Date Received : October 15,

Cal Poly State Univ.
Robert J. McNeil, Ph.D.
Crop Science Department
San Luis Obispo, CA 93407

Property : 1998 - Cal Poly Orchards
Sample Area : #18, Hass Avocado, Mexican St.
Age : Mature
Condition : N/A

Sampled by : Cal Poly St

RE: LEAF ANALYSIS - HASS AVOCADO

Test Description	Result		Optimum Range	Graphical Results Presentati			
				Deficient	Low	Ample	Hig
Macro Nutrients							
Total Nitrogen	2.5	%	2.3 - 2.6				
Phosphorus	0.13	%	0.08 - 0.25				
Potassium	0.89	%	0.75 - 2.00				
Calcium	1.1	%	1.0 - 3.0				
Magnesium	0.77	%	0.25 - 0.80				
Micro Nutrients							
Zinc	120	ppm	30 - 150				
Manganese	140	ppm	30 - 500				
Iron	100	ppm	50 - 200				
Copper	6.8	ppm	5 - 35				
Boron	18	ppm	12 - 100				
Sodium	0.007	%	< 0.25				

Good: :Problem

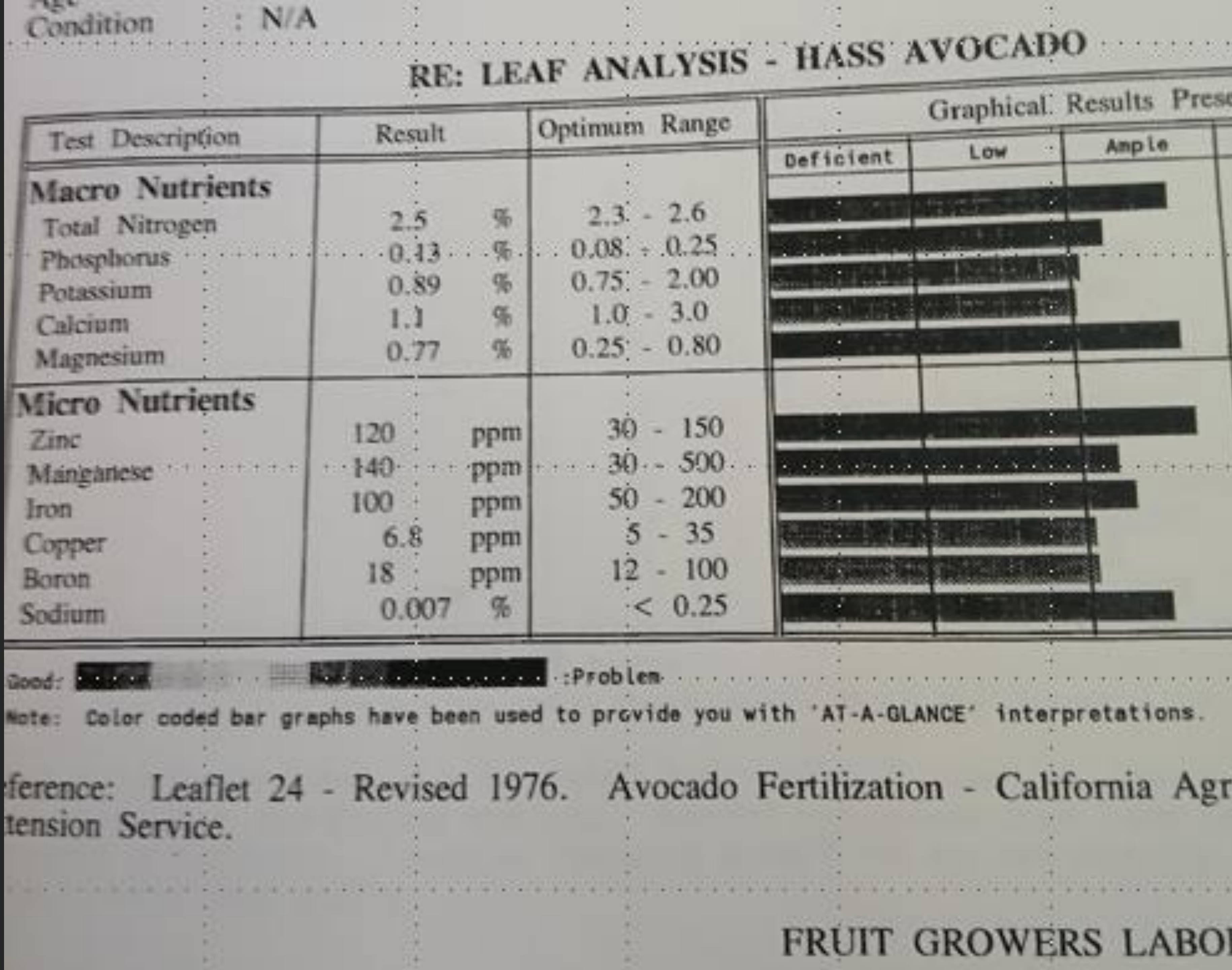
Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.

ference: Leaflet 24 - Revised 1976. Avocado Fertilization - California Agricul
tension Service.

FRUIT GROWERS LABORAT

Hass Avocado Leaf Analysis results example. All elements are ample. Only

increase or decrease fertilizer if low, deficient or high.



Condition : N/A

RE: LEAF ANALYSIS - HASS AVOCADO

Test Description	Result		Optimum Range	Graphical Results Prese
				Deficient / Low / Ample
Macro Nutrients				
Total Nitrogen	2.5	%	2.3 - 2.6	
Phosphorus	0.13	%	0.08 - 0.25	
Potassium	0.89	%	0.75 - 2.00	
Calcium	1.1	%	1.0 - 3.0	
Magnesium	0.77	%	0.25 - 0.80	
Micro Nutrients				
Zinc	120	ppm	30 - 150	
Manganese	140	ppm	30 - 500	
Iron	100	ppm	50 - 200	
Copper	6.8	ppm	5 - 35	
Boron	18	ppm	12 - 100	
Sodium	0.007	%	< 0.25	

Good: :Problem

Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.

eference: Leaflet 24 - Revised 1976. Avocado Fertilization - California Agr
tension Service.

FRUIT GROWERS LABO

Nitrogen Fertilization.

Nitrogen can be applied as a dry fertilizer to the soil, injection in irrigation water, but urea foliar spray has been ineffective on avocado trees, except for Jaganath and Lovatt (1996), but effective on citrus trees. See:
https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=7889

Amounts of nitrogen to inject into a drip irrigation system (Use Leaf analysis to monitor)

(https://www.avocadosource.com/papers/research_articles/goodallgeorge1978.pdf)

	Amount per tree per month*		
Orchard age	Urea	Ammonium nitrate	Calcium nitrate
	pounds	*pounds*	*pounds*
1st year	0.03	0.04	0.09
2nd year	.06	.08	.17
3rd year	.09	.13	.29
4th year	.14	.19	.43
5th year (and older)	.28	.38	.90

* Pounds of fertilizer material per tree per month during a typical 8-month irrigation season.

Average Nitrogen Rates for Avocados Versus Tree Age in Pounds (McNeil,1997)

1st year	1/10-1/8 (Break into monthly applications)
2nd year	1/8-1/4 (6 applications, Feb,Apr,June,July,Aug,Sept)
3rd year	¼-1/2 (4 applications, Feb,May,July,Sept)
4th year	¼-1/2 (2 applications, Feb and May or June)
4th-5th year on	Amount determined by leaf analysis
5th-7th year	½+ (in Jan or Feb, or by leaf analysis)
8th-9th year	3/4 + (in Jan or Feb, or by leaf analysis)
10th-14th year	1 (in Jan or Feb, or by leaf analysis)
15th year+	1-1.5 (in Jan or Feb, or by leaf analysis)

Fertilizer Injection Through Irrigation. Farm Supply Companies.

Contact farm supply companies for fertilizer injectors.
www.farmsupplycompany.com
Farm Supply Company
224 Tank Farm Rd, San Luis Obispo, CA 93401
(805) 543-3751 or
fruitgrowers.com
Fruit Growers Supply - Supply Store
980 W Telegraph Rd, Santa Paula, CA 93060
(805) 918-4374
Or others.

Fertigation Videos from ITRC CalPolySLO
Go to www.ITRC.org
Download three books online for free on their website above or those below.

https://www.youtube.com/watch?v=hywgsfFA-8Y&list=PLZoNTroHi9o-lQOmMyr8O_twZB2dwzWDO

Free Online Resources

itrc.org/fertigation/videos.html

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Dr. Charles Burt

Prof. Emeritus, BioResource and Agric. Engr. Dept

Cal Poly San Luis Obispo

www.itrc.org

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California Dept. of Food and Ag. (CDFA)

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Avocado Fertilization-Foliar Potassium Sprays at CalPolySLO

Julie Limaco Sing and Robert J. McNeil

Crop Science Department, California Polytechnic State University, San Luis Obispo, CA 93407, USA

The Effectiveness of Foliar Potassium Nitrate Sprays on the 'Hass' Avocado (Persea americana Mill.)

Proc. of Second World Avocado Congress 1992 pp. 337-342

https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=7889

Foliar Potassium Sprays at CalPolySLO

Abstract. Potassium nitrate (KNO3) was sprayed on the leaves of four-year-old bearing 'Hass' avocado trees at the rate of 13.6 kg (30 pounds) per 378.5 liters (100 gallons) of water. Spray application was done either at half leaf expansion, full leaf expansion or one month after full expansion. A combination of two and three of these spray treatment times was also done. **Foliar applications of KNO3 were effective in increasing the K level in the leaves of 'Hass' avocado trees.** Two and three applications were effective. All treatments lowered the leaf Mg level below that of the control with three sprays lowering it significantly. **All treatments significantly increased the leaf Zn level above that of the control. The three spray treatments significantly increased the Mn level above** the control. Leaf levels of N, P and Na were generally higher while Ca was generally lower in treated versus control leaves. Leaf Fe and Cu levels appeared to be unaffected. The foliar sprays of KNO3 were estimated to be more expensive than soil-applied (banded) potassium sulfate (K2SO4) applied every three years, however the farmer has the choice of foliar sprays of potassium nitrate. Zinc sulfate is already applied by foliar spray annually. The potassium spray might be combined with the zinc spray to say time and labor.

Foliar Potassium Sprays at CalPolySLO

On avocados, K deficiency is characterized by lack of growth and vigor of the tree and some leaves are yellow or pale green with dry (necrotic) dead spots on the leaves (Koo, 1968). The University of California recommended concentrations of potassium in avocado leaves based upon analysis of the spring growth cycle sampled during mid August to mid-October are as follow: less than 0.35% = deficient; 0.75 to 2% = adequate; more than 3% = excess (Goodall, 1979).

Foliar Potassium Sprays at CalPolySLO

The general purpose of this experiment was to provide potassium by foliar KNO3 sprays on 'Hass' avocado trees. It should be noted that other trees in the orchard under study had a history of K deficiency. The analyses for the last two years for percent of K in the leaves in the trees that were used had been below optimum range but were not considered deficient (McNeil, 1997). Foliarly-applied potassium was utilized in this study in order to test it as a possibly effective and hopefully more economical application method than soil-applied potassium. The only known effective alternative means of applying potassium would have been to band 2.27 to 4.54 kg (5-10 pounds) of K2S04 under the dripline of each tree. Banding, rather than broadcasting, would be required because the serpentine derived soils in this growing area are of high magnesium content which competes with potassium uptake by the plant. The latter treatment may last for two or three years (McNeil, 1997).

Foliar Potassium Sprays at CalPolySLO

Conclusions

The following conclusions can be drawn from this study:

Foliar applications of KNO_3 were effective in increasing the K level in the leaves of 'Hass' avocado trees.

Several interactions appeared to exist among the macro- and micronutrient content of 'Hass' avocado leaves as induced by the K applications.

Foliar sprays of KNO_3 were estimated to be more expensive than soil-applied (banded) K_2SO_4. Soil applied banded K_2SO_4 at 5-10 lb per tree is recommended. It was done and lasted at least a few years. Leaf analysis for K was adequate. Foliar sprays are effective. Combine with zinc sprays to save money.

$48.59 for KNO_3 50 lb (Fruit Growers Supply 2024)

$28.45 for K_2SO_4 50 lb (Fruit Growers Supply 2024)

Foliar Zinc Sprays

(https://www.avocadosource.com/papers/research_articles/goodallgeorge1978.pdf)

Zinc deficiency or "mottle leaf," as it is commonly called, occurs in many avocado orchards in southern California. The avocado tree may decline and even die without a small, but essential, amount of zinc.

Best results are obtained by wetting the foliage. Amounts of spray required per acre depend on tree size; 300 to 400 gallons are suggested for young bearing orchards and up to 600 to 800 gallons for large mature orchards. Either of the following two formulas is satisfactory.

Zinc Spray Formulas

Formula No.1:

1 pound zinc sulfate

(36 percent metallic zinc)

In 100 gallons of water.

Formula No.2:

2 pounds zinc oxide

In 100 gallons of water.

Suggested Amounts of Zinc Sulfate for Soil Applications

https://www.avocadosource.com/papers/research_articles/goodallgeorge1978.pdf

Tree age	Dosage per tree: Surface band	Dosage per tree: Inserted in holes
years	*pounds*	*pounds*
2	0.7	–
5	2.0	0.7
7	2.6	1.3
10	3.3	2.0
15	5.2	2.6
20	6.5	3.3

Iron Deficiency

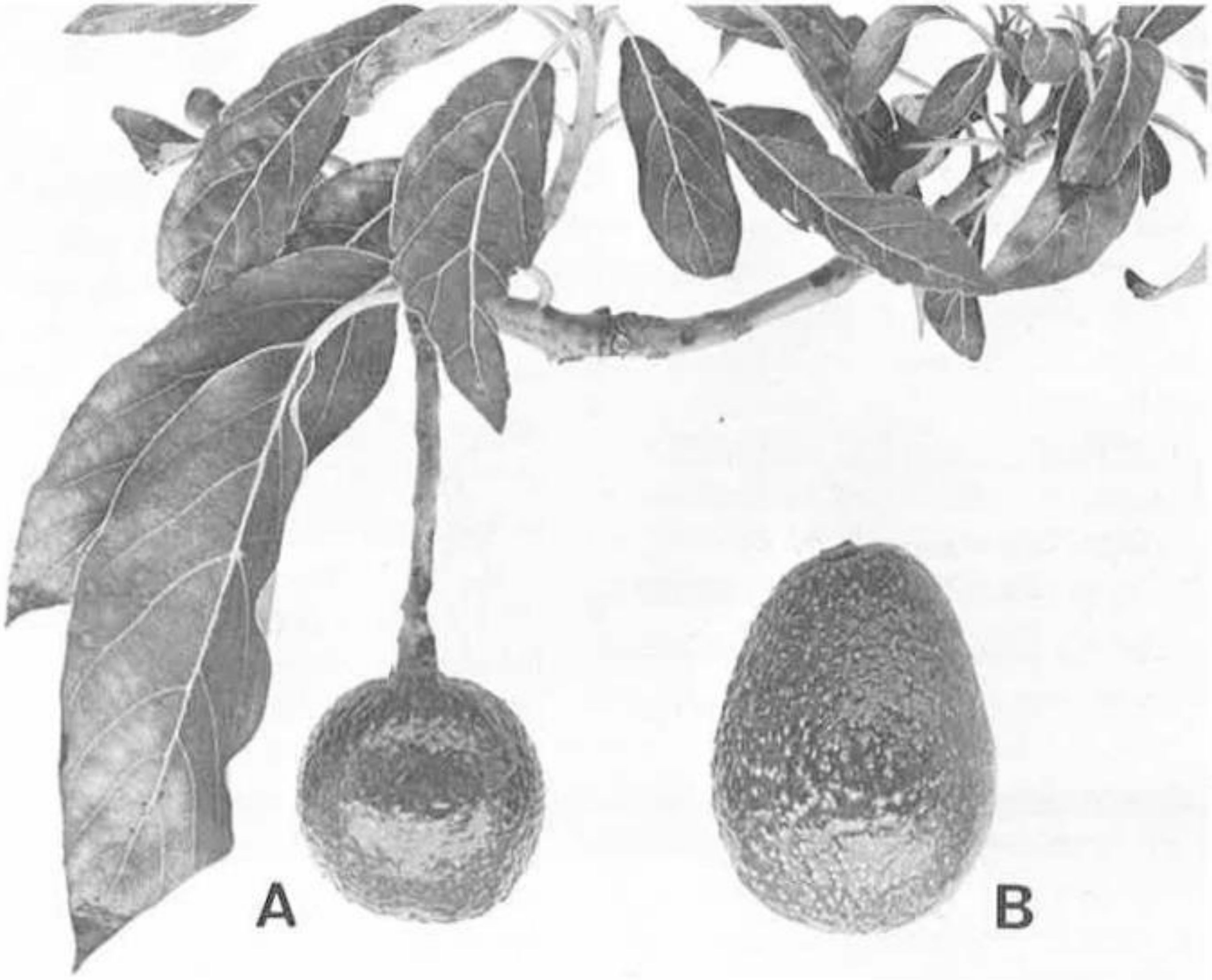
Iron deficiency is difficult to correct. It is not generally found in California orchards. This deficiency usually occurs on soils containing lime (calcium carbonate), which limits the utilization of iron by the tree. The deficiency is accentuated by excess soil moisture and low oxygen content in the soil.
The use of less water is sometimes helpful (alternate middles or replace furrows with sprinklers).

Iron Treatments

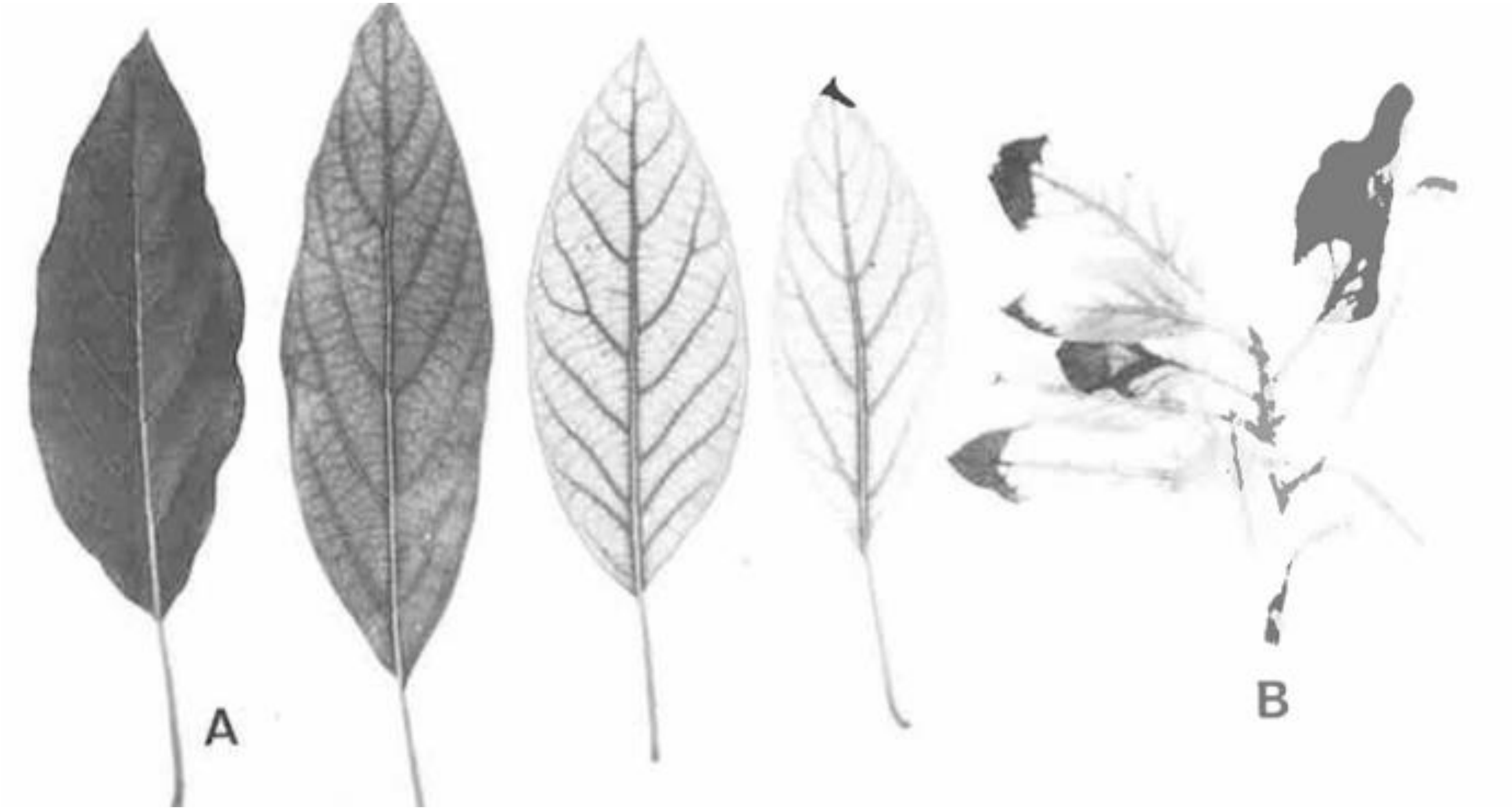
The most effective application methods have been to inject the chelates in solution into the root zone or to rake back the leaves, broadcast the material, and work it into the surface soil, pushing the leaves back and irrigating immediately. The suggested amountsof Sequestrene® 138-Iron are 1/4 to ½ pound per mature tree applied in May or June. Annual applications appear necessary.

Deficiency Symptoms, Zinc Deficiency (https://www.avocadosource.com/papers/research_articles/goodallgeorge1978.pdf)

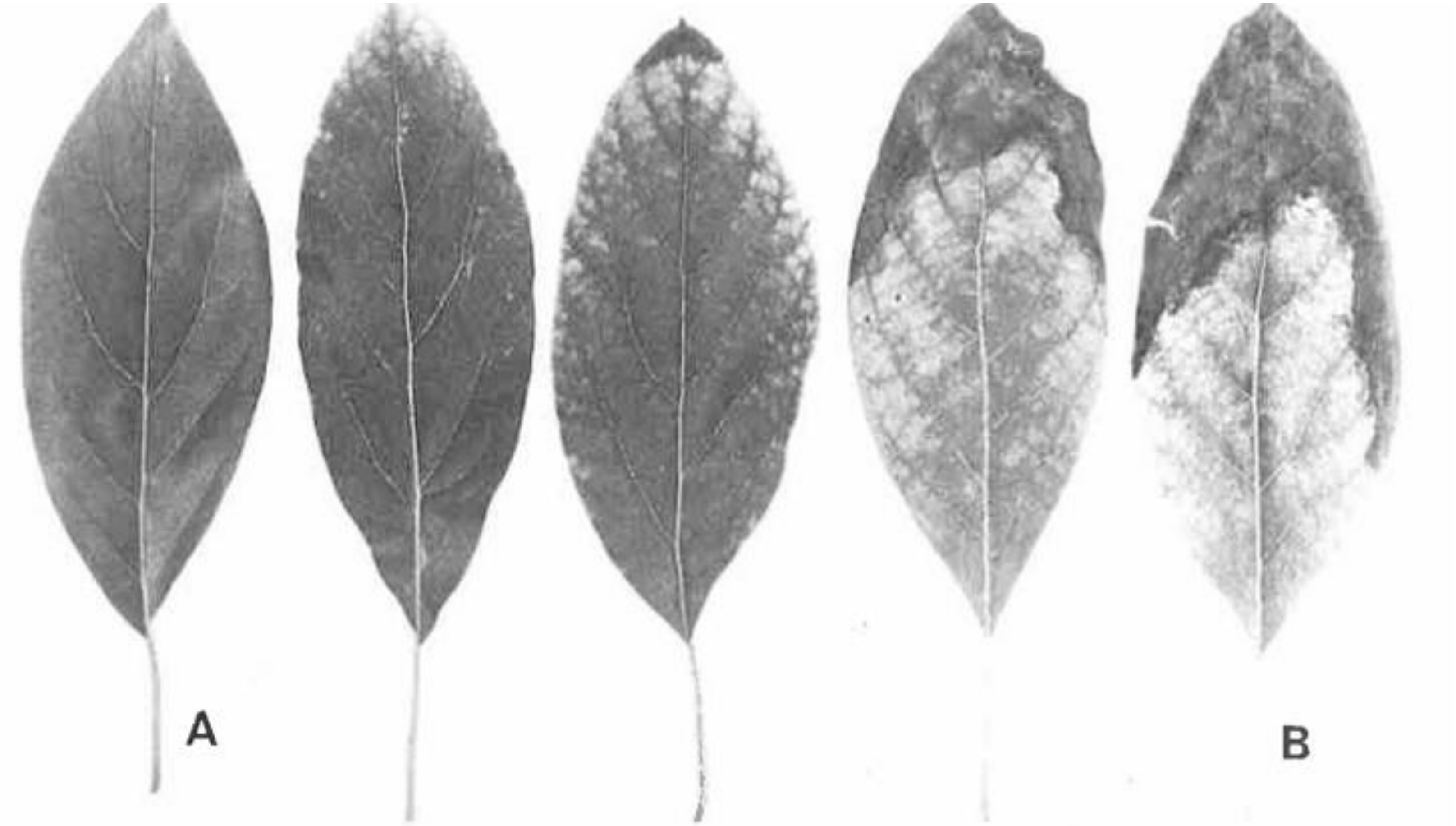
Zinc Deficient Hass Fruit A, Normal B



Iron Deficiency A-Normal B-Severe



Chloride Excess in Leaves A-Normal B-Severe



Excess Salts

The avocado is particularly sensitive to salts. It accumulates chlorides and sodium more readily than do most other tree crops. An accumulation of chloride manifests itself as a tip and marginal burn of the older leaves. Excess sodium shows up as an interveinal leaf burn along with twig dieback. A rapid burn at the tip or at the base of the leaf, followed by defoliation, suggests either an excessive fertilizer application or inadequate irrigation.

Leaching to Reduce Salts or Salinity

Leaching of salts or salinity requires three successive deep irrigations spaced a few days apart, not continuously. Continuously would go through large pore openings in the soil and not leach. Test the soil before and after using a solubridge device. An EC of 3.4 is the toxic level for salinity or total salts.

Dr. Robert J McNeil.

Excess soil sodium can be treated with gypsum.

(http://avocadosource.com/cas_yearbooks/CAS_96_2013/CAS_2013_V96_PG_074-105.pdf)

Hass Avocado Nutrition Research In California by

Carol J. Lovatt

Professor Emeritus of Plant Physiology

Department of Botany and Plant Sciences

University of California, Riverside, CA

A complete review of California avocado nutrition is at the website above.

Copy and paste it.

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Chapter 10. Orchard Planting Designs

Orchard Planting Designs

There are several objectives that serve as a basis for the choice of systematic orchard planting designs: (1) Allow adequate spacing between trees for growth, (2) Allow maximum exposure of trees to sunlight to maximize production, (3) Allow good air circulation which will help control diseases, (4) Facilitate cultural practices, (5) Make the most efficient use of the land, and (6) To allow enough space for each tree when it is full-sized at maturity.

There are two basic planting design systems, the square and the triangular, with several variations of each (McNeil, 1993; Sauls, 1979). A 20 feet mature tree spacing will be used as an example for each planting design.

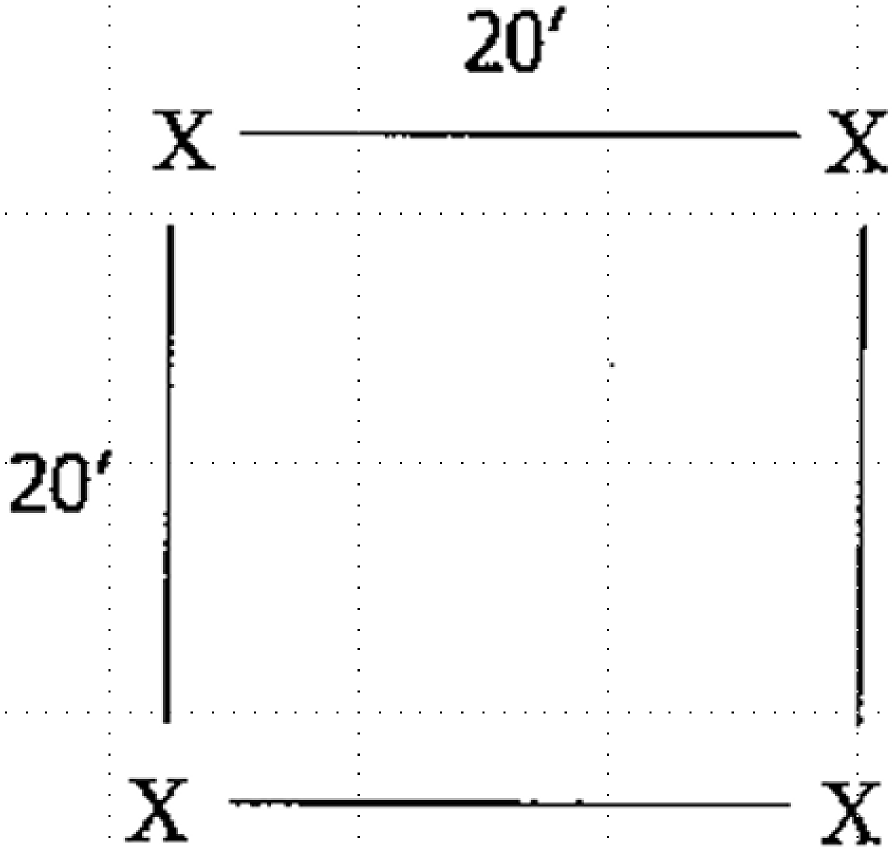
Square Designs

Square designs are more common and simpler than triangular designs. There are three types of square designs: (1) The square, (2) The rectangular, and (3) The quincunx.

The square design has an equal distance between tree rows and trees within a row. Rows run in two directions, north-south and east-west. Every tree has an equal amount of space. It has the fewest trees (109) per acre of all designs at both an initial and mature tree spacing of 20 x 20 feet.

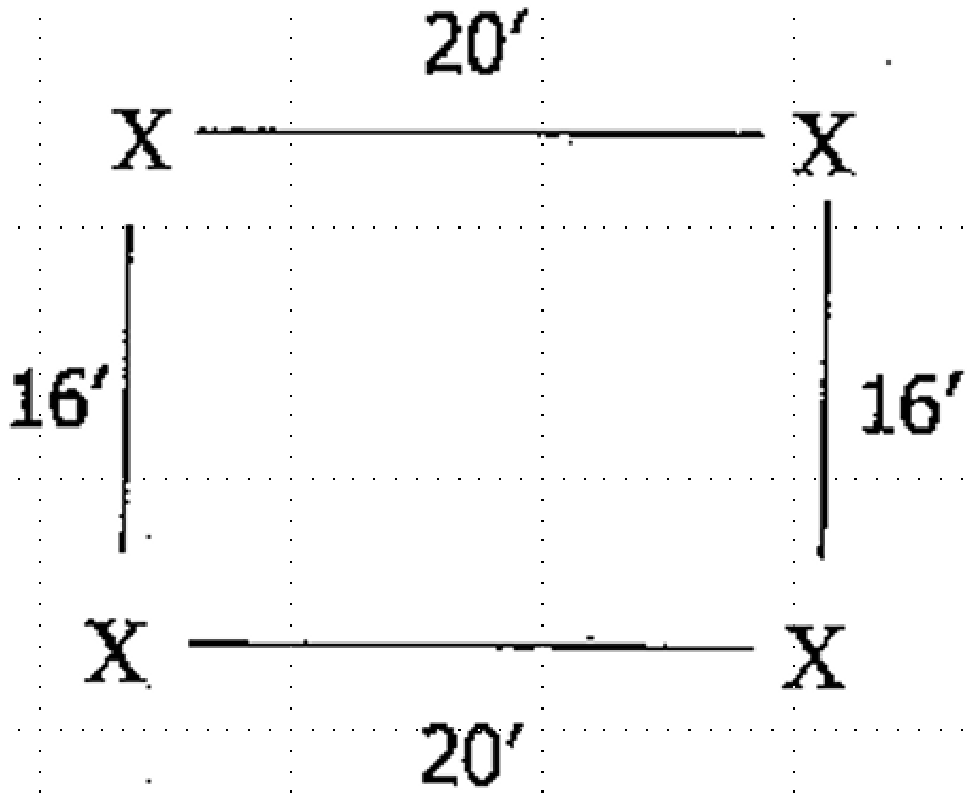
<u>Square Design</u>

Example:



Rectangular Design

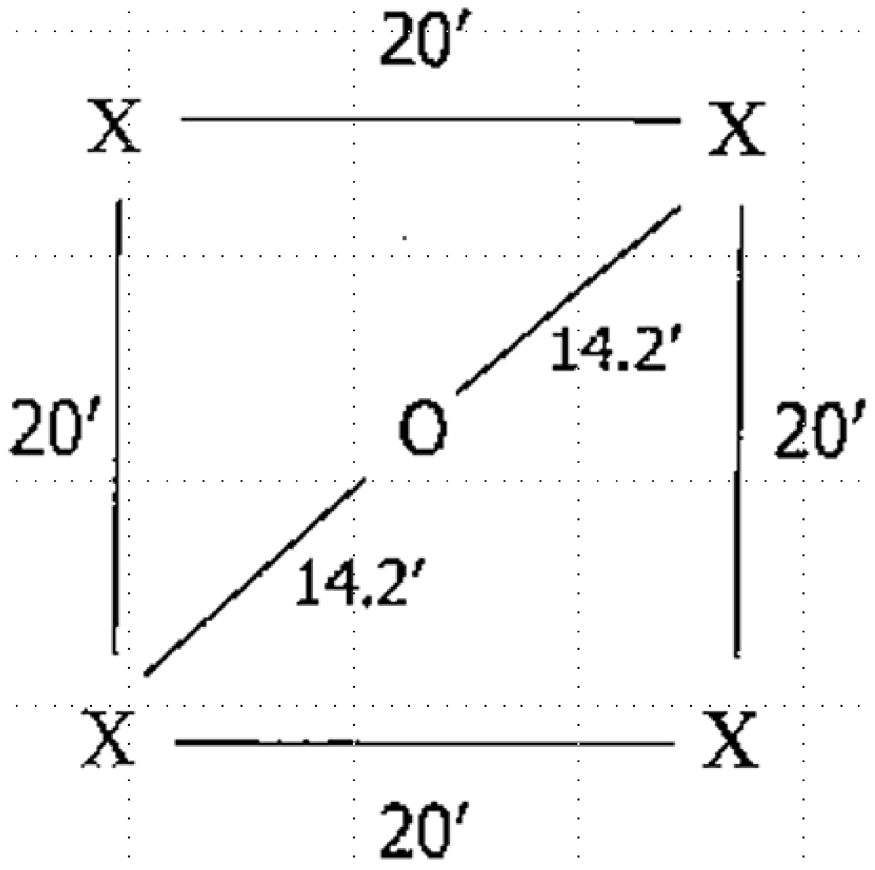
Examples:



The quincunx design consists of the basic square with an extra tree set in the center of the square. Temporary rows run diagonally in two directions, northeast-southwest and northwest-southeast. Permanent rows at the mature tree spacing after temporary tree removal will run in north-south and east-west. This system increases the number of trees (216) during the early years of production to 98% more than that of the 20 x 20 feet square design. Temporary trees must be removed when crowding begins. It becomes the basic square after temporary trees are removed. The design gives temporary trees more space than does the double-density rectangular design, therefore temporary trees would not have to be removed as soon. There is less space for equipment between temporary rows than for the rectangular designs, however.

Quincunx Design

Example:

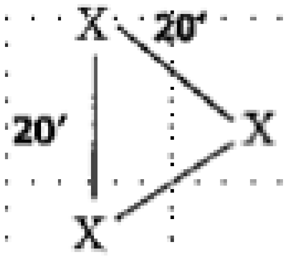
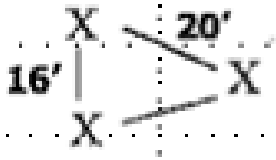


O=Temporary Tree

Triangular Designs

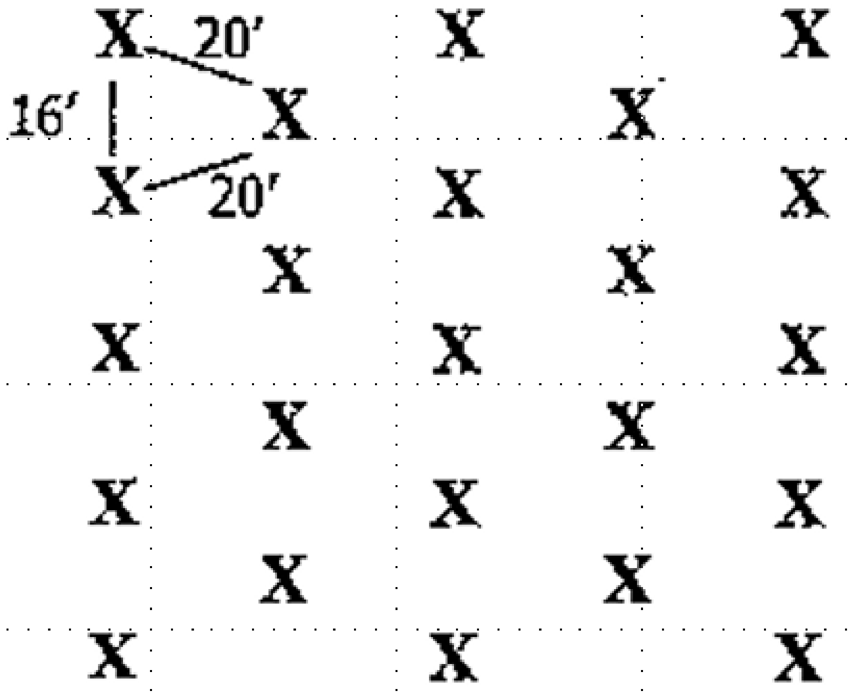
Triangular designs are more difficult to use than square designs. Their main advantage is a greater number of trees per acre than square designs using the same spacings between trees in adjacent rows and within rows. Optimum use is made of available space by setting trees in one row opposite the gaps between trees in adjacent rows. There are two types of triangular designs: (1) The hexagonal design, and (2) The triangular design.

The hexagonal design has every three trees forming an equilateral triangle such that every tree is equidistant from every other adjacent tree. Rows run in three directions. Each tree has equal space. Tree density per acre (120) at a 20 x 20 x 20 feet spacing is about 10% more permanent trees than the basic square.

		Initial Density	Mature Density
		(Trees per Acre)	
Triangular Systems			
Hexagonal		120	120
Triangular		144	144

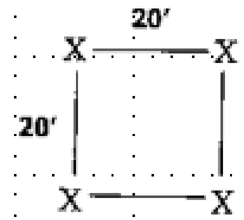
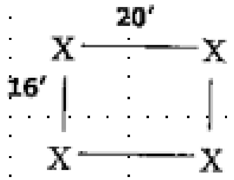
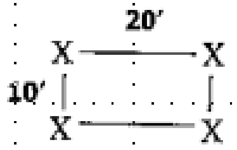
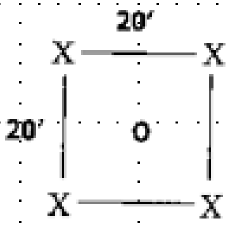
Triangular Design

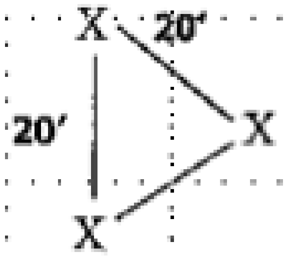
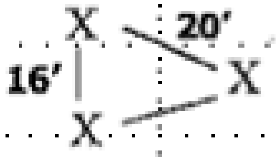
Example:



The triangular design is based on the isosceles triangle where trees are set closer within rows but with the same distance between trees in adjacent rows. This system has the greatest number (144) of permanent trees of all designs at a 16 x 20 x 20 feet spacing, 32% more than the basic square, 6% more than the rectangular. Rows run in only one direction, north-south.

Comparison of Tree Density Per Acre For Several Planting Designs

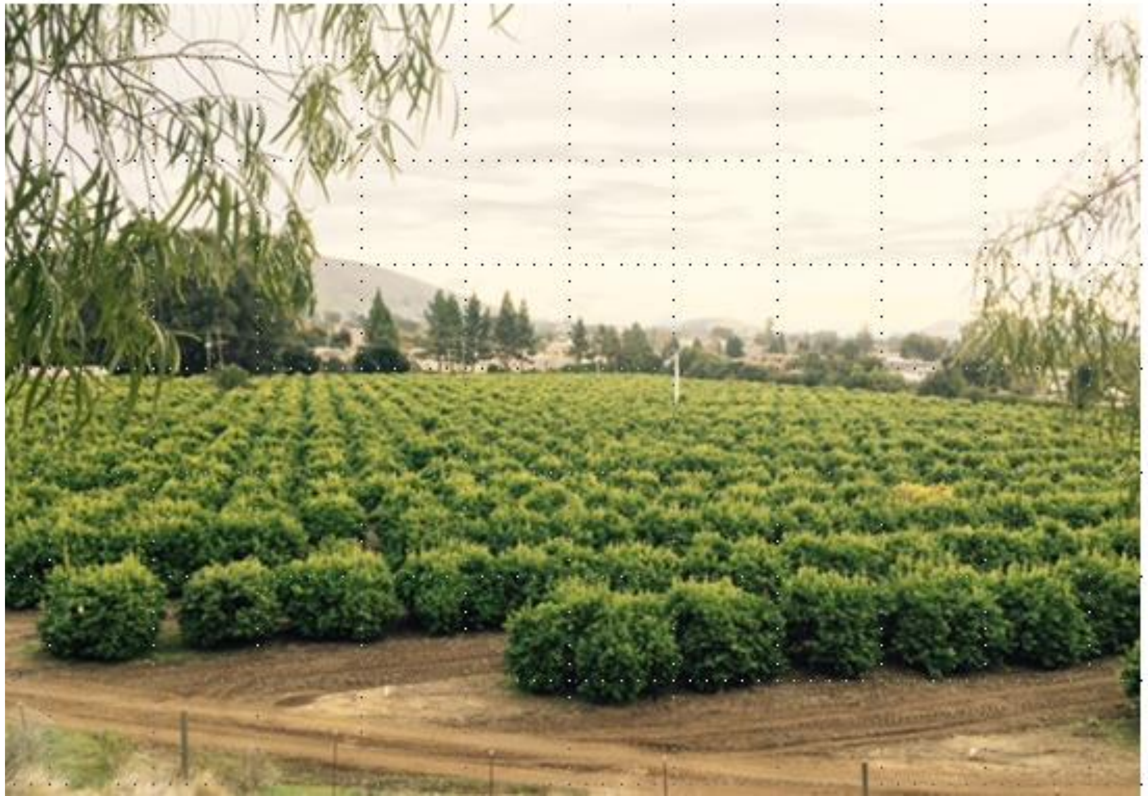
Square Systems		Initial Density (Trees per Acre)	Mature Density (Trees per Acre)
Square		109	109
Rectangle		136	136
		218	109
Quincunx		216	109

	Initial Density	Mature Density
	(Trees per Acre)	
Triangular Systems		
Hexagonal		
	120	120
Triangular		
	144	144

Design selection is based on factors such as optimum use of land, mature tree size, and space needed for equipment. Square designs (especially rectangular) are better for hedged trees, especially if row spacing is important to allow room for equipment. Triangular systems are better for unhedged trees, full diameter canopies. They make the most efficient use of space for mature trees.

<u>Rectangular systems are most common</u> because they allow room for equipment, lend themselves well to hedging of rows, and are suitable for initial high-density plantings such as the double-density system where trees are started at one-half the mature tree spacing in the rows but at a mature tree spacing between rows. Temporary trees may be hedged back on their sides within rows to delay removal or removed when crowding begins so as not to lose production. This side hedging may only need to be done every 3 or 4 years. Trees may be left at a double-density spacing for 10 to 15 years at which time they may start to crowd such that production declines. Crowding may be delayed by the use of size-controlling rootstocks such as trifoliate orange. Production and income should have been twice that of a mature tree density for the 10 to 15 years at the double-density.

The CalPolySLO Lemon Orchard, 10.9 acres of Lisbon lemons (Limoneira8A) on Carrizo, Macrophylla, C-35 rootstocks. Double density 12.5 x 25 feet, (McNeil, 2020). 1518 trees. Every other tree will eventually be removed. Two wind machines for frost protection. Planted 1996.



trifoliate orange. Production and income should have been twice that of a mature tree density for the 10 to 15 years at the double-density.

Disadvantages of the double-density initial planting are: (1) The extra cost of trees and planting labor, and (2) The wall of closely spaced trees in the row may block both cold air drainage and wind machine air as trees increase in height and width. The additional income produced by the high density of the initial planting should offset the additional tree and planting costs. Skirting the trees and/or orienting rows up and down slopes may help alleviate the cold air dam effect.

How to determine tree (in-row) and row (between-row) spacing.

Spacing between trees in the row should be some multiple of the maximum tree diameter that the trees will reach at maturity. The maximum mature tree diameter can be estimated by measuring 25 year or older trees growing in the same climate and soil area. Double-density trees should be planted at half the mature tree diameter. An exception would be if trees will be hedged between trees with in the row. Trees could be planted closer in that case. When every other double-density tree is thinned out within rows, remaining trees will then be at the mature tree spacing and have enough room to grow and produce to their full potential.

The spacing between rows (for unhedged trees) should be the sum of the mature tree diameter plus the maximum diameter of equipment utilized. Hedged rows could be closer.

Common spacings for citrus in California are as follows for standard-sized trees and for mature orchards (McNeil, 1997; Pehrson, 1976).

	Spacing in Feet
Navels	20 x 20 to 22 x 22
Valencias	22 x 22 to 28 x 28
Lemons	22 x 22 to 28 x 28
Grapefruit	24 x 24 to 30 x 30
Limes	18 x 20 to 20 x 20
Tangerines & Tangelos	18 x 20 to 18 x 22
Satsuma Mandarins (semi-dwarf)	8 x 12 to 14 x 16

Avocado Tree Spacings in California

Double Density:

Hass, Fuerte 20 x 20 feet, eventually 40 x 40 feet.

Bacon, Zutano (tall narrow varieties) 15 x 15 feet, eventually 30 x 30 feet.

A double density Hass avocado orchard (20 x 20 feet). Crowded so every other tree and every other row needs to be eventually removed or dehorned. (Bing.com)

Double-density plantings would be started at half the in-row spacing except for satsuma mandarins.

How to calculate tree density per acre. Use the following formula for square designs:

$$\#\text{ of trees/acre} = \frac{43{,}560\text{ sq. ft. / acre}}{\text{Product of tree and row spacing (in feet)}}$$

Example (for a spacing of 11ft x 22ft.):

$$\frac{43{,}560\text{ sq. ft. / acre}}{11\text{ ft. x } 22\text{ ft.}} = \frac{43{,}560\text{sq. ft. / acre}}{242\text{ sq. ft. / tree}} = 180\text{ trees / acre}$$

Use the following formula for triangular designs:

$$\#\text{ of trees / acre} = \frac{43{,}560\text{ sq. ft. / acre}}{\text{area of the triangle in feet } (= \tfrac{1}{2}\text{ base x height})}$$

Orchard Layout

Row orientation is usually north-south for maximum exposure to sunlight, especially for designs where trees are closer within rows than between rows. East-west rows would have the north side always in the shade. Rows should run up and down hillsides with a steep slope to avoid equipment turnover as might occur with rows oriented parallel to the contours. Four-wheel drive or track-layer vehicles may be needed to drive up and down such steep slopes safely. Terracing may be necessary to safely orient rows parallel to the contours of steep hillsides and to allow access for equipment.

Turning space between the ends of the rows and ditches or fences should be provided for equipment. This should be calculated as ¾ of the length of the longest piece of equipment plus half the diameter of mature trees (the radius).

Example:

(Tractor + Bin Trailer Length)x (.75) + Mature Tree Radius = Turning Space

(10 ft. + 15 ft.) (.75) + 11 ft. = 29.75 ft.

__**A base line should be established**__ to use as a basis for laying out the orchard rows. Rows can then be laid out parallel or perpendicular to this base line. A base line could be a road, ditch, or fence at the edge of the property to be planted or it could be the first row of trees. The base line could be established using a surveyor's transit. It should be as straight as possible.

__The 3,4,5 right triangle method__ can be utilized to lay out orchard rows parallel or perpendicular to the baseline. If tape measures, strings, or wires are laid out in lengths in multiples of 3, 4, and 5 a right triangle will be formed between the lengths with multiples of 3 or 4. Examples are 30, 40 and 50 feet lengths, or 300, 400 and 500 feet lengths. Surveyor's instruments may be used to lay out large commercial orchards.

There are three forms in which nursery plants are obtained: (1) Balled and burlapped, (2) Plastic pots, and (3) Plastic sleeves. Balled and burlapped trees have been field grown and are usually of large caliper. Those in plastic sleeves have been greenhouse grown and although they are usually smaller in caliper they have an extensive root ball. Trees in plastic pots may have been field-grown or greenhouse grown. The form in which nursery plants are obtained does not seem to significantly affect the performance of the trees in the field as long as they are quality trees. Within a few years all nursery tree forms will have grown to about the same orchard tree size in the field.

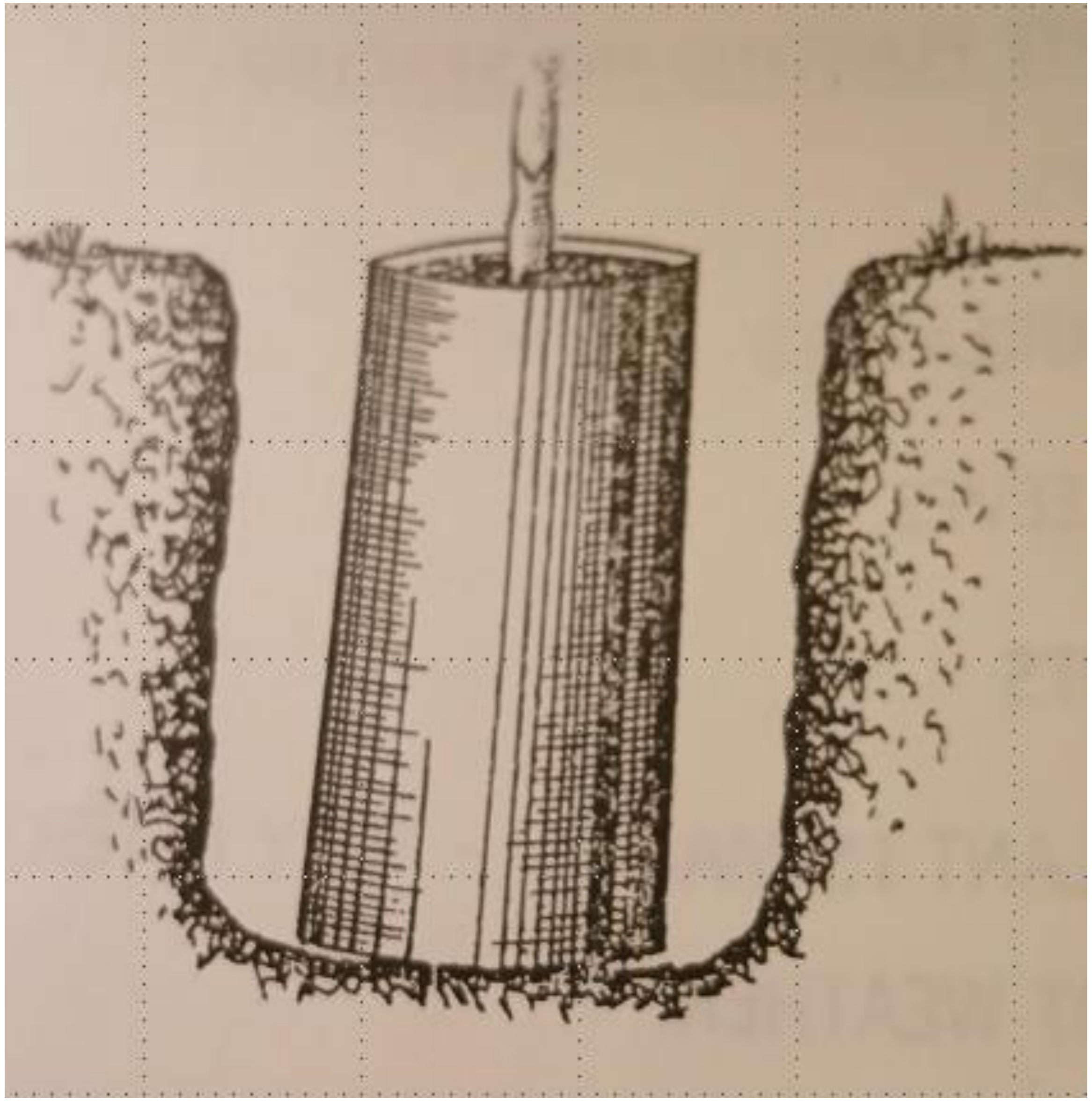
Tree planting

The best time to plant citrus trees is from March to May which is after the chance of freezing weather and before hot weather. This will also allow for a long growing season after planting so that trees can grow to their full potential and mature their growth before the next winter frost season.

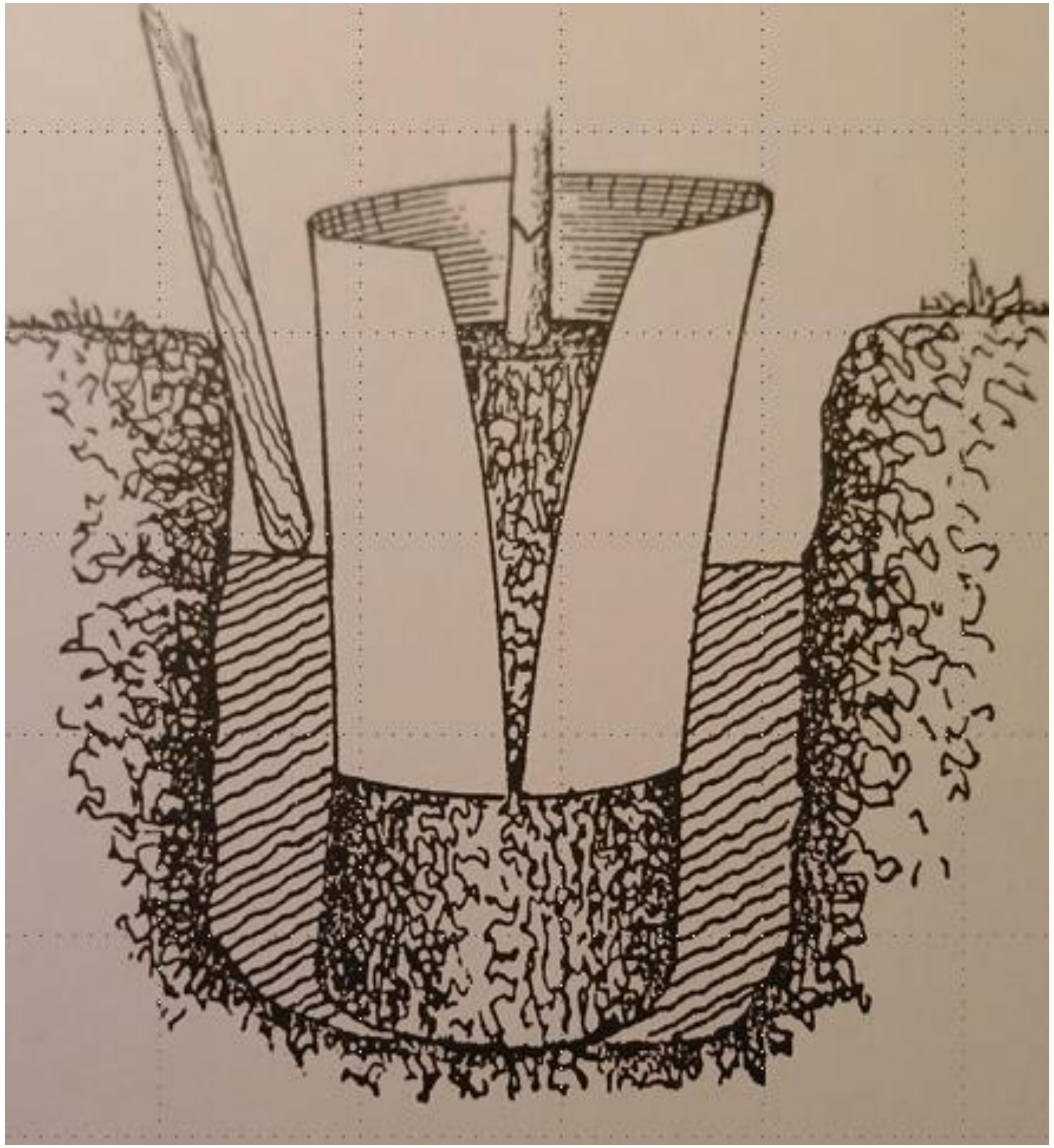
Balled and burlapped trees are planted with the burlap still on so as not to disturb the roots. Only the string and tied burlap at the base of the trunk needs to be loosened after planting, folded back, and covered with soil. Trees in plastic sleeves or pots are placed in the planting hole while still in the container and then the container is slit vertically on one side and carefully removed with minimal root disturbance.

A young avocado tree in a plastic sleeve ready for orchard planting.
(Costa, 1989)

Avocado Tree in Plastic Sleeve or Pot. Dig hole to same depth as soil in sleeve or pot or set it higher. (UC Cooperative Extension)

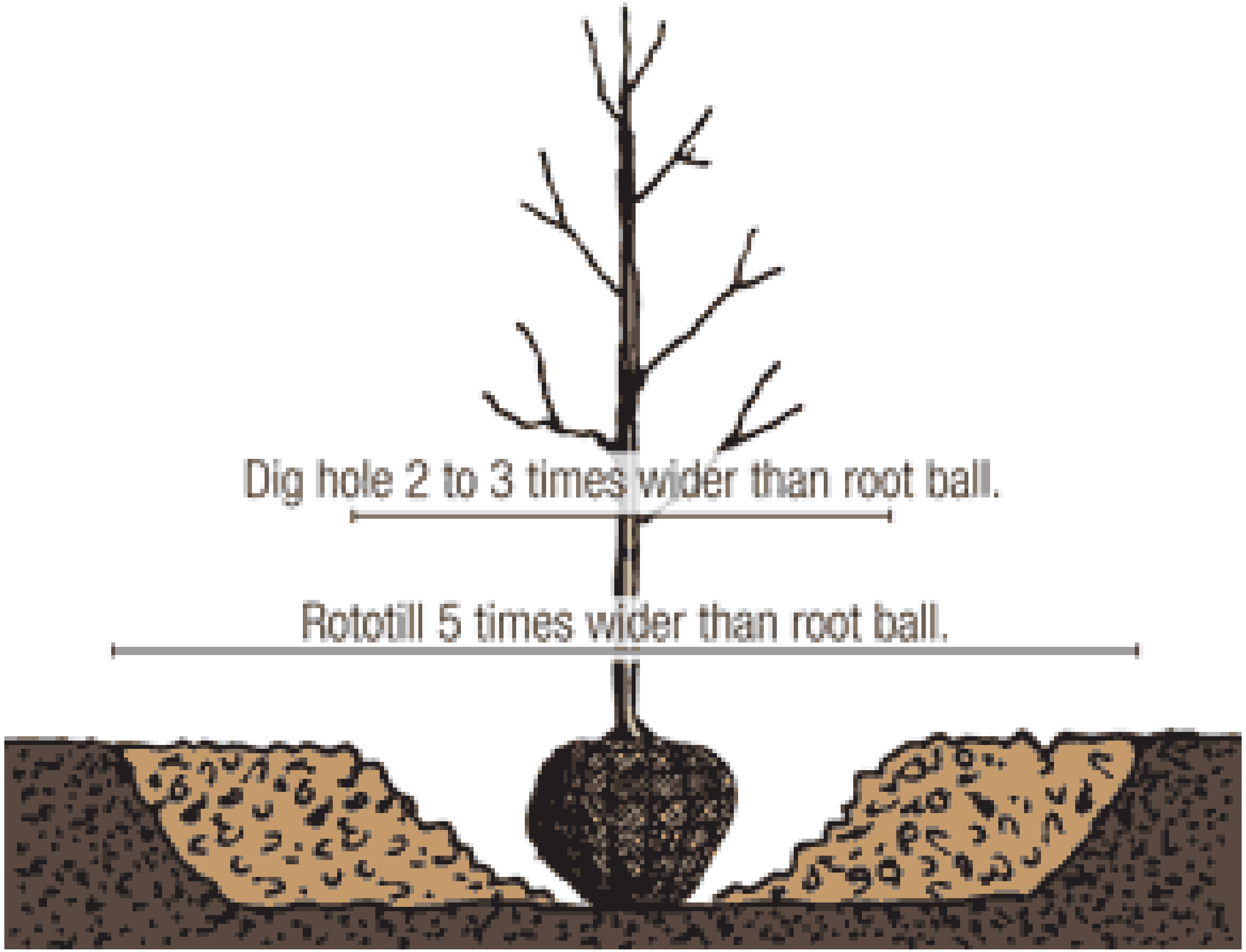


Avocado Tree Planted in Plastic Sleeve or Pot. Cut and remove sleeve or pot. Fill the hole to ground level. (UC Cooperative Extension)



Avocado Tree in Burlap (Arborday.org)

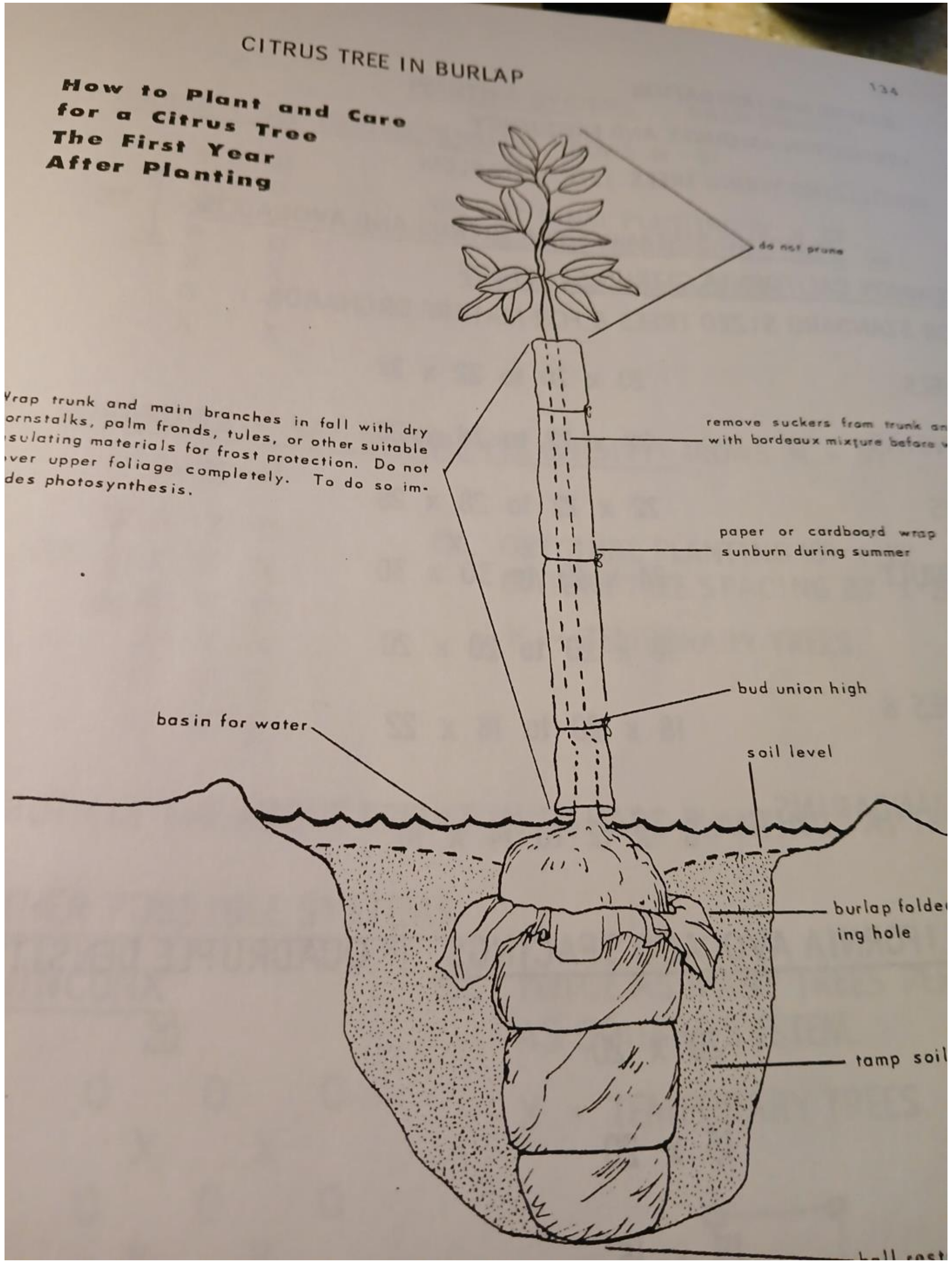
Planting in Burlap.
Plant at same depth as soil in burlap. Or slightly higher.

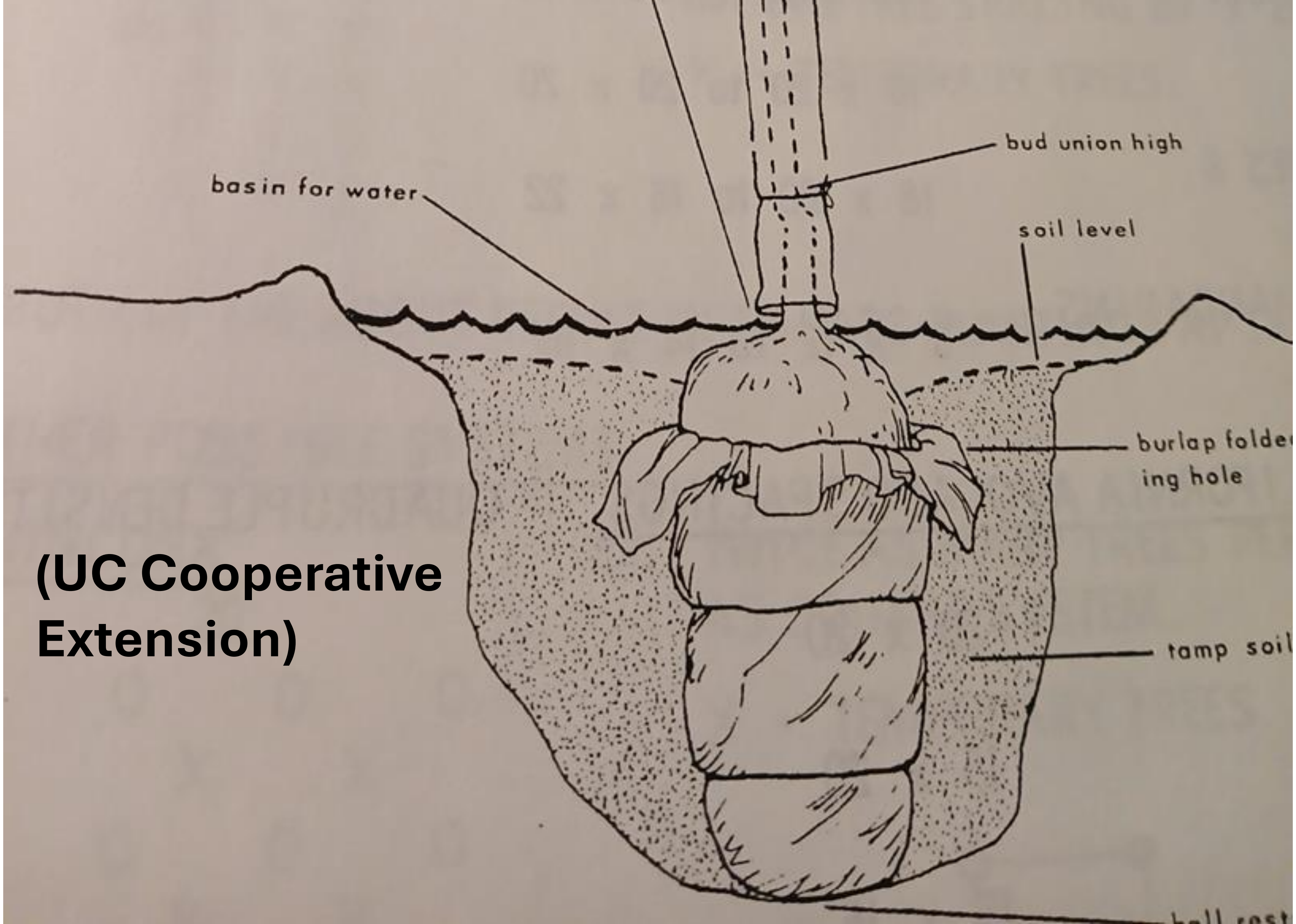


Planting Trees in Burlap.
1. You’ll need to dig a saucer-shaped hole. If you can, rototill an area five times the diameter and as deep as the root ball. The prepared soil will make the hole easier to dig and encourage root growth. Measure the depth of the root ball to make sure the root collar will be at or a little above ground level when your tree is planted.

2. Dig the hole 2 or 3 times as wide and as deep as the root ball. The hole should have sloping sides, and don’t disturb the soil at the bottom of the hole.
3. Set the tree in the center of the hole. When moving the tree, handle it by the root ball. Don't move or lift the tree by the trunk as this can cause the root ball to separate from the trunk. Check the planting depth. If the root collar is below ground level, compact some soil under the root ball to bring the root collar up to slightly above ground level.

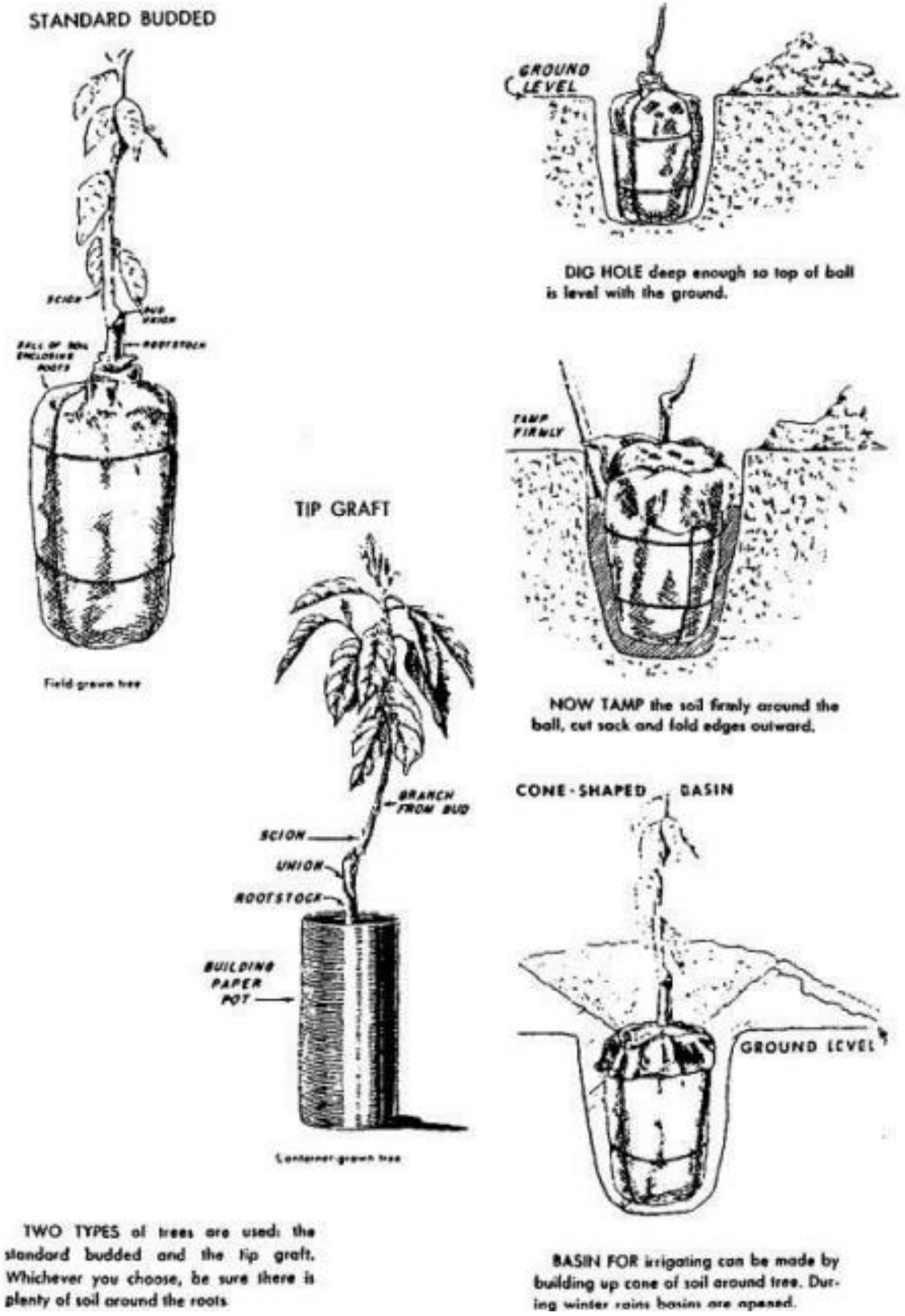
Avocado Tree
Planted in Burlap. Leave burlap on but fold it back in the planting hole.
Fill hole to ground level.
Plant at same depth as soil in burlap or slightly higher. (UC Cooperative Extension)





(UC Cooperative Extension)

Trees in burlap and plastic sleeves (Koch,1983)



Dig the planting holes so the soil level in the container is level with or slightly above ground level. A planting board is useful to position trees at the proper depth and location in the row. The hole need be only wide enough to accommodate the root ball. It should be as wide in the bottom as it is near the top. Firm the soil in the bottom of the hole to avoid settling of the trees. Holes dug by hand with shovels are best but augers may be utilized for large-scale plantings or for hard to dig clay loam soils. Fill the hole with soil after setting the trees and tamp moderately to remove air spaces. Soil should slope inward toward the trunk so water will get to the root ball. A donut shaped ridge of soil several inches high should be shaped in a 2.5 feet diameter around each tree to form a basin. This basin should be filled by water tank or furrow with enough water to wet the soil at least 18 inches deep after planting to settle in the plants. This may be 5 to 10 gallons per tree or 2 to 4 inches of water depending on the soil texture. Basins may have to be filled twice on heavy soils (clay loam) to irrigate deep enough. Future irrigations could then be accomplished by the usual orchard methods (drip, mini-sprinklers, furrow, or flood).

__Staking of trees__ should be on the windward side of the trees with 1-inch x 1-inch x 4 feet stakes pounded 1.5 feet into the ground so they will not fall over during wet and windy weather. 2-inch x 2-inch x 6 feet grape stakes may be used in very windy areas. Tie the tree above a limb near the top of the tree for best support and so the tie does not slide down too low on the tree. Tying lower on the trunk would allow the tree tops to blow over and snap off in very windy weather. Use plastic tie ribbon to avoid girdling the tree.

<u>White cardboard collars or whitewash</u> (½ white interior flat latex wall paint + ½ water) should be applied to trunks after planting to prevent summer sunscald of green bark. Collars will also help shade out sucker growth from the rootstock. Collars can be removed before the second growing season when enough foliage has grown to shade the trunks from sunscald. Additional pest control may be needed for pests (snails, earwigs, etc.) that may hide under the collars. Use whitewash instead of collars if such pests become difficult to control.

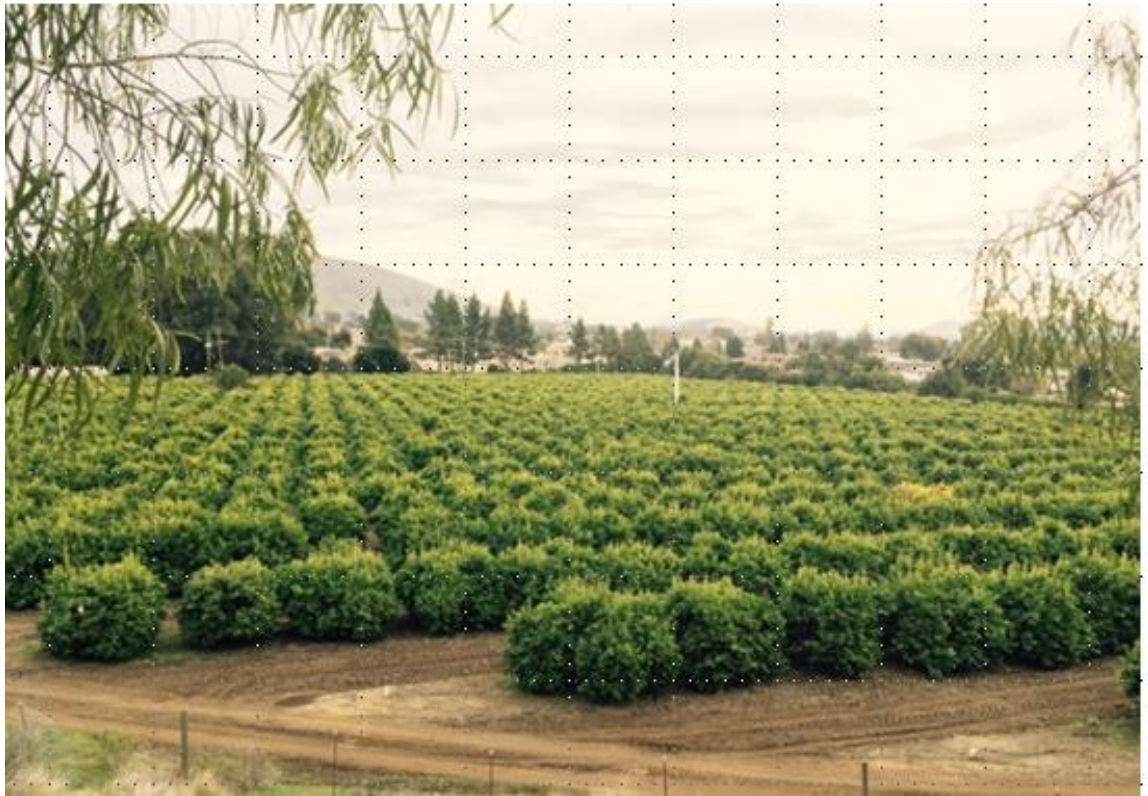
Insulating tree trunk wraps such as corn stalks, palm fronds, or commercial insulating materials should be applied to young trees in the fall before the winter frost season for freezing protection.

Copper fungicide may be applied to the trunks before applying collars or tree wraps to prevent gummosis in the humid conditions under the materials. Follow label directions.

Fertilization of the Newly Planted Orchard

Need not begin until about one month after planting or when new growth begins. This will allow the roots to get established before fertilization. Greenhouse grown plants may already have enough residual fertilizer to last a month or so. See the chapter on fertilization/nutrition for fertilizer rates (especially for nitrogen) for newly planted trees.

The CalPolySLO Lemon Orchard, 10.9 acres of Lisbon lemons (Limoneira8A) on Carrizo, Macrophylla, C-35 rootstocks. Double density 12.5 x 25 feet, (McNeil, 2020). 1518 trees. Every other tree will eventually be removed. Two wind machines for frost protection. Planted 1996.



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A double density avocado orchard. Bing.com.

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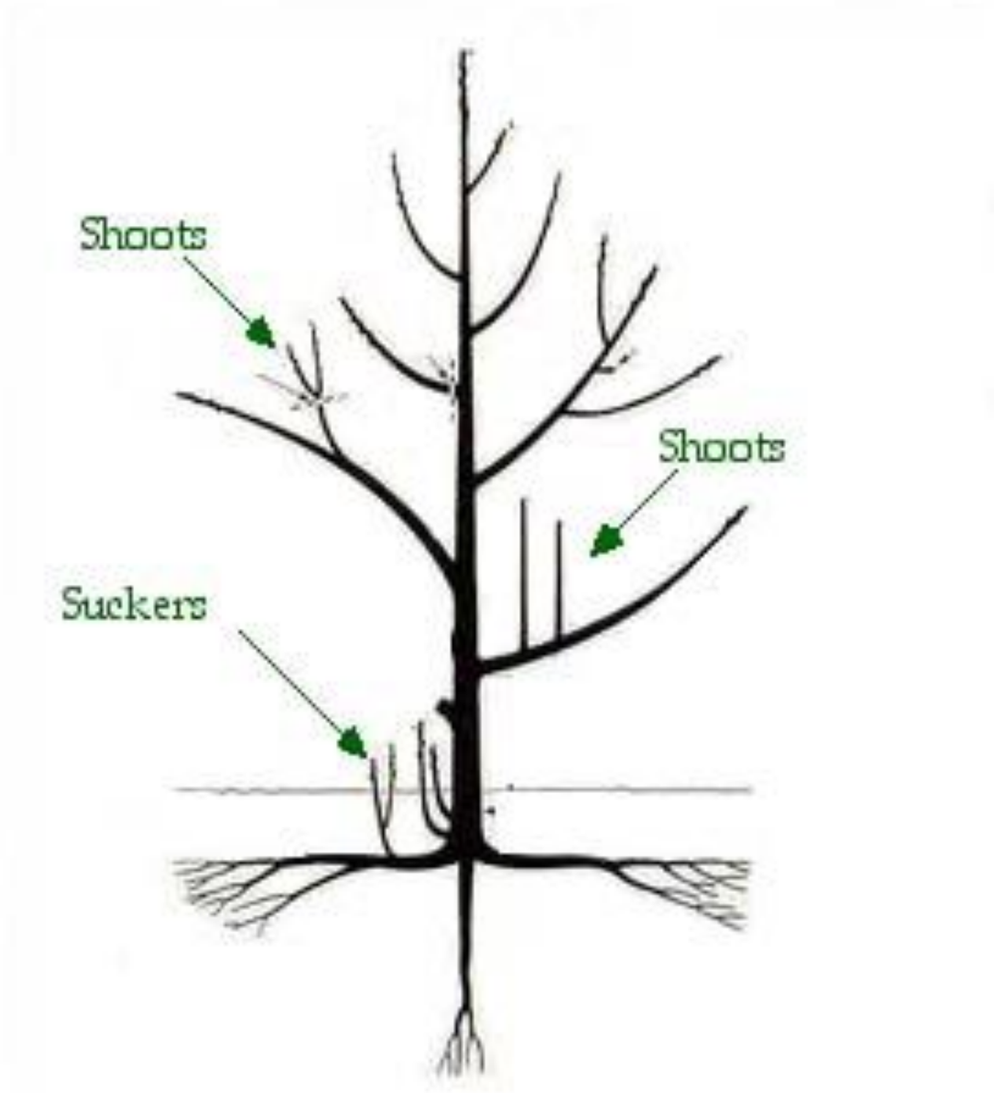
Koch, 1983. California Avocado Production Manual.

Chapter 11. Avocado Tree Pruning Summary by Dr. Robert J McNeil, Professor Emeritus, Cal Poly State University, San Luis Obispo, CA 93407

Avocado trees do not need much pruning. In fact no pruning is best for fruit production. Allowing the trees to grow undisturbed naturally will yield the earliest and best fruit production.

Pruning newly planted trees. Do not prune newly planted trees other than sucker removal from the rootstock below the graft union. Also remove watersprouts from the trunk and limbs. Remove suckers and watersprouts for the lifetime of the tree. These are non-productive parts of the tree.

Prune off all suckers and watersprouts (labeled shoots here). (UCIPM)



Remove watersprouts. Don't leave stubs. (Wikihow.com)

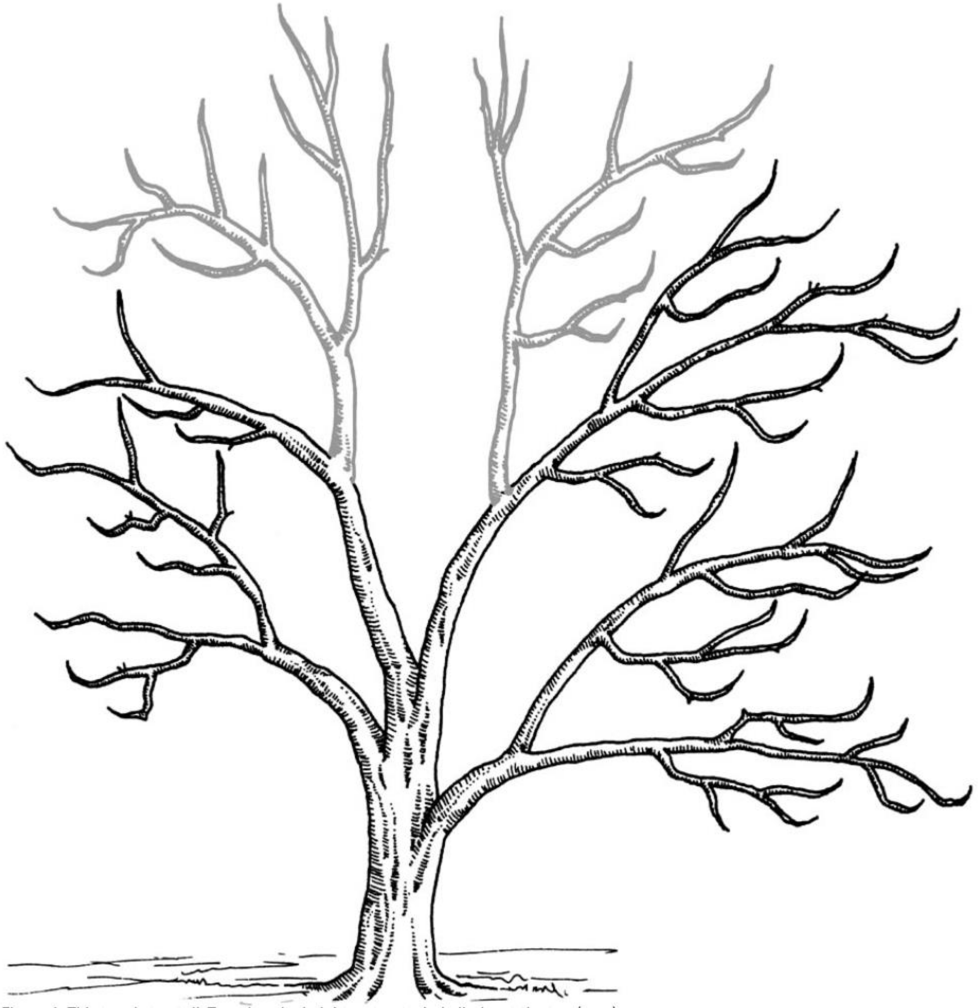
Pruning newly planted avocado trees.

Do not prune newly planted avocado trees other than sucker and watersprout removal. Allow trees to grow naturally into their irregular shape and full canopy. They will naturally develop branches into a full canopy. Any pruning will delay fruit production. Earliest fruit production will occur without pruning.

Pruning of mature trees.

Let trees grow and produce for their lifetime without pruning other than sucker and watersprout removal. Mature trees may also need removal of dead wood periodically as needed. Thinning out of upper limbs making trees too tall for harvest may also be practiced if desired although picking crews may use picking poles and extension ladders for tall trees, so pruning for height control may not be needed. Any pruning will reduce production. Pruning should be avoided. Cutting back crowded trees may be necessary. Cutting back main limbs may be necessary. Whitewash them to avoid sunburn. Let trees regrow without disturbance.

This avocado tree is too tall. To reduce its height, thin out whole limbs at the top (gray)(WSU.pdf). Picking crews may reach the upper limbs using picking poles and extension ladders so the upper limbs may be left undisturbed. They may bear much fruit so removing them would reduce yield.



Pruning of lower stems (skirts) in the way of minisprinklers may be necessary.

University of California Research. (Some after Bender et al, 2015).

Researchers at the University of California in the 1960's remarked- "experience has shown that heavy pruning does not increase production but reduces it by stimulating new vegetative growth at the expense of fruit production" (McCarty et al. 1962). However, the desire to increase yield per acre is only one factor involved in the decision whether to maintain a pruning program; other factors such as reduced picking costs, improved safety for pickers working in shorter trees, and better spray coverage when applying pesticides are all good reasons for pruning avocado trees. The latter point has become more important in recent years with the infestations of thrips and persea mites in the California avocado groves.

Tree thinning (removal of every other tree) has traditionally been the method for dealing with the crowding problem and was promoted by University of California extension specialists and farm advisors in the 1970's (Platt et al, 1975). Thinning is advantageous in that the operation opens up the grove and allows light to reach the the lower limbs. Light on the lower limbs initiates vegetative growth from dormant buds, and eventually flowering and fruit-set occurs. The thinning operation increases yield on the remaining trees, but does not solve the problem of picking fruit high up in the trees. The question remains as to whether thinning can increase yield per acre. Surprisingly, there is little data from California to answer this question. Platt et al presented yield data from a Fuerte grove that averaged 8760 lbs/ac during years 10-14 when the grove was not crowded, 7675 lbs/ac during years 15-19 when the grove was crowded, and 11,033 lbs/ac during years 20-22 after the grove was thinned. In this example, they showed that yield per acre increased after thinning, with half the number of trees per acre.

Crowded Avocado Orchard (Bing.com). No fruit on lower limbs. Only in tops.

Dehorning Crowded Avocado Trees.

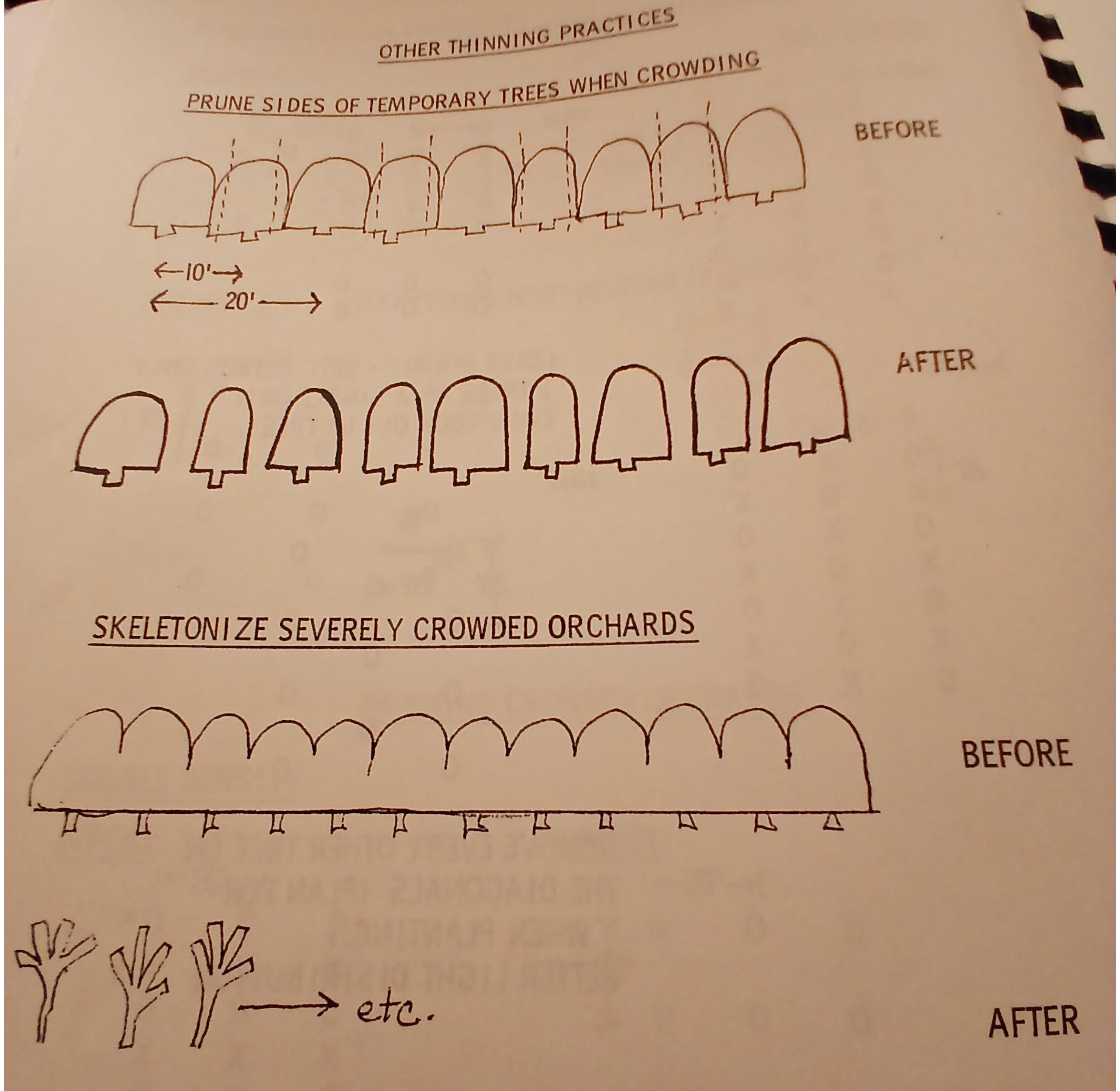
Cut the trees back and only leave two foot long limbs. Whitewash them with half and half white water based wall paint and half water. They will produce a crop again in two years. See photos on the next two pages. Let them grow back undisturbed. Do not thin out the new growth. That will reduce production.

Dehorning Crowded Avocado Trees (Gettyimages.com)

(Bing.com)

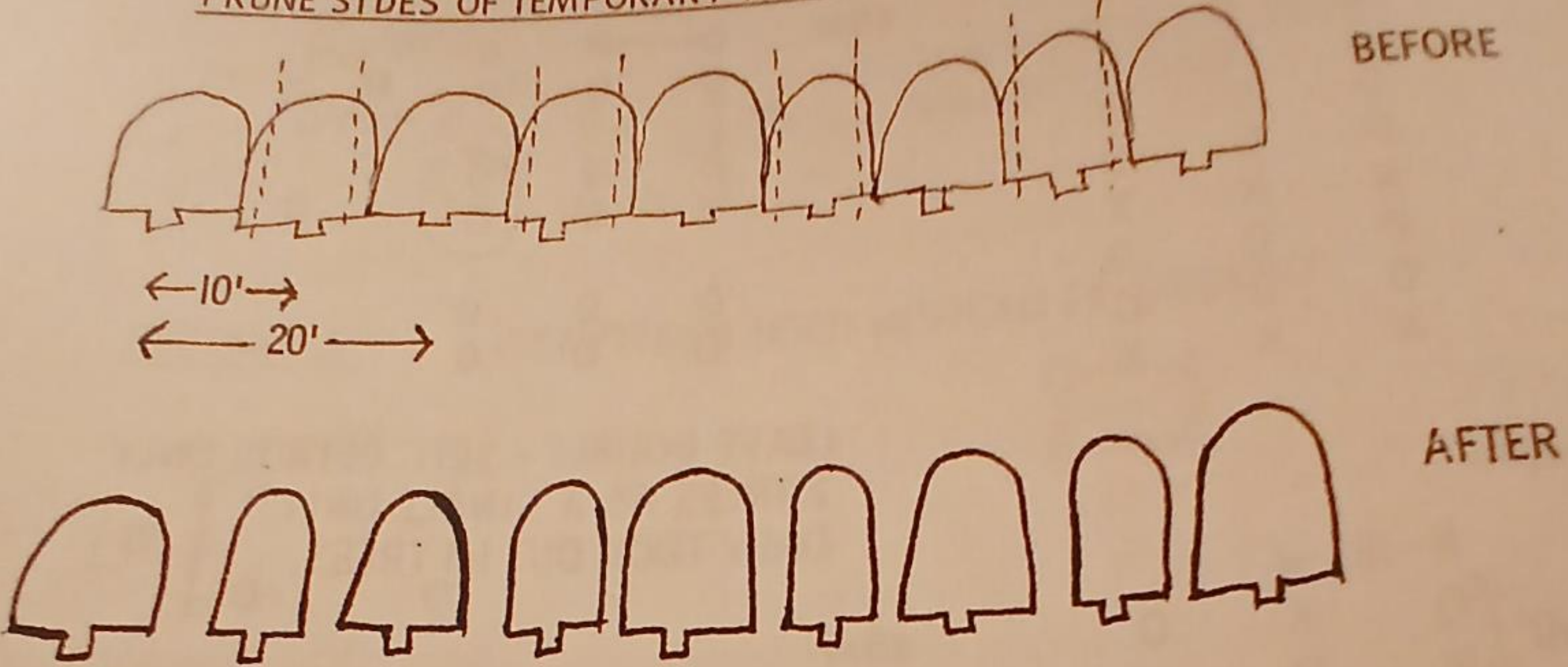
Dehorning Crowded Avocado Trees (Bing.com)

Other Orchard Thinning Practices

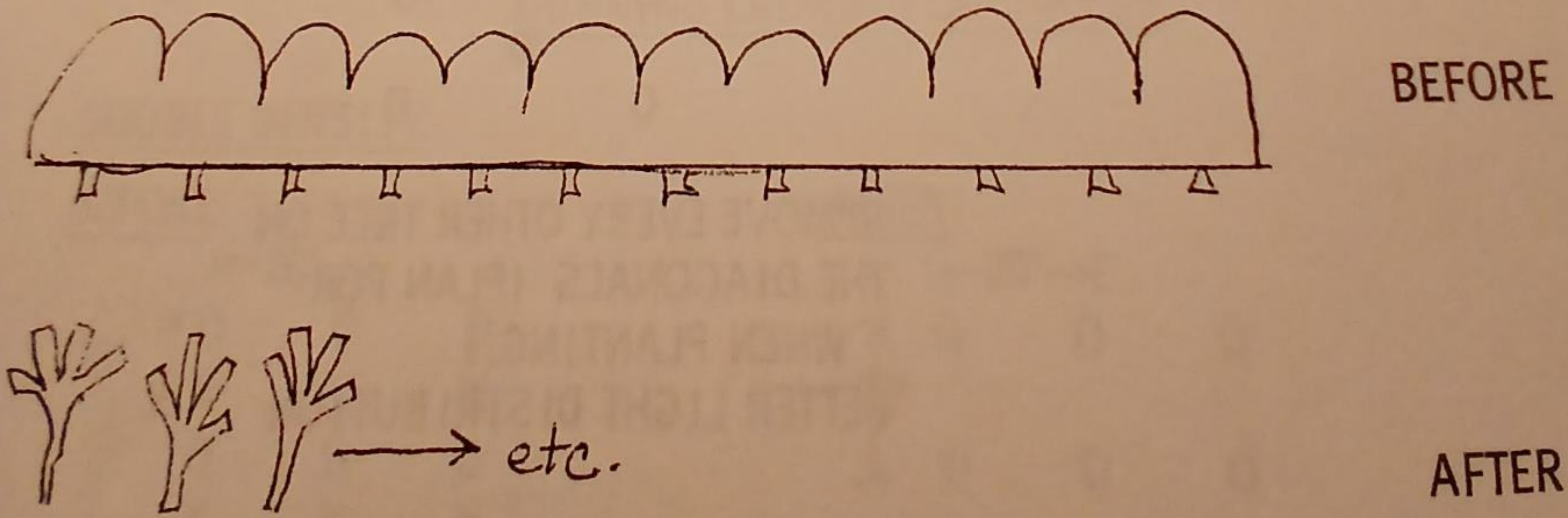


OTHER THINNING PRACTICES

PRUNE SIDES OF TEMPORARY TREES WHEN CROWDING



SKELETONIZE SEVERELY CROWDED ORCHARDS



Pruning of avocado trees is not recommended.

Other than sucker removal, watersprout removal, dead wood removal, and partial removal of skirts blocking minisprinklers. Pruning is a grower decision such as to keep trees shorter. Crowded trees may be dehorned or thinned out. Any pruning of existing trees, however will reduce production and gross income.

References Cited. Pruning. Chapter 11.

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McCarty, C.D., R.G. Platt and L.N. Lewis. 1962. Pruning avocado trees. Calif. Avocado Soc. Yearbook. 46:42-43.

Platt, R.G., G.E. Goodall, C.D. Gustafson, B.W. Lee., 1975. Thinning avocado orchards.

GettyImages.com

CrowdedAvocadoOrchard Bing.com

WSU.pdf

Pruning of Avocados in Other States.

Texas: **Avocados do not need to be trained or pruned for normal growth and cropping. Prune freeze-damaged trees to remove dead wood. If only limb damage occurs, wait until regrowth begins, and cut back to live tissue. If the tree is killed to the ground, cut it off at ground level. If the roots are alive, many suckers or trunks will emerge (hopefully above the graft line) that will need to be pruned if a single-trunk tree is desired.**

avocados_2015.pdf (tamu.edu)

Florida. CIR1034/MG213: Avocado Growing in the Florida Home Landscape (ufl.edu)

Formative pruning during the first 2 years may be desirable to encourage lateral branching and growth. After several years of production it is desirable to cut back the tops of the trees to 10 to 15 feet (3.1 to 4.6 m). Selectively removing a few upper limbs back to their origin (crotches) each year will help prevent the loss of the lower tree canopy due to shading by the upper canopy. In addition, maintaining a smaller tree facilitates tree care and fruit harvest, makes it easier to spray the tree, and greatly reduces possible storm damage. Do not remove lower tree branches.

Pruning should be done soon after harvest for early varieties, but after danger of frost has passed for late varieties. Severe pruning is sometimes used to reduce tree height or width of very large trees. It does not injure avocado trees, but reduces fruit production for one to several seasons. Once avocado trees become 30 ft (9.1 m) or taller extreme caution should be used in pruning the trees. Climbing trees to prune them is dangerous and not recommended. Pruning of large avocado trees should be done by a professional arborist that is licensed and insured.

Florida. ENH-594/ST435: Persea americana: Avocado (ufl.edu)
Avocado production in Florida (ufl.edu)

Pruning.—No systematic pruning methods for the avocado are generally followed. Trees which have been well cared for and have never suffered a setback require little pruning. Sometimes, with certain varieties, small limbs which have carried a very heavy crop are devitalized and these should be cut back to strong healthy growth. Likewise, trees dying back from root troubles may be greatly benefited by severe pruning, giving the roots a chance to develop without heavy transpiration demand for a season. Limbs resting on the ground should be removed if they interfere with mowing and other cultural operations. Fruit on such limbs is sometimes scarred and bruised and is more likely to be eaten by rats and other animals. Some varieties, especially Lula and Taylor, tend to grow very tall and these should be pinched back periodically while young to encourage a more spreading habit. Low, spreading trees are more economically handled in spraying, pruning, picking and other cultural operations and are less liable to wind damage. Dead, broken or diseased limbs should be removed, the cuts being made close to the limbs from which these branches originate.

The best time to prune is in the dormant period of winter after the fruit has been picked, if it matures in the fall or early winter. All exposed surfaces should be painted with some protective material soon after the cuts are made. Carbolineum and several commercial pruning paints having an asphalt base have been found very satisfactory for this work. When cuts are left unpainted, wood borers are sometimes found deep in the pith. These insects gradually burrow downward and weaken the limb to such an extent that it rarely recovers, and wood-decaying fungi follow them.

Hawaii. Avocados: The Complete Guide To Growing In Hawaii | Homesteadin‘ Hawai‘i (homesteadinhawaii.com)

Pruning An Avocado Tree: How Often Should You Do It

Annual or bi-annual light pruning is usually enough for adult trees. You're going to need a good pair of hand pruners and some loppers.

Pruning removes any weak or dead branches and allows sufficient sunlight to penetrate to lower branches. This will help your tree to be healthier, overall.

Heavy pruning can adversely affect the size of your avocado harvest in adult trees, or lengthen when your tree will fruit, in younger trees.

Avocado trees grown from seeds can grow to massive heights. If you have grown yours from seed, you may need to prune it even from a young age to help control the shape of the tree. Consider pruning a young avocado tree (grown from seed) every 4-6 months.

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Hawaii. (https://mauimastergardeners.org/docs/pruning-avocado-trees/)

Training and pruning avocado trees

Young avocado trees should not require extensive pruning. Whenever possible, allow trees to develop naturally. Be sure to prune off any suckers that arise below the graft or bud union.

Avocados require early training. Terminal shoots should be pinched beginning the second growing season and continuing until the tree is properly shaped to promote lateral growth. If upright-growing varieties are not trained early, they tend to grow too high and the fruit develops in the upper two-thirds of the tree, making harvest difficult. Training early will help restrict the tree's height, and fruit will be produced closer to the ground and more evenly throughout the tree.

Hawaii. **(https://mauimastergardeners.org/docs/pruning-avocado-trees/)**

Pruning and thinning are not required to keep avocado trees productive or attractive. If you do prune to keep trees smaller or more confined, the ideal time is just before bloom or just after fruit set. That way the tree can naturally adjust its fruit load during the June drop. Minor pruning can be done at any time, but avoid late-season pruning, which can stimulate excessive tender growth that is likely to be injured by frost. Prune sparingly and remove as little green wood and as few green leaves as possible. Protect any exposed branches after pruning from sunburn by painting with a 50:50 white [interior] latex paint and water mixture.

Hawaii. (https://mauimastergardeners.org/docs/pruning-avocado-trees/)

Prune to Reduce Pest Damage and to Manage Tree Growth

Remove dead limbs and old fruit, possible sources of canker and fruit rot pathogens, at least once per tree every year, usually during fall. Periodically thin canopies to reduce disease-favoring humidity and increase mortality of certain invertebrate pests.

If anthracnose or fruit rots were problems in the grove in previous seasons on fruit after harvest, prune low branches to remove disease inoculum.

Skirt prune trees:

- Reduce spores splashing from soil to infect fruit, especially if weather has been wet.
- Exclude flightless invertebrates from trees by pruning in combination with barriers or other treatments.
- Reduce access to trees by certain vertebrate pests.

Prune and thin to reduce protected sites and minimize canopy bridges that facilitate insect movement between trees, thereby reducing the abundance of caterpillars, greenhouse thrips, and mealybugs.

Do not prune or pick fruit when plants are wet.

Clean and disinfect cutting tools before working on a new tree, to reduce mechanical spread of pathogens and infection of wounds.

Puerto Rico. [(How to prune an avocado tree: mastering the craft 🥑✂️ Essential techniques revealed (homefortheharvest.com)]

Avocado trees are wonderful additions to any backyard, producing delicious fruits consistently with little effort. Although they are not difficult trees to grow, avocados do benefit from regular pruning to control their growth and improve fruiting. [This is not true. Pruning of avocado trees has not proven to improve fruiting. It decreases fruiting. Dr. Robert J McNeil, Professor Emeritus, Personal comment. CalPolySLO.]

Avocados are best pruned soon after harvesting, with the exact time depending on your chosen species and climate. The technique will also differ based on the age and form of the tree, but a general trim each year is best to encourage new and healthy growth and to improve airflow. Remove any branches growing very low and any dead, diseased, or damaged branches. You may also wish to thin the upper canopy and remove any crossing branches.

Puerto Rico. [(How to prune an avocado tree: mastering the craft 🥑✂️ Essential techniques revealed (homefortheharvest.com)]

Pruning basics

Pruning your fruit trees helps them produce a large, healthy crop of good-sized fruits. It can also control their eventual size and make harvesting much easier. Lastly, increasing air circulation can decrease the incidence of common diseases (especially in humid climates).

Avocado trees are not small. They are known to grow up to 40 feet tall or more when their growth is not monitored. Pruning helps manage this size, stopping you from having to reach for a ladder every time to need to harvest the fruit.

Avocados are also quite dense, with plenty of branches and lush leaves. This dense growth can become overcrowded, stopping light from reaching the branches lower down. Selective pruning helps improve light penetration and ultimately delivers better-quality fruits.

Avocado Tree Pruning Reduces Production.

Remember. Avocado Tree Pruning Reduces Production. So only prune if necessary for a good reason.

Texas A&M says "Avocados do not need to be trained or pruned for normal growth and cropping."

Hawaii says "Pruning and thinning are not required to keep avocado trees trees productive or attractive." And

"Young avocado trees should not require extensive pruning. Whenever possible, allow trees to develop naturally."

Florida says: No systematic pruning methods for the avocado are generally followed. Trees that have been well cared for and have never suffered a setback require little pruning.

And "Severe pruning is sometimes used to reduce tree height or width of very large trees. It does not injure avocado trees, but reduces fruit production for one to several seasons."

Researchers at the University of California in the 1960's remarked- "experience has shown that heavy pruning does not increase production but reduces it by stimulating new vegetative growth at the expense of fruit production" (McCarty et al. 1962).

All the above statements are true about avocado tree pruning, so use caution before pruning avocado trees.

Dr. Robert J McNeil, Professor Emeritus, Fruit Science, CalPolySLO CA

California Avocado Pruning websites.

https://ipm.ucanr.edu/PMG/C008/m008fcprune.html

https://www.californiaavocadogrowers.com/cultural-management-library/avocado-tree-pruning-basics

Pruning-Avocado-Trees

http://www.avocadosource.com/

Avocado Pruning in California

(https://www.californiaavocadogrowers.com/cultural-management-library/avocado-tree-pruning-basics)

AVOCADO TREE PRUNING BASICS

Apr 22, 2013

When pruning avocado trees, remember this: always prune with a purpose and avoid under- or over-pruning the avocado trees. Also remember that what works for one tree may not work for another tree — pruning should be done on a case-by-case basis as no two avocado trees are the same.

Basic shaping of avocado trees should start in the nursery, while training should begin immediately following planting. This is especially important when training for the central-leader shape. Remember that avocado trees tend to be broad-spreading trees with only moderate apical dominance. Before pruning, picture what you want the avocado tree to look like now and in 2, 5, 10 and 15 years.

Hygiene is also very important when pruning avocado trees. Pruning tools should be cleaned regularly, and sick – or unhealthy – trees should be pruned separately from the healthy trees in order to prevent the spread of sunblotch and fungal – or bacterial – diseases like blackstreak. Dispose of infected prunings responsibly..

Avocado Pruning in California

(https://www.californiaavocadogrowers.com/cultural-management-library/avocado-tree-pruning-basics)

There are different pruning methods that can be used to manage avocado tree size and improve light interception.

Selective limb removal.

Mechanical pruning to a hedgerow.

Stumping (stag-horning); remember to whitewash the trunks.

Tree thinning; remove every second tree.

Replacement of the entire tree block.

Central leader.

Avocado Pruning in California

(https://www.californiaavocadogrowers.com/cultural-management-library/avocado-tree-pruning-basics)

WHAT TO PRUNE ON AN AVOCADO TREE

What —and how much — is removed, depends on the reason(s) for pruning. Pruning involves large branches, small branches and flowering branches.

General avocado pruning principles are:

Prune horizontal branches developing low to the ground, as these interfere with tree access.

Push light into the tree interior, by cutting "windows" in the canopy.

Trees grown on slopes should be pruned to a lower height than trees on flat land.

Space the main limbs 3- to 4- feet apart, to allow access inside the tree.

Rejuvenation can require cutting the tree back to the main trunk; however, don’t expect production in the second year.

Avocado Pruning in California

(https://www.californiaavocadogrowers.com/cultural-management-library/avocado-tree-pruning-basics)

Eliminate 'v-type' crotches, as these are mechanically weak and prone to developing rots.

Remove dead wood, as much as possible.

Make major cuts clean, and in line, with the trunk contour.

When renovating a grove, aim to remove large, interfering — and low-lying — laterals, badly crossed limbs and spilt crotches.

Pruning needs to balance the side-shoot growth and remove strong, upright water shoots, in order to achieve a good central-leader shape.

A conical, or pyramidal, tree shape enables good light interception and minimizes unproductive bare areas.

Constant attention to pruning detail, with small cuts at the correct time, minimizes need for additional major pruning cuts.

Chapter 12. Harvesting and Packing Avocados

https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Harvesting/Harvesting_Avocados_/

Oil Content. The main criteria and most reliable method for determining maturity of avocados in California is by oil content and percent dry weight. California state law has established minimum oil and minimum percent dry weight requirements. Oil content is determined by laboratory test and can be made by most marketing organizations.

Minimum dry weights are required for each variety. See page 684-689.

Appearance of the fruit. By observing the fruit on the tree, an experienced grower can tell much about its maturity. Dark-colored varieties are usually mature when they start to turn from green to dark color. Green-colored varieties become smoother, may develop corky spots, and develop a yellow tint to skin and stem.

Seed Coat. The appearance of the seed coat is a valuable check of maturity. If the seed coat is dark brown and tissue-thin, the fruit is probably mature. Remember - Immature fruit may be rejected at the market by State inspectors. An oil test is the most reliable method to determine maturity. Determining maturity is most important early in the season. After the season for a variety is well under way in your area, you should be able to pick for size only.

How to pick. Remember that by careful harvesting you will receive a higher price per pound for your fruit. Remember that avocados are easily bruised or scratched.

Care in Picking. Wear cotton gloves. Do not drop fruit. Do not lay fruit on the ground without some protection underneath it. Use proper picking equipment such as ladders, poles, clippers and canvas picking bags.

Do not pull fruit from the stem. Clip the stem as close as possible without injuring the fruit.

An avocado clipper. (Bing.com)

How to properly clip an avocado. This avocado has been clipped properly.

An avocado picking pole. (Bing.com)

An orchard ladder (Stokes.com)

(https://www.tractorsupply.com/tsc/product/stokes-ladders)

Care in Handling
Do not overfill field boxes as top fruit will be bruised.
Store the picked fruit in shade or cover the top box with an empty box or avocado branches with leaves.
Haul fruit to processing plant as soon as possible.
Source - U.C. Leaflet 108, Harvesting and Marketing Avocados by Richard E. Puffer.

Avocado Harvest and Packing Video. Copy and paste website below to view.

https://www.bing.com/videos/riverview/relatedvideo?&q=packing+avocados&qpvt=packing+avocados&mid=43BC78A17EB6751B8D4843BC78A17EB6751B8D48&&FORM=VRDGAR

SIZING AND APPLICATION

Per 25 lb carton.

Popular Variety	Sizing					
Hass	There is usually a cost difference between larger-sized and smaller-sized avocados, with larger sizes generally more expensive. The most widely used avocados in foodservice are 48 and 60 count, with 48 count being the most prominent choice. On average, avocados yield around 63%. To understand the net usable product or yield on additional produce items, check out our Produce Yield Guide.					
Approximate Count	84	70	60	48	40	36
Weight (oz.)	3.7 oz.	5.0 oz.	5.9 oz.	7.7 oz.	10 oz.	10.7 oz.
Average Yield (oz.)	2.6 oz.	3.6 oz.	3.9 oz.	5.4 oz.	7.0 oz.	7.4 oz.
Measure (cup)	1/3 cup	7/16 cup	1/2 cup	2/3 cup	7/8 cup	15/16 cup

Avocado Packing Sizes Per 25 lb carton.

https://www.bing.com/search?q=avocado+packing+sizes

Avocado Ripening Stages

Firm/Unripe

(hard stage 1) Pre-conditioned, firm to touch. Allow 5-7 days to ripen at room temperature (60-65℉).

Breaking

(breaker stages 2-3) Pre-conditioned, beginning to soften. Allow 2-5 days to ripen at room temperature (60-65℉). Preferred stage of ripeness for cutting into wedges or slices.

Ripe

(ripe stages 4-5) Ready-to-eat, yields to gentle pressure. Store refrigerated at 36-40℉ for up to 5 days. Preferred stage of ripeness for guacamole, but typically too soft to hold shape when cut into wedges or slices.

Short-term (7 days or Fewer) Storage Recommendations for Whole Avocado

Firm/Unripe Characteristics and Storage

Firm/Unripe 36-40℉ will arrest the ripening process of the fruit

45-50℉ will continue to ripen the fruit

Ripe 36-40℉

90-98% relative humidity

Storage recommendations for processed avocados.

Slicing open avocados will naturally cause oxidation, and avocados will turn brown over a length of time once exposed to air.

Recommendations for keeping the natural yellow-green hue of avocados once they are cut.

Process only what you plan to use the same day.

Apply lemon or lime juice to the exposed pulp to help slow oxidation.

Store in airtight or double-sealed plastic containers with clear plastic wrap, and refrigerate. Do not store in metal containers.

Maturity Testing. Dry Weight.

Apparatus

Scale or balance (accurate to .01 grams)

Microwave oven

Glass dish or unwaxed paper container

Paring knife

Potato peeler

Pencil and paper for calculations

Dry Weight Maturity Procedure

Weigh container and record weight (c)
Cut avocado lengthwise into quarters
Remove seed, seed coat and peel
With potato peeler cut slices off each cut surface of each quarter of avocado
Transfer approximately 10 grams of fresh slices into container
Weigh container with fruit slices and record weight (F)
Place container in microwave oven and cook until dried to a constant weight. Usually 10 to 15 minutes. Start with 5-minute intervals and reduce to 30 second intervals until no more weight is lost. Slightly burnt samples will still produce satisfactory dry-weight figures.
Quickly weigh container containing dried slices and record the weight (D).
Calculate the percent dry weight.

Calculation

% Dry Weight =

D - C X 100

F - C

D = dry tissue weight plus container

C = container tare weight

F = fresh tissue weight plus container

Example

A fresh sample weighing 16.9 grams including a container weighing 4.5 grams was dried to a constant weight of 6.9 grams. Calculate dry weight.

D = 6.9 grams

C = 4.5 grams

F = 16.9 grams

% Dry Weight =
6.9 - 4.5 X 100
16.9 - 4.5
=
2.4 X 100
12.4
=
.193 X 100
=
19.3
Dry weight and oil content increase at a constant ratio. Preliminary unofficial results indicate that percent dry matter minus 10 equals oil content. Hence, above sample would have a 9.3% oil content.

Precautions

When using a balance of low sensitivity, i.e., .1 gram, use a larger container and a 100-gram sample instead of 10 grams and record weight to nearest .1 gram.

When using a conventional oven for drying, set oven at 212 F and cook sample for about 5 hours or until dried to constant weight.

Postal scales are not accurate enough for this test.

A number of balances or scales are available for making dry-weight analysis.

Minimum dry matter standards for some major varieties:

17.7
Bacon
21.6
Pinkerton
19.0
Fuerte
18.7
Reed
24.2
Gwen
Susan 18.4
20.4
Rincon
20.8
Hass
18.4

Susan
19.3
Jim
18.7
Zutano

Source - Seung Koo-Lee, Plant Physiologist, UCR

Lamb Hass 22.8

Avocado Packouts

There are 17 avocado packers in California.

An example of a packout statement for Lamb Hass avocados is on the next page.

The statement lists how many pounds for each size class, 28 through 120, and for culls.

Price per pound for each size class will be listed on the final statement and multiplied by pounds for each size class.

The California Avocado Commission assessment of 2.25% and HAB assessment costs (.025/lb on this statement) will be subtracted from total gross income.

Packout Report for Lot Number: 507

Grower ID:		**Grower Type:**	Growers
Grower Name:		**Bins:**	6
Block ID:		**Variety:**	LambConv
Grower Address:		**Picking:**	NO
Pack Date:	Aug 30, 2024	**Picker:**	-
Harvest Date:	Aug 27, 2024	**Field Rep:**	

Bin Summary

Bin #	Pounds	Bin #	Pounds
48518	958		
50886	969		
54672	640		
59172	936		
A1774	969		
A2192	968		

Fruit Sizing

	Size	Pounds	Percent	Price	Total
GR1	28	202	3.71%		
	32	1,079	19.83%		
	36	976	17.94%		
	40	948	17.43%		
	48	937	17.22%		
	60	234	4.30%		
	70	50	0.92%		
	84	22	0.40%		
	96	7	0.13%		
	120	5	0.09%		
	Subtotal	**4,460**	**81.99%**		
GR2	2LG	494	9.08%		
	2ME	379	6.97%		
	2SM	47	0.86%		
	Subtotal	**920**	**16.91%**		
Marketable Pounds		**5,380**		**Gross Return**	
Culls		**60**	**1.10%**		
Total Fruit Weight		**5,440**			

Additional Charges

CAC Assessment 2.25%
Picking:
HAB Assessment .025/Lb

Sub Total

Grand Total

California Avocado Inspection:
https://www.cdfa.ca.gov/is/i_%26_c/avocado.html
https://www.californiaavocadogrowers.com/sites/default/files/CAC-Food-Safety-Manual-Version-5-%28APPROVED-8-18-22%29-FILLABLE.pdf
https://www.cdfa.ca.gov/is/i_&_c/spi.html

In 1972, the California avocado industry sponsored legislation requiring mandatory inspection and certification, establishing the Avocado Certification and Inspection Program. The goal is to protect the industry and consumer by providing uniform inspection to ensure that all avocados comply with minimum standards. (https://www.cdfa.ca.gov/is/i_%26_c/avocado.html)

From 1972 to 1986, CDFA inspectors performed the avocado inspections. In 1986, the California Avocado Commission, through a Memorandum of Understanding with the CDFA, became the employer and paymaster of the inspectors – the Commission pays inspection personnel. The Avocado Inspection Committee is advisory to the Secretary on all matters pertaining to avocado inspection.

The assessment rate changes to reflect both the crop size and the revenue needed to meet the budget. Current assessment fee is $.25 cents per 100 pounds.

Avocados are inspected for the following: maturity; defects; size, count and weight; standard container and pack; and container markings. Each lot is tested for maturity only until a 'released date' for each size and variety is established. After the release date, maturity testing is no longer required.

California Safety Manual. Go to:

(https://www.californiaavocadogrowers.com/sites/default/files/CAC-Food-Safety-Manual-Version-5-%28APPROVED-8-18-22%29-FILLABLE.pdf) **Not required.**

Shipping Point Inspection Program

(https://www.cdfa.ca.gov/is/i_&_c/spi.html)

The California Shipping Point (SPI) program is part of the nationwide fresh fruit and vegetable inspection program administered by the U.S. Department of Agriculture (USDA). It exists under a cooperative agreement/contract with the California Department of Food and Agriculture. State employed inspectors are authorized to make inspections on the basis of US grade standards or other written government or private specifications for fresh products, including certificates showing how the products measure up to the official grades or other State or Private specifications.

Services Provided

Shipping Point Inspection is the largest type of inspection activity in the program. Inspection service users can request inspection to be done in the field, at packing houses, or at cold storage facilities. Inspectors can certify California produced commodities as to quality (grade), condition, size, net weight, temperature, and other factors required by users.

Terminal Market Inspection is available from SPI employees in nearly all offices statewide and in Federal offices in Los Angeles and San Francisco. This type of inspection normally occurs at a receiving point as a result of a dispute between a seller and buyer. A small number of Federal employees are authorized to travel world wide to conduct receiving point inspections for users. More information about this international service is available from USDA in Washington, D.C.

Continuous Inspection is a program authorized by USDA where a contract applicant may affix a USDA shield or "Continuous Inspection" language to containers to indicate that all packed products are inspected by USDA.

Imported products are regularly inspected at the U.S. border crossings. Several products, such as tomatoes and kiwifruit, are covered by US import requirements and must meet minimum quality and/or size levels before being permitted to be brought into the US. Other products are inspected solely for user information.

Export inspections on table grapes, apples are required under Acts of US Congress. The Acts were established by industry request in order to promote sales of these products in foreign countries, to require all shippers to export at a minimum grade and to promote high quality US products.
Institutional Inspection is conducted in various districts statewide. Inspectors verify that products will meet the specifications stated in the institutional purchase contract.
DPSC inspections assure that products purchase by the military meet military purchase specifications.
GAP/GHP Food Safety Services are offered to growers and handlers of agricultural products. Federal-State Inspection Services personnel review participating companies' facilities and agronomic practices and documentation to help determine if "Good Agricultural Practices" and "Good Handling Practices" are being maintained. USDA Specialty Crops Program:

The AMS Specialty Crops Program helps buyers and sellers of all sizes in the U.S. produce industry to market their perishable products in the most efficient manner. We partner with State agencies and other industry organizations for the benefit of nationwide growers, shippers, brokers, receivers, processors, retailers and restaurants, direct to consumer sales, and the foodservice industry.

The program offers a wide array of services that span from helping market the quality of products to ensuring that there is fair trade in the produce industry. The program also helps specialty crops growers and handlers to combine their resources to help their respective industries overcome marketing barriers.

What is a specialty crop? Avocados yes.

Section 101 of the Specialty Crops Competitiveness Act of 2004 (7 U.S.C. 1621 note), amended under section 10010 of the Agricultural Act of 2014, Public Law 113-79 (the Farm Bill), defines specialty crops as, “Fruits and vegetables, tree nuts, dried fruits, horticulture, and nursery crops (including floriculture)." Eligible plants must be cultivated or managed and used by people for food, medicinal purposes, and/or aesthetic gratification to be considered specialty crops. Processed products shall consist of greater than 50% of the specialty crop by weight, exclusive of added water.

A detailed definition of specialty crops (pdf) was also developed for the purposes of this program and other U.S. Department of Agriculture programs.

Tables are provided that list plants commonly considered fruits and tree nuts, vegetables, culinary herbs and spices, medicinal plants, as well as nursery, floriculture, and horticulture crops. There is also a separate list of ineligible commodities. These lists are not intended to be all inclusive, but rather to provide examples of the most common specialty crops. This web page will be updated as the U.S. Department of Agriculture receives new questions about the eligibility of various crops.

Florida Avocados, Shipping Point and Market Inspection Instructions: Go to:

https://www.ams.usda.gov/sites/default/files/media/AvocadoFloridaInspectionInstructions.pdf

USDA standards apply to California, Florida, Texas, Hawaii, Puerto Rico, all states, too.

https://www.ams.usda.gov/sites/default/files/media/AvocadoFloridaInspectionInstructions.pdf

Freezing and Freezing Injury {C) The term "frozen" should only be used when ice crystals are present. Frozen avocados will be darker in color and glassy in comparison to unaffected avocados.

"Freezing injury" is the term that should be used when it is evident that the avocados have been frozen, but are not in a frozen condition at the time of inspection. The avocados may be discolored, watersoaked and dull in appearance.

When reporting freezing or freezing injury, it is important to give the following information: • Pulp temperatures taken at various locations. • Extent of the injury in the load. • Extent of the injury in the containers. • The degree to which individual specimens are affected. • The pattern of freezing or freezing injury in clear, concise terms. When the location of injury indicates where or when the freezing occurred, this is to be stated. For example: "freezing injury so located as to indicate it occurred after packing but not in present location."

https://www.ams.usda.gov/sites/default/files/media/AvocadoFloridaInspectionInstructions.pdf

Grades §51.3050 U.S. No. 1.

"U.S. No. 1" consists of avocados of similar varietal characteristics which are mature but not overripe, well formed, clean, well colored, well trimmed and which are free from decay, anthracnose, and freezing injury and are free from damage caused by bruises, cuts or other skin breaks, pulled stems, russeting or similar discoloration, scars or scab, sunburn, sunscald or sprayburn, cercospora spot, other disease, insects, or mechanical or other means. (a) Tolerances. In order to allow for variations incident to proper grading and handling, not more than a total of 10 percent, by count, of the avocados in any lot may fail to meet the Compliance with the provisions of these requirements of this grade: Provided, That not more than one-half of this amount, or 5 percent, shall be allowed for avocados affected by decay or anthracnose, including therein not more than 1 percent for avocados affected by decay. (See §§51.3055 and 51.3056.) §51.3051 U.S. Combination. "U.S. Combination" consists of a combination of U.S. No. 1 and U.S. No. 2 avocados: Provided, That at least 60 percent, by count, of the avocados in each container meet the requirements of the U.S. No. 1 grade.

https://www.ams.usda.gov/sites/default/files/media/AvocadoFloridaInspectionInstructions.pdf

(a) Tolerances. In order to allow for variations incident to proper grading and handling, not more than a total of 10 percent, by count, of the avocados in any lot may fail to meet the requirements of the U.S. No. 2 grade: Provided, That not more than one-half of this amount, or 5 percent, shall be allowed for avocados affected by decay or seriously damaged by anthracnose, including therein not more than 1 percent for avocados affected by decay. No part of any tolerance shall be allowed to reduce for the lot as a whole the percentage of U.S. No. 1 fruit required or specified in the combination, but individual containers may have not more than 10 percent less than the percentage of U.S. No. 1 fruit required or specified. (See §§51.3055 and 51.3056.)

https://www.ams.usda.gov/sites/default/files/media/AvocadoFloridaInspectionInstructions.pdf

§51.3052 U.S. No. 2. "U.S. No. 2" consists of avocados of similar varietal characteristics which are mature but not overripe, fairly well formed, clean, fairly well colored, well trimmed and which are **free from decay and freezing injury** and are free from serious damage caused by anthracnose, bruises, cuts or other skin breaks, pulled stems, russeting or similar discoloration, scars or scab, sunburn, sunscald or sprayburn, cercospora spot, other disease, insects, or mechanical or other means. (a) Tolerances. In order to allow for variations incident to proper grading and handling, **not more than a total of 10 percent, by count, of the avocados in any lot may fail to meet the requirements of this grade:** Provided, That not more than one-half of this amount, or 5 percent, shall be allowed for avocados affected by decay or seriously damaged by anthracnose, including therein not more than 1 percent for avocados affected by decay. (See §§51.3055 and 51.3056.)

https://www.ams.usda.gov/sites/default/files/media/AvocadoFloridaInspectionInstructions.pdf

§51.3053 U.S. No. 3. "U.S. No. 3" consists of avocados of similar varietal characteristics which are mature but not overripe, which are not badly misshapen, and which are free from decay and are free from serious damage caused by anthracnose and are free from very serious damage caused by freezing injury, bruises, cuts or other skin breaks, pulled stems, russeting or similar discoloration, scars or scab, sunburn, sunscald or sprayburn, cercospora spot, other disease, insects, dirt or mechanical or other means. (a) Tolerances. In order to allow for variations incident to proper grading and handling, not more than a total of 10 percent, by count, of the avocados in any lot may fail to meet the requirements of this grade, including therein not more than 2 percent for avocados affected by decay. (See §§51.3055 and 51.3056.)

https://www.ams.usda.gov/sites/default/files/media/AvocadoFloridaInspectionInstructions.pdf

§51.3054 Unclassified. "Unclassified" consists of avocados which have not been classified in accordance with any of the foregoing grades. The term "unclassified" is not a grade within the meaning of these standards, but is provided as a designation to show that no grade has been applied to the lot.

https://www.ams.usda.gov/sites/default/files/media/AvocadoFloridaInspectionInstructions.pdf

Standard Pack §51.3055 Standard pack. (a) The avocados shall be packed in accordance with good commercial practice and the pack shall be at least fairly tight. The weight of the smallest fruit in any container shall be not less than 75 percent of the weight of the largest fruit in the container. Size of the avocados may be specified by count. (b) In order to allow for variations incident to proper sizing and packing, not more than 5 percent, by count, of the avocados in any container may weigh less than 75 percent of the weight of the largest fruit: Provided, That no fruit in any container shall weigh less than 60 percent of the weight of the largest fruit in the container. In addition, not more than 5 percent of the containers in any lot may fail to meet the requirement as to tightness of pack.

https://www.ams.usda.gov/sites/default/files/media/AvocadoFloridaInspectionInstructions.pdf

Application of Tolerances §51.3056 Application of tolerances. (a) The contents of individual packages in the lot, based on sample inspection, are subject to the following limitations: Provided, That the averages for the entire lot are within the tolerances specified for the grade: (1) For packages which contain more than 20 avocados and a tolerance of 10 percent or more is provided, individual packages in any lot shall have not more than one and one-half times the tolerance specified. For packages which contain more than 20 avocados and a tolerance of less than 10 percent is provided, individual packages in any lot shall have not more than double the tolerance specified, except that at least one defective and one off-size specimen may be permitted in any package; and, (2) For packages which contain 20 avocados or less, individual packages shall have not more than double the tolerance specified, except that at least one defective and one off-size specimen may be permitted in any package.

https://www.ams.usda.gov/sites/default/files/media/AvocadoFloridaInspectionInstructions.pdf

Definitions §51.3057 Similar varietal characteristics. Similar varietal characteristics means that the avocados in any container are ar in shape, texture, and color of skin and flesh. §51.3058 Mature. Mature means that the avocado has reached a stage of growth which will insure a proper completion of the ripening process. §51.3059 Overripe. Overripe means that the avocado is dead ripe with flesh soft or discolored and past commercial use. §51.3060 Well formed. Well formed means that the avocado has the normal shape characteristic of the variety. §51.3061 Clean. Clean means that the avocado is practically free from dirt, staining or other foreign material. §51.3062 Well colored. Well colored means that the avocado has the color characteristic of the variety. §51.3063 Well trimmed. Well trimmed means that the stem, when present, is cut off fairly smoothly at a point not more than one-fourth inch beyond the shoulder of the avocado.

Freezing Damage Tolerances for Avocado Fruit Calif Agr Code (McNeil, 1997) May no longer apply. See 2024 information. See the next three pages here for latest information for 2024. Federal regulations are now 10% by count.

% of Fruit, Flesh	% of Fruit by Count
20 %	15%

California Code of Regulations. Avocado Freezing.

https://regulations.justia.com/states/california/title-3/division-3/chapter-1/subchapter-4/article-11/section-1408-7/

Freezing temperatures can cause fruit loss and tree damage in California's avocado growing regions. Avocados are considered damaged by freezing injury when there is bronze color on the outside surface of the skin or water-soaked discoloration of the flesh adjacent to the skin. Severe freezes can destroy individual avocado trees, particularly when temperatures fall below 30°F.

California Code of Regulations
Title 3 - Food and Agriculture
Division 3 - Economics
Chapter 1 - Fruit and Vegetable Standardization
Subchapter 4 - Fresh Fruits, Nuts and Vegetables
Article 11 - Avocados
Section 1408.7 - Avocados, Freezing Injury
Universal Citation: 3 CA Code of Regs 1408.7
Current through Register 2024 Notice Reg. No. 38, September 20, 2024

Notwithstanding the provisions of Section 1408.5, avocados shall be considered damaged by freezing injury when:
(a) There is any amount of bronze color on the outside surface of the skin; or
(b) There is any amount of water-soaked discoloration of the flesh adjacent to the skin as determined on the surface of a transverse cut made at least 1 inch from the stem end of the fruit; or (c) Any discoloration or desiccation of the flesh occurs on a transverse cut made at least 1 inch from either the stem or distal end of the fruit, or on either such cut surface if it covers an aggregate area of more than 1/2 inch in diameter; or (d) Ten or more vascular fiber bundles, which are as dark as the color guide established by the Director, appear on the surface of a transverse cut made at least 1 inch from the stem end of the fruit; or (e) There is any internal void as determined on the surface of a transverse cut made at least 1 inch from either the stem or distal end of the fruit.

1. Renumbering from section 1397 filed 1-21-75; effective thirtieth day thereafter (Register 75, No. 4). For prior history, see Register 57, No. 9.
2. Amendment filed 11-7-88; operative 11-7-88 (Register 88, No. 46).
3. Amendment of section and NOTE filed 9-16-92; operative 9-16-92 (Register 92, No. 38).
4. Editorial correction of subsection (a) (Register 2014, No. 10).

Note: Authority cited: Sections 14, 407 and 42684, Food and Agricultural Code. Reference: Sections 42941 and 44973, Food and Agricultural Code.

References Cited. Chapter 12 Harvest and Packing.

https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Harvesting/Harvesting_Avocados_/

Puffer, Richard E. U.C. Leaflet 108, Harvesting and Marketing Avocados.

https://www.bing.com/videos/riverview/relatedvideo?&q=packing+avocados&qpvt=packing+avocados&mid=43BC78A17EB6751B8D4843BC78A17EB6751B8D48&&FORM=VRDGAR

https://www.bing.com/search?q=avocado+packing+sizes

Mission Produce, Inc. Oxnard, CA packout statement

https://www.cdfa.ca.gov/is/i_%26_c/avocado.html

https://www.californiaavocadogrowers.com/sites/default/files/CAC-Food-Safety-Manual-Version-5-%28APPROVED-8-18-22%29-FILLABLE.pdf

https://www.cdfa.ca.gov/is/i_&_c/spi.html

https://www.ams.usda.gov/sites/default/files/media/AvocadoFloridaInspectionInstructions.pdf

https://regulations.justia.com/states/california/title-3/division-3/chapter-1/subchapter-4/article-11/section-1408-7/

Chapter 13. Avocado Diseases. See the following website:

https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Diseases/

Anthracnose

Armillaria root rot

Avocado black streak

Avocado root rot

Bacterial canker

Dothiorella fruit rot

Phytophthora fruit rot

Recommendations for preventing the introduction of root rot organisms in new avocado plantings

Root rot, how to spot it and what to do about it

Sampling and determination of avocado root rot

Some do's and don'ts to prevent the spread of avocado root rot

Sunblotch

Verticillium Wilt

https://www.google.com/

Anthracnose is a fungal disease that can affect avocado trees and fruits, causing brown spots that turn black and eventually fall off. It's one of the most common and damaging diseases that affects avocados worldwide.

See more at: https://ipm.ucanr.edu/agriculture/avocado/anthracnose/#gsc.tab=0

Armillaria Root Rot. Armillaria is a soil-borne fungus that causes a root and trunk rot of avocado. The fungus can become well established in roots and the root crown before any symptoms become visible above ground. Infected trees usually die prematurely, and young trees often die quickly after infection. (https://alamedabackyardgrowers.org/oak-root-fungus/) See more at: (https://ipm.ucanr.edu/agriculture/avocado/armillaria-root-rot-oak-root-fungus/#gsc.tab=0)

Avocado Black Streak.

Avocado black streak (BSD) is a bacterial disease that causes black streaks to appear on the trunk and limbs of avocado trees. It's a serious disease that can kill avocado trees, but there are ways to prevent and treat it:

Symptoms

BSD can cause cankers to appear on the trunk and branches of the tree. These cankers have a dry, powdery, water-soluble sugar that exudes through cracks in the bark. The tree may also grow a tuft of brown felt-like fuzz on the black streaks or cavities.

Google.com

See also more at: https://ipm.ucanr.edu/agriculture/avocado/avocado-black-streak/#gsc.tab=0

Avocado Root Rot.

Avocado root rot is a disease that can be caused by a number of pathogens, including Phytophthora and Armillaria:

Phytophthora root rot

This is the most destructive and serious disease that affects avocado trees. It's caused by the fungus-like oomycete *P. cinnamomi*, which thrives in areas with poor drainage and excess soil moisture. Symptoms include:

Small, pale green or yellowish leaves that wilt and have brown tips

Sparse foliage and little new growth

Small branches dying back, exposing other branches to sunburn

Small, black, brittle feeder roots

Trees may produce a heavy crop of small fruit before dying. (Google.com) The Daily Garden.

Also more at: https://ipm.ucanr.edu/agriculture/avocado/phytophthora-root-rot/#gsc.tab=0

Bacterial Canker. See more at:

https://ipm.ucanr.edu/agriculture/avocado/bacterial-canker/#gsc.tab=0

Bacterial canker in avocado can occur on twigs, branches, or trunks. It is caused by a complex of fungal pathogens including species in the Botryosphaeria, Diaporthe, and Colletotrichum. The bacterium Xanthomonas campestris can also infect avocado through wounds and branch stubs. Symptoms include shoot blight, dieback, leaf scorch, branch cankers, and stem-end rot of fruit. (https://www.bing.com/search?q=bacterial+canker+of+avocado)

(Bing.com/images)

Dothiorella fruit rot.

See more at: https://ipm.ucanr.edu/agriculture/avocado/branch-canker-and-dieback-formerly-dothiorella-canker/#gsc.tab=0

Dothiorella fruit rot does not appear when the fruit is still on the tree but develops after the fruit is picked and starts to soften. Small purplish brown spots may then appear on any part of the fruit, but more often at the stem end. These spots gradually enlarge and may involve the entire fruit surface. (https://www.google.com/search?q=dothiorella+fruit+rot&oq=dothiorella+fruit+rot)

Photo: https://ucanr.edu/sites/eskalenlab/files/297605.pdf

Dothiorella stem-end rot symptom of fruit

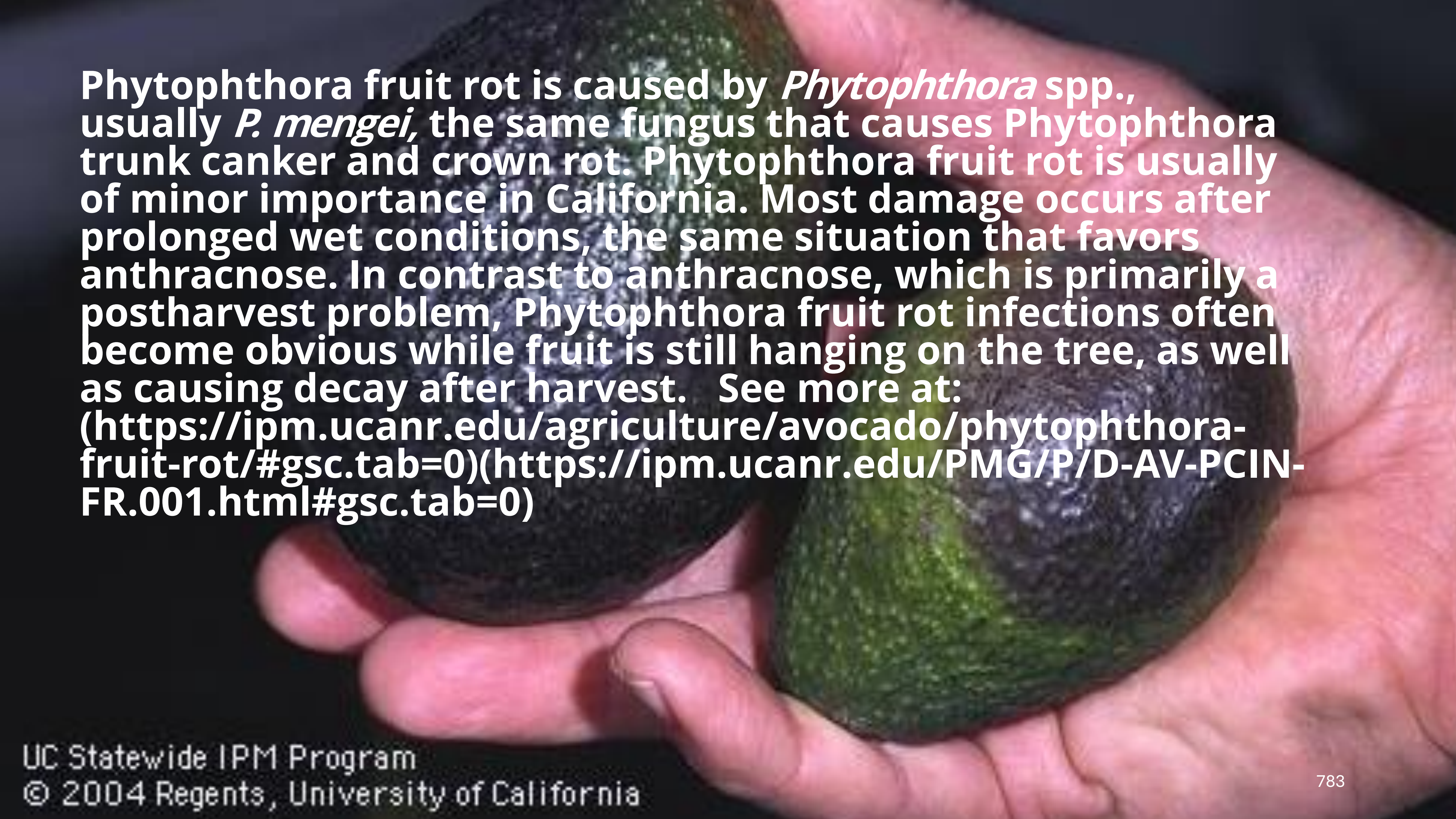
Phytophthora Fruit Rot. See more at:

https://ipm.ucanr.edu/agriculture/avocado/phytophthora-fruit-rot/#gsc.tab=0

Phytophthora is most commonly associated with root rot disease. However, this pathogen can also damage above-ground plant parts such as fruit and leaves. The disease is known as buckeye rot in tomatoes and leather rot in strawberries. (https://www.google.com/search?q=phytophthora+fruit+rot)

Diseased fruit have a distinct circular black area that usually occurs near the bottom portion or lowest spot on the fruit. Internally, the rot extends into the flesh, darkening it in the same pattern as on the affected surface. Affected fruit are often touching the soil or are hanging on low branches. Most damage occurs within 3 feet of the ground. (https://ipm.ucanr.edu/PMG/P/D-AV-PCIN-FR.001.html#gsc.tab=0)

Phytophthora fruit rot is caused by *Phytophthora* spp., usually *P. mengei,* the same fungus that causes Phytophthora trunk canker and crown rot. Phytophthora fruit rot is usually of minor importance in California. Most damage occurs after prolonged wet conditions, the same situation that favors anthracnose. In contrast to anthracnose, which is primarily a postharvest problem, Phytophthora fruit rot infections often become obvious while fruit is still hanging on the tree, as well as causing decay after harvest.   See more at: (https://ipm.ucanr.edu/agriculture/avocado/phytophthora-fruit-rot/#gsc.tab=0)(https://ipm.ucanr.edu/PMG/P/D-AV-PCIN-FR.001.html#gsc.tab=0)



Phytophthora fruit rot: black circular area on an avocado fruit.
Credit: David Rosen. See more at:
(https://ipm.ucanr.edu/PMG/P/D-AV-PCIN-FR.001.html#gsc.tab=0)

Sunblotch.

See more at:
(https://ipm.ucanr.edu/agriculture/avocado/sunblotch/#gsc.tab=0)
Photo:
(https://www.researchgate.net/figure/Severity-of-ASBVd-symptomatic-fruits-assessed-using-a-4-class-scale-Class-0_fig1_260556083)
Avocado sunblotch viroid is a disease affecting avocado trees. Infections result in lower yields and poorer quality fruit. ASBV is the smallest known viroid that infects plants and is transmitted by pollen and infected seeds or budwood.
(Wikipedia)

Verticillium Wilt.

See more at: (https://ipm.ucanr.edu/agriculture/avocado/verticillium-wilt/#gsc.tab=0)

The entire tree or only one or several branches wilt suddenly when affected by Verticillium wilt fungus. Leaves turn brown and die, but the dead leaves usually remain on the tree for several months. Brown to gray-brown streaks are visible in the xylem of the branches or roots when the bark is removed. (https://www.google.com/search?q=verticillium+wilt+of+avocado&oq=verticillium+wilt+of+avocado)

Photos: Verticillium wilt in western Australia.

Laurel Wilt in California. CAC.

https://www.californiaavocadogrowers.com/growing/cultural-management-library/laurelwilt#:~:text=Raffaela%20lauricola%2C%20the%20causal%20agent%20of%20laurel%20wilt,found%20in%20the%20southeastern%20United%20States%20in%202004.

Raffaela lauricola, the causal agent of laurel wilt disease (LWD) is a devastating pathogen that has the potential to greatly impact the California avocado industry if it gets here. Laurel wilt is a vascular wilt disease that has led to substantial mortality on trees in the Lauraceae family since it was first found in the southeastern United States in 2004.

Learn more about laurel wilt from University of Florida researchers.

How laurel wilt is transferred

R. lauricola is transferred by a non-native redbay ambrosia beetle.

Adult beetles are very small (~1/16 inch long), dark brown to black in color, slender and cylindrical in shape and spend most of their life within the tree.

Larvae are white, legless grubs with an amber colored head capsule and are found within galleries throughout infected trees.

The female beetles bore the wood of healthy avocado trees to lay their eggs and while doing so inoculate the galleries with fungal spores carried in her mouth.

The fungus colonizes the wall of the gallery and after hatching, the larvae feed on the fungus. R. lauricola then moves through the water and nutrient transport tissues of the tree, eventually plugging the flow of the water and causing the tree to wilt.

How laurel wilt disease spreads

Redbay ambrosia beetles also infect and kill California bay laurel — thus these trees could assist in the spread of laurel wilt disease.

Redbay ambrosia beetles can fly short distances, but laurel wilt disease spreads more quickly through the movement of infested plant material such as firewood.

Symptoms of laurel wilt disease

Trees with laurel wilt show various stages of crown decline, including branch dieback and occasionally defoliation with reddish and purple discoloration.

Wilted leaves may remain on the trees for up to a year.

Removal of the bark from wilted branch section exposes black to brown streaks of discoloration extended into the adjacent wood.

Affected trees also may show sawdust protruding from the stem, produced by the beetle as they bore into the wood.

Symptoms of laurel wilt disease

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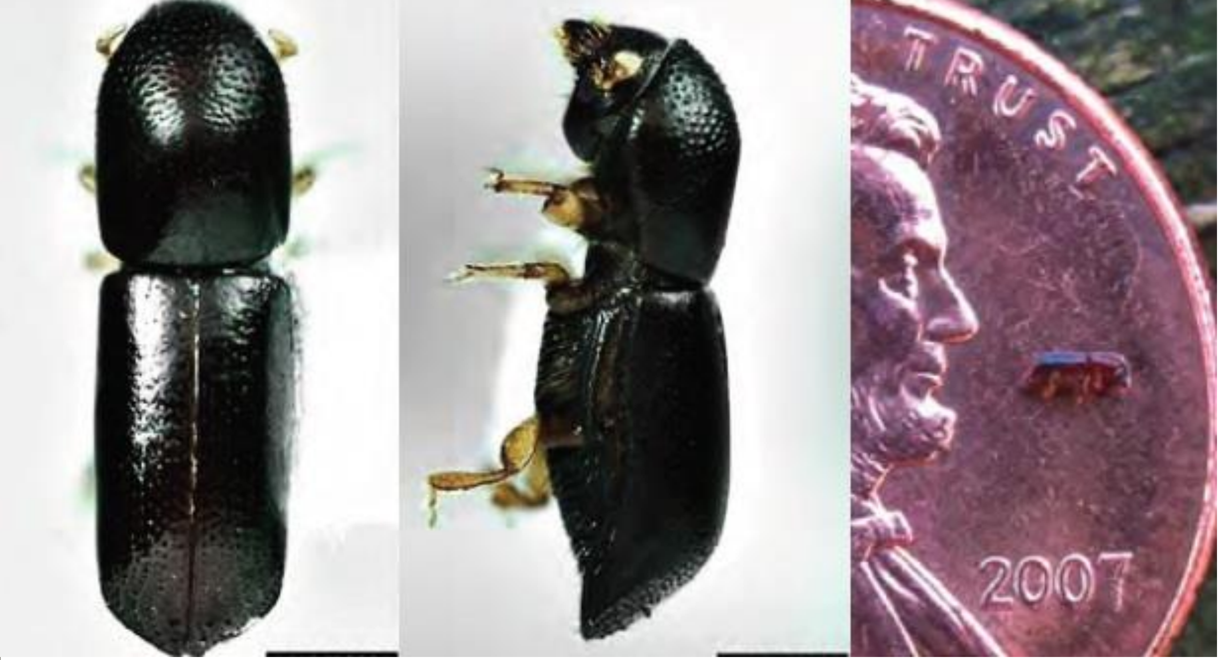
Laurel wilt disease



Laurel wilt disease and the vector. Ambrosia beetle.

Physiological Problems

https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Physiological_/

See the website above for the following avocado problems:

Asphyxiation

Avocado Troubles

Abnormal avocado fruit

An asphyxiated avocado tree

(https://samuelsgarden.com/what-does-an-overwatered-avocado-tree-look-like/)

An asphyxiated avocado tree

Sunburned Avocado Fruit (https://gregalder.com)

Avocado Chimeras, Mutations (Bing.com)

Cocktail Avocados (Seedless Cukes) from Fuerte Trees (Specialtyproduce.com)

References Cited. Chapter 13. Diseases and Disorders

Sources: R.G. Platt - California Avocado Society Yearbook 1972-73 and Reuben Hofshi and M.L. Arpaia Yearbook 2002
https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Physiological_/
https://ucanr.edu/sites/ucceventura/files/263757.pdf
Avocado Chimeras Bing.com
https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Diseases

Chapter 14. Avocado Insects and Rodents.
Go to:
(https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Insects/)

Amorbia
Armored Scales
Avocado Brown Mite
Avocado Thrips
Branch and Twig Borer
Brown Garden Snail
Deer
False Chinch Bug
Fuller Rose Beetle
Greenhouse Thrips
June Beetles
Omnivorous Looper
Orange Tortrix
Persea Mite
Rodents
Six Spotted Mite
Soft scales
Whiteflies


Amorbia. (https://avocado.org.au/bpr-articles/page/20/) **Amorbia cuneanum, the western avocado leafroller moth, is a species of moth of the family Tortricidae. It is found from Baja California, Mexico, to south-western Canada. To the east, the range extends to Arizona and Idaho in the United States (Wikipedia). Fruit and leaf damage occurs. See more at: (https://ipm.ucanr.edu/agriculture/avocado/amorbia-western-avocado-leafroller/#gsc.tab=0)**

Armored Scales. See more at: https://ipm.ucanr.edu/agriculture/avocado/armored-scales/#gsc.tab=0

Scales in avocado are usually under good biological control. Latania scale occasionally damages avocado. Large numbers of latania scale on bark can kill twigs, especially on young trees. Unlike many plant-sucking insects, armored scales do not secrete any noticeable liquid. Economic damage is from scale covers on the fruit skin, which appear as tiny dimples or light-colored spots. Feeding may also cause small discolored spots in the skin. Internal fruit quality is not impaired, but infested or spotted fruit may be culled. California red scale is a rare problem, and only on avocado near citrus. Dictyospermum scale and greedy scale occur in avocado only at very low numbers.

Armored Scales. See more at:
https://ipm.ucanr.edu/agriculture/avocado/armored-scales/#gsc.tab=0

California red scale: Aonidiella aurantii

Dictyospermum scale: Chrysomphalus dictyospermi

Greedy scale: Hemiberlesia rapax

Latania scale: Hemiberlesia lataniae

Armored scales are rarely a problem on avocados in California. If you see high numbers of armored scales on avocados, contact your local agricultural commissioner, as it is quite possibly an exotic species introduced into the state.

California Red Scale (Bing.com)

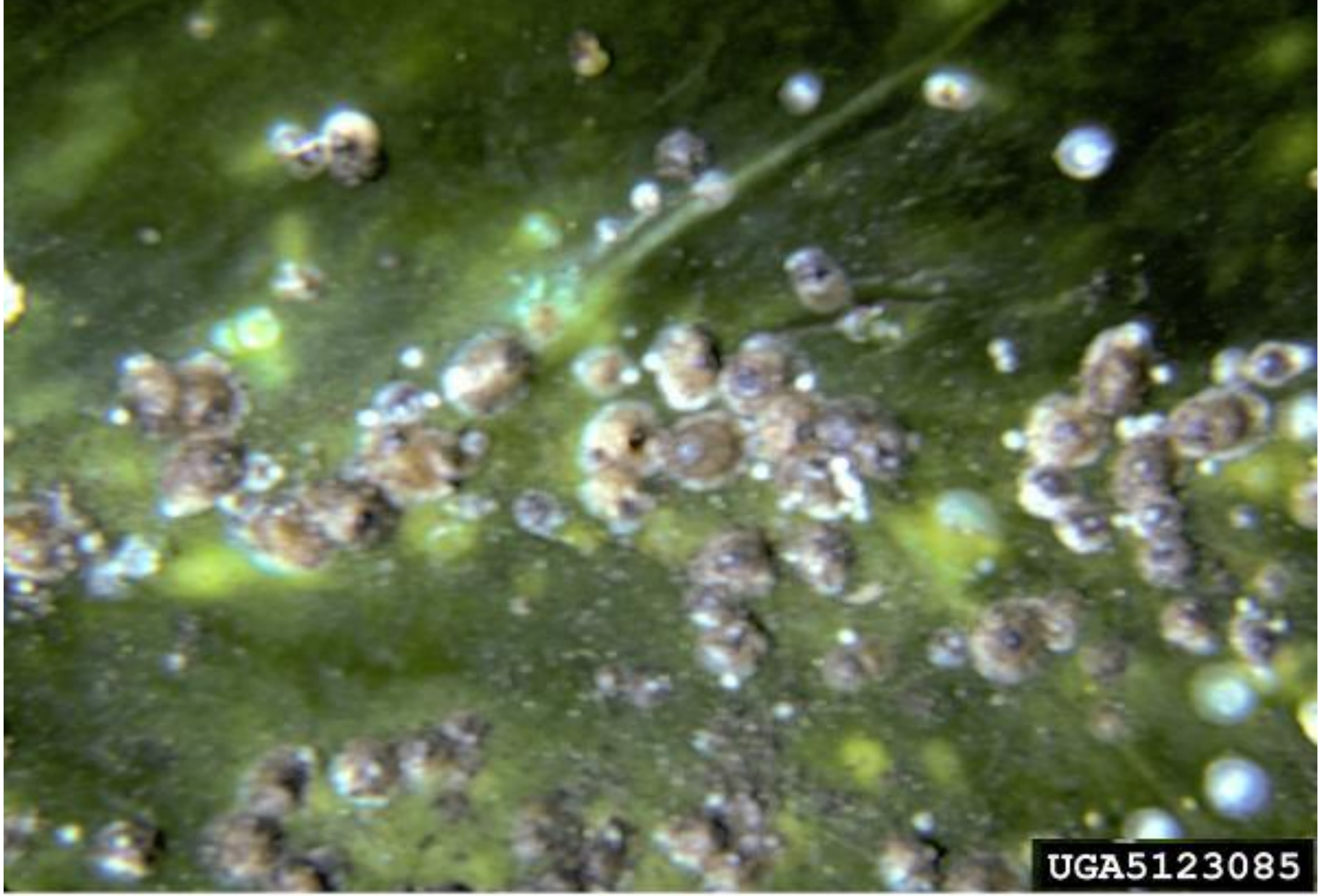
Dictyospermum Scale (Bing.com)

On an orange.

A group of mature female greedy scale insects and three immature scales.

Latania scale insects, older scales on the right and young scales on the left.

Photo by J. R. Bake



Various stages of latania scale insects.

Cropped from photo by United States National Collection of Scale Insects Photographs Archive, USDA Agricultural Research Service, Bugwood.org

A single latania scale insect.
Charles Olsen, USDA APHIS PPQ, Bugwood.org

Avocado Brown Mite Damage. See more at: https://ipm.ucanr.edu/agriculture/avocado/avocado-brown-mite/#gsc.tab=0 Avocado brown mite is a sporadic pest, mostly in coastal growing areas. Bronzing of leaves, mite cast skins, and partial defoliation of some trees by avocado brown mite is most noticeable from about July to September. Severe infestations tend to occur in border row trees along dirt roads, where road dust is detrimental to mite predators. Photo: Avosource.com

Avocado thrips prefer to feed and lay eggs in succulent leaves. Feeding on young leaves causes irregular bronzing or scarring on both sides of the leaf. Discoloration is typically concentrated along the midrib and lateral leaf veins, and then appears in scattered patches between veins as numbers increase. And fruit scarring.

https://plantwiseplusknowledgebank.org/doi/10.1079/pwkb.species.49072

See more at: https://ipm.ucanr.edu/agriculture/avocado/avocado-thrips/#gsc.tab=0

Scirtothrips perseae

Branch and Twig Borer.
See more at: https://ipm.ucanr.edu/agriculture/avocado/branch-and-twig-borer/#gsc.tab=0
Photo: Wikipedia.com

Branch and Twig Borer. See more at:

https://ipm.ucanr.edu/agriculture/avocado/branch-and-twig-borer/#gsc.tab=0

When present, borers cause a recognizable hole in branches. This entrance to a larval feeding tunnel often exudes sugary sap that turns white and flaky. Infested branches with tunnels can be easily broken by wind. Branch and twig borer is not common in avocado and seldom causes economic injury.

Branch and Twig Borer. (Britannica.com)

(Amphicerus bicaudatus) bores into living fruit-tree branches and grape vines but breeds in dead wood. The lead-cable borer, or short-circuit beetle (Scobicia declivis), bores into the lead covering of older telephone cables. Moisture entering through the hole can cause short circuits. This beetle lives in oak, maple, or other trees and does not feed on the cable sheathing. The psoid branch and twig beetles (subfamily Psoinae) differ from the bostrichids in having a large head that is visible from above. The adults are black or brown and range from 14 to 28 mm. The larvae bore through the heartwood. The spotted-limb borer (Psoa maculata) breeds only in dead wood, and the genus Polycaon is often destructive in orchards.

Brown Garden Snail. See more at:

https://ipm.ucanr.edu/agriculture/avocado/brown-garden-snail/#gsc.tab=0

Brown garden snail ***(Helix aspera)*** **can cause serious damage to avocados by feeding on leaves, green bark, and skin especially in mild, wet winters and in coastal areas.**

Cultural control before winter rain by skirting trees 12 to 30 inches and applying copper materials to the trunk is very effective. Copper repels the snails such that they will not crawl up the trunk. Copper barriers around the trunk can be a band of copper foil, annual application of a Bordeaux slurry, or sticky material containing tribasic copper sulfate (Grafton-Cardwell et al, 1996). Brown Garden Snail: (Wikipedia.com)

Copper foil plus skirting totally eliminated snails in the CalPolySLO citrus orchards.

Copper foil as a snail barrier. Skirts pruned up to reduce snail damage. (UCIPM)

Brown Garden Snail. See more at:

https://ipm.ucanr.edu/agriculture/avocado/brown-garden-snail/#gsc.tab=0

Biological control is effective by the decollate snail (Rumina decollata). They will control brown snails in four to ten years after introduction. Introduce eight to ten decollate snails to the shady northeast side of every other tree in every other row during mild and damp weather (February through May) so they may get established. Decollate snails may be released only in the California counties of Fresno, Kern, Tulare, Imperial, Los Angeles, Madera, Orange, Riverside, San Bernardino, San Diego, Santa Barbara, and Ventura. (Grafton-Cardwell et al, 1996)

Decollate snail, a predator of the brown garden snail. (UCIPM)

European Earwig.

See more at:

https://ipm.ucanr.edu/agriculture/avocado/european-earwig/#gsc.tab=0

Photo: Wikipedia.com

European Earwig. See more at:

https://ipm.ucanr.edu/agriculture/avocado/european-earwig/#gsc.tab=0

Earwigs feed mostly at night and hide during the day. Common hiding places include bark crevices, mulch, topsoil, protected (touching) plant parts, and under trunk wraps. Females lay masses of 30 or more eggs in soil. Nymphs are whitish and remain in soil until their first molt, after which they darken and begin searching for food. Earwigs generally have one or two generations a year. They can be active year round. Remove tree wraps so they cannot hide.

Earwigs feed on dead and living insects and insect eggs, other organisms, and on succulent plant parts. Earwigs occasionally damage buds and leaves on young or newly grafted trees. They can be especially problematic on trees with trunk wraps or cardboard guards. The cause of damage can be difficult to distinguish from that of other chewing pests that hide during day and feed at night, including brown garden snail, Fuller rose beetle, and June beetles.

False Chinch Bug.

See more at:
https://ipm.ucanr.edu/agriculture/avocado/false-chinch-bug/#gsc.tab=0
Wikipedia: Adult False Chinch Bug.

False Chinch Bug. See more at:

https://ipm.ucanr.edu/agriculture/avocado/false-chinch-bug/#gsc.tab=0

During winter and early spring, false chinch bug primarily feeds on foliage, stems, and seeds of wild grasses and cruciferous weeds. When vegetation dries or is cut, or weeds are treated with a herbicide, bugs move in large numbers to feed on virtually any nearby green plants, including irrigated fruit and nut trees, grains, and vegetable crops. These feeding aggregations can be very large.

False chinch bug occasionally causes severe injury on young trees by sucking sap from shoots and young stems. Infested shoots wither and die suddenly after attack, which typically occurs in May and June. Economic damage normally occurs in groves away from the coast only on young trees in border rows adjacent to uncultivated areas or grasslands. Otherwise healthy mature trees tolerate bug feeding.

Fuller Rose Beetle.

See more at: https://ipm.ucanr.edu/agriculture/avocado/fuller-rose-beetle/#gsc.tab=0

Photo: Wikipedia.

Fuller Rose Beetle. See more at:

https://ipm.ucanr.edu/agriculture/avocado/fuller-rose-beetle/#gsc.tab=0

Fuller rose beetle is an occasional problem in young avocado plantings. It can also damage top-worked, recently grafted, or severely pruned trees that have relatively little mature foliage and an abundance of developing immature leaves. Fuller rose beetle usually is common only on avocado growing near citrus or other preferred hosts.

Fuller rose beetle adults chew leaf margins, causing a ragged, notched, or serrated appearance that is quite different from damage caused by other pests such as snails. Most chewed leaves are on lower branches because adults cannot fly and must climb trunks and branches to reach foliage. Leaf chewing on older trees with a well-developed canopy is not economically important.

Fuller Rose Beetle. See more at:

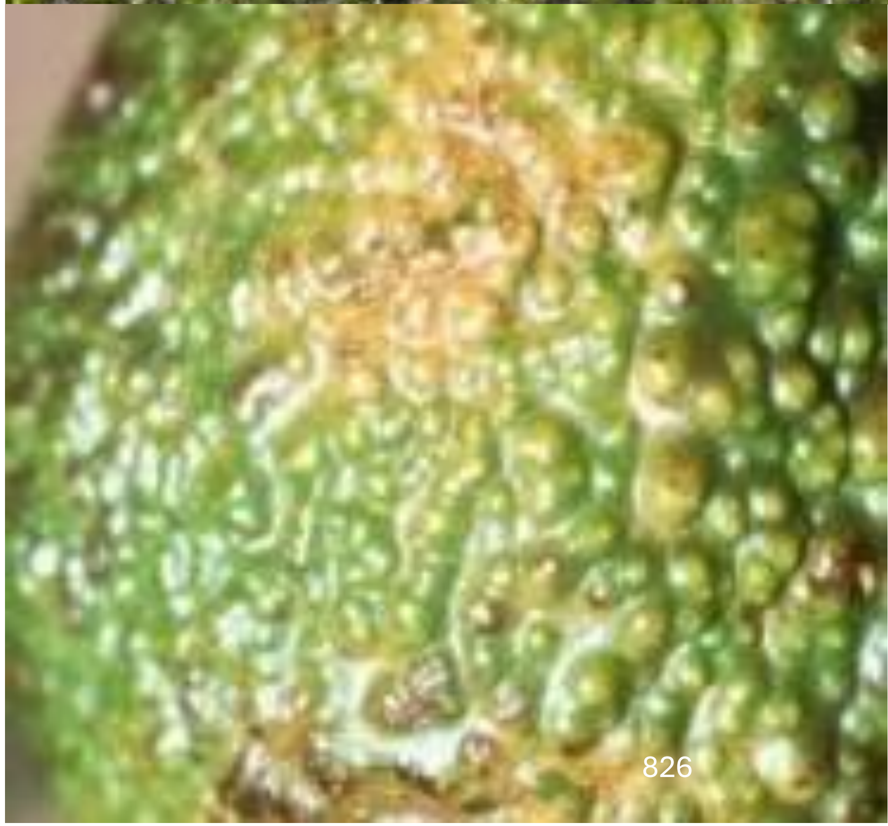
[Fuller Rose Beetle | NC State Extension Publications (ncsu.edu)]

The Fuller rose beetle, Naupactus gomanni, is a common foliage-feeding pest of a wide range of ornamentals, fruits, and vegetables across most of the United States. Although first documented in the United States in California, these pests are now distributed throughout the United States.

Common host plants include but are not limited to: [avocado], maples, azalea, camellia, citrus, persimmon, pineapple, strawberry, beans, peach, rose, and potato. Both larvae and adults feed on the plant but adult feeding is most apparent and damaging. Larvae feed on roots. Populations rarely reach high enough levels to cause host plant death but larval root damage can cause stunted growth, reduced water and nutrient uptake, as well as increased susceptibility to disease. Adults feed on foliage, buds, and blossoms of host plants leaving behind a trail of fecal droppings on the uneaten leaves. Entire leaves may be consumed leaving only the midrib.

Greenhouse Thrips. See more at: https://ipm.ucanr.edu/agriculture/avocado/greenhouse-thrips/#gsc.tab=0

Greenhouse thrips occasionally is a serious pest in coastal avocado groves. Feeding on fruit skin causes scarring and the downgrading and culling of fruit at the packing house. Damage to leaves, although unsightly, is of no significance to tree health. (Bing.com) (https://industry.nzavocado.co.nz/greenhouse-thrip-2/) Heliothrips haemorrhoidalis. Feeding by both larval and adult Greenhouse Thrips causes severe damage to avocado leaves and fruit resulting in fruit being downgraded or even rejected for export. Pupae and larvae. Russet or scarring of fruit.



June Beetles. See more at:

https://ipm.ucanr.edu/agriculture/avocado/june-beetles/#gsc.tab=0

June bug, (genus *Phyllopaga*), genus of nearly 300 species of plant-eating beetles that commonly appear in the Northern Hemisphere during warm spring evenings and are attracted to lights. (Britannica.com) June bug (also June beetle) n. a large brown scarab beetle (genus Phyllophaga) that appears in late spring and early summer. Several species include the northern June bug (P. fusca). Also called May beetle.

June Beetles. See more at:

https://ipm.ucanr.edu/agriculture/avocado/june-beetles/#gsc.tab=0

Adult beetles fly into avocado from untilled fields and brush land during late spring or early summer. Adults chew tree foliage at night and when present night-after-night can completely defoliate a large number of young trees in a single grove. During the day, adults hide under litter or burrow into the upper 2 inches of soil, reappearing the following night to resume feeding.

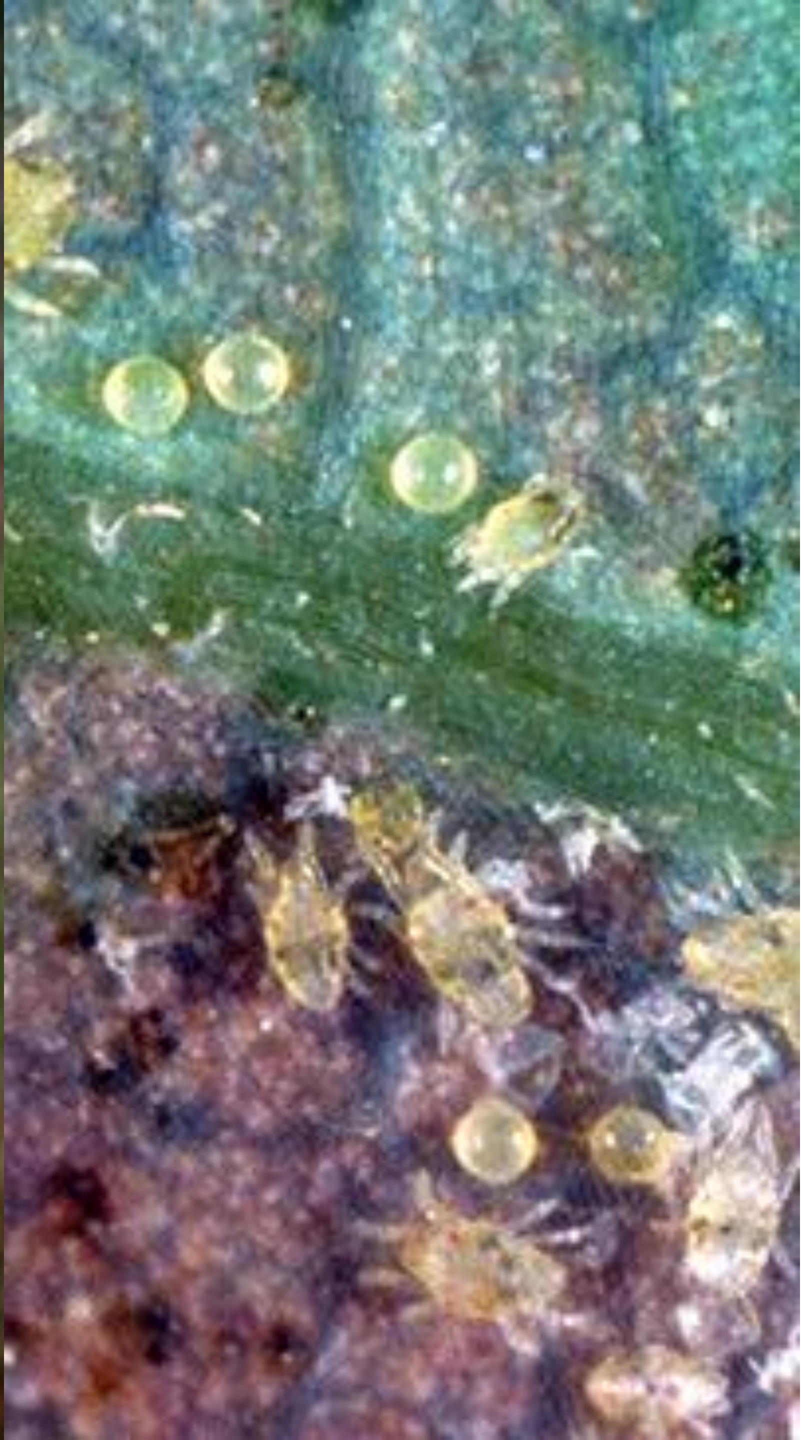
During spring they sometimes injure young, newly planted trees, typically near uncultivated land away from the coast. Chewing on mature trees with a well-developed canopy is generally of no economic importance.

Omnivorous Looper. See more at: https://ipm.ucanr.edu/agriculture/avocado/omnivorous-looper/#gsc.tab=0 (inaturalist.org) The omnivorous looper (family Geometridae), also called looper or avocado looper, feeds on several dozen plant species. Omnivorous looper occurs in most avocado groves, generally in low numbers, unless natural enemies are disrupted by application of broad-spectrum insecticides.

Orange Tortrix.

See more at: https://ipm.ucanr.edu/agriculture/avocado/orange-tortrix/#gsc.tab=0

The orange tortrix, Argyrotaenia citrana (Fernald), a citrus pest from California, is not known east of citrus regions of Arizona and has never been in Florida. (Bing.com) Orange tortrix (family Tortricidae) is an uncommon problem on avocados grown in coastal areas. It rarely is injurious at inland growing areas. Orange tortrix feeds on various weeds and crops including citrus, grape, and strawberry. Larvae usually feed singly on shoot tips or on succulent leaves in nests they web together with silk. (Bing.com/images)



Persea Mite: See more at: https://ipm.ucanr.edu/agriculture/avocado/persea-mite/#gsc.tab=0

Photo from: Flickr.com https://s3.amazonaws.com/plantvillage-production-new/images/pics/000/099/560/original/14968281886_95d806b21d_o.jpg?1487701368

High persea mite numbers cause premature leaf drop and defoliation. Defoliation leads to sunburned bark and fruit, aborted or dropped fruit, and severely stressed trees, which later reduces yields. Persea mite feeding on the underside of leaves causes discrete circular chlorotic to brown spots on the lower leaf surface.

Six Spotted Mite. See more at: https://ipm.ucanr.edu/agriculture/avocado/sixspotted-mite/#gsc.tab=0

Sixspotted mite feeds only on the lower avocado leaf surface. It causes irregular brown to purplish discoloring, mostly along the midrib and larger veins. Sixspotted mite produces webbing, but not the dense roundish silk patches formed by persea mite. Densities of 25 to 30 mites per leaf may lead to defoliation. Persea mite is a key pest of California-grown avocados. Avocado brown mite and sixspotted mite are sporadic pests. Several beneficial mites are important predators of pest mites and certain insects. Natural enemies and certain management strategies vary among pest mites. (Bing.com) (https://original-ufdc.uflib.ufl.edu/IR00004620/00001#:~:text=Generally%2C%20the%20six-spotted%20mite)

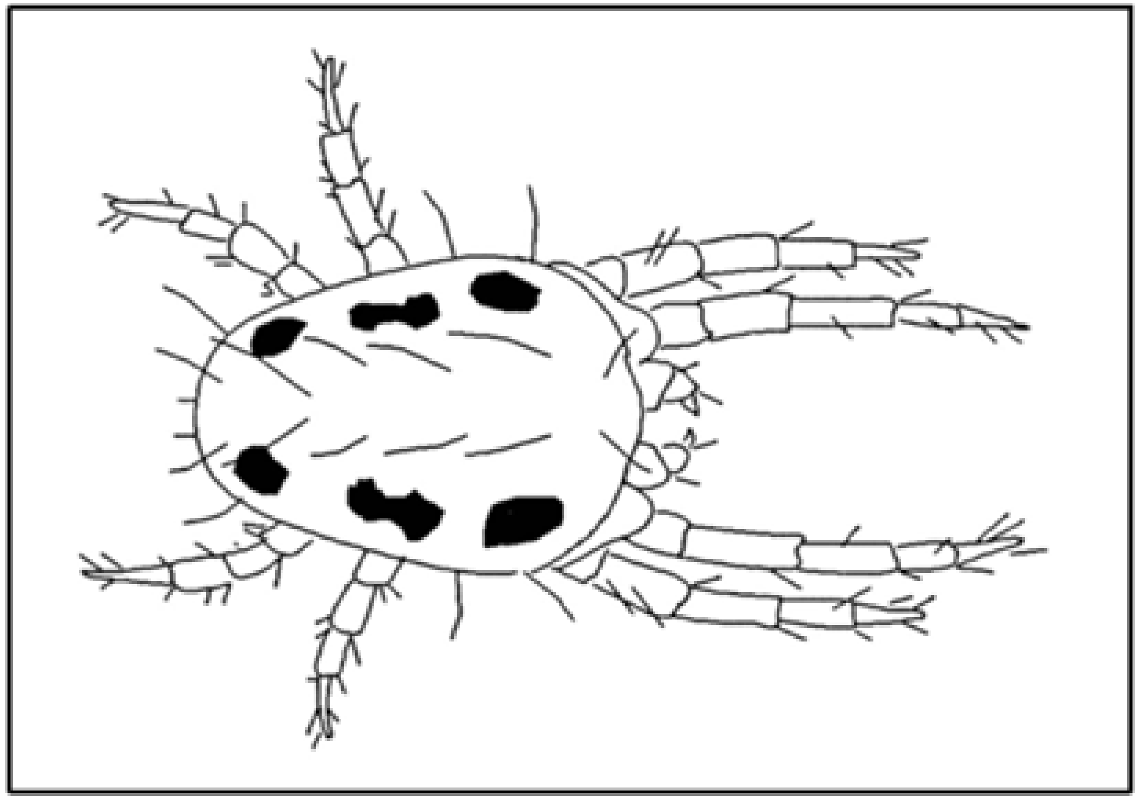


Figure 1. Adult female six-spotted mite.

Soft Scales. See more at:

https://ipm.ucanr.edu/agriculture/avocado/soft-scales/#gsc.tab=0

Black scale: Saissetia oleae

Brown soft scale: Coccus hesperidum

European fruit lecanium: Parthenolecanium corni

Hemispherical scale: Saissetia coffeae

Soft Scales

Black scale is the most common soft scale (family Coccidae) in California avocado. Other species occasionally present include brown soft scale, European fruit lecanium, and hemispherical scale. Pyriform scale occurs on avocado in landscapes, but is absent or rare in commercial groves.

Soft scales rarely are pests in avocado. They suck phloem sap from foliage and twigs. Rarely do they feed on fruit. Where soft scales are common, the large quantities of sticky honeydew they excrete promotes growth of blackish sooty mold, which can foul fruit.

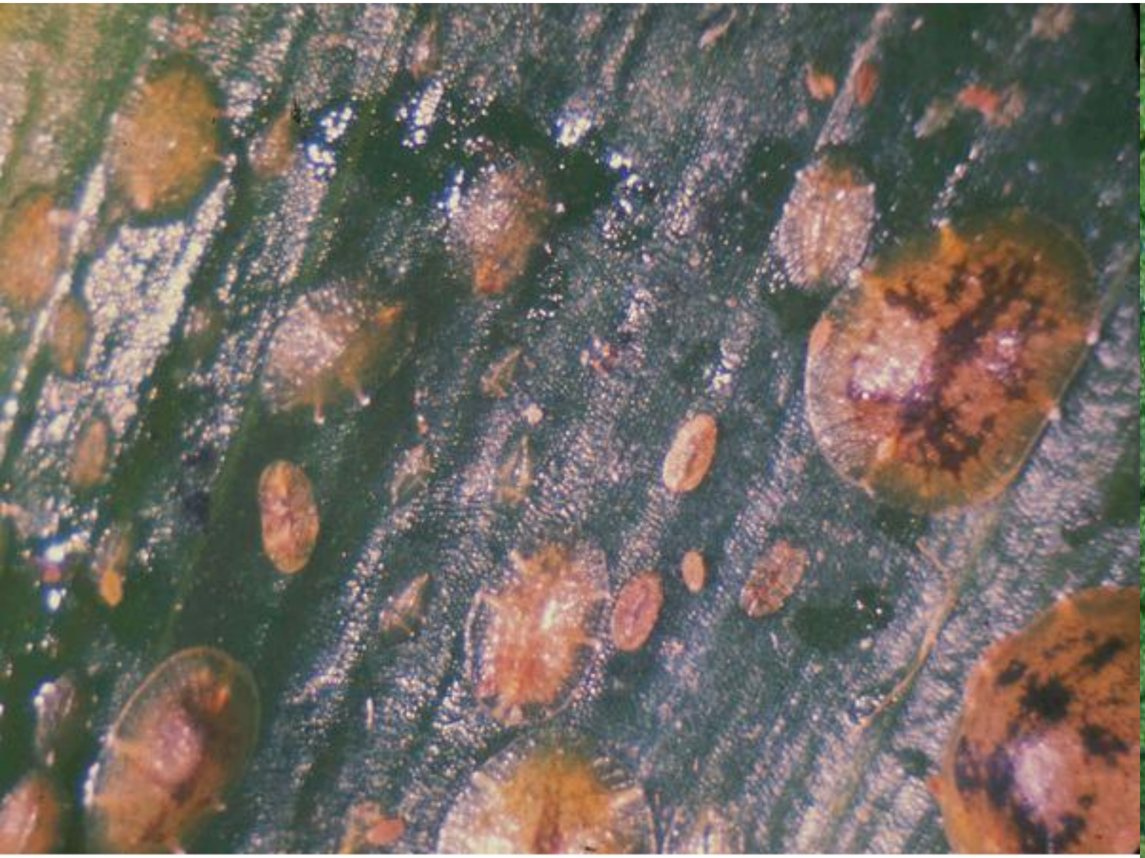
Soft Scales

Treating scales is rarely warranted. Soft scales usually are controlled by predators and parasites. Conserve natural enemies by reducing dust and selectively controlling sugar-feeding ants. Whenever possible, apply only selective or short-residual pesticides to control other pests.

Parasitic wasps are especially important in controlling scales. Parasites include Coccophagus spp. (family Aphelinidae) and Metaphycus and Microterys spp. (Encyrtidae). Scale-feeding lady beetles include Chilocorus, Hyperaspis, and Rhyzobius species and along the south coast, the steelblue lady beetle (Halmus chalybeus). Lady beetles can easily be overlooked because many are tiny, colored and shaped like scales, or (as small larvae) feed hidden beneath scales' bodies. Lacewings, predaceous bugs, and predatory mites are among the other invertebrates that at least occasionally feed on scales.


Black Scale (Bing.com)

Brown Soft Scale (Bing.com)



All stages of the brown soft scale insect plus its honeydew.

Photo by J. R. Baker, NC State University

European Fruit Lucanium

(https://s3-us-west-2.amazonaws.com/treefruit.wsu.edu/)

Hemispherical Scale (Bing.com)

Whiteflies.

See more at: https://ipm.ucanr.edu/agriculture/avocado/whiteflies/#gsc.tab=0

Photo: Wikipedia.com

Whiteflies. See more at:

https://ipm.ucanr.edu/agriculture/avocado/whiteflies/#gsc.tab=0

Giant whitefly: Aleurodicus dugesii

Greenhouse whitefly: Trialeurodes vaporariorum

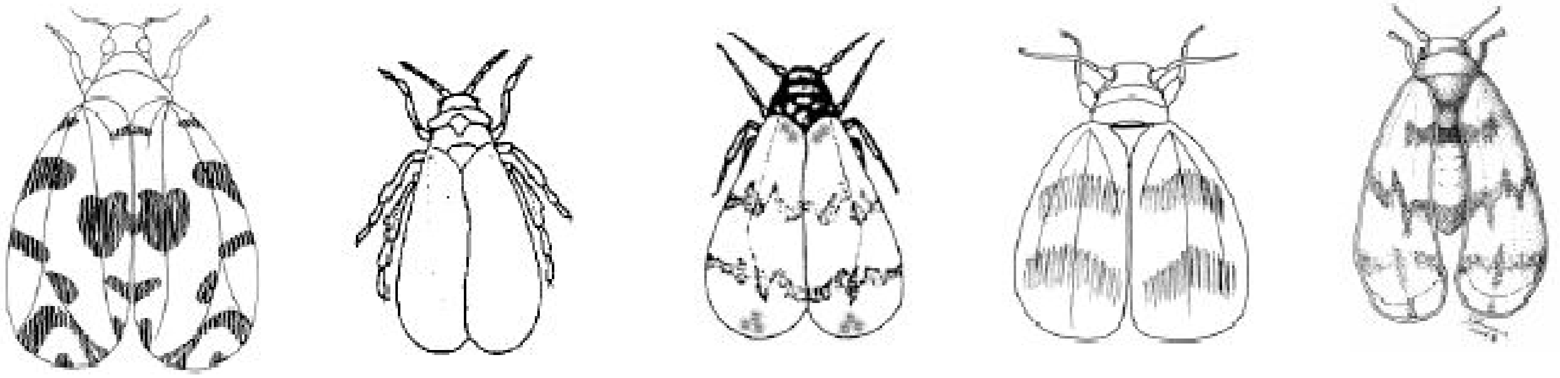
Mulberry whitefly: Tetraleurodes mori

Nesting whitefly: Paraleyrodes minei

Redbanded whitefly: Tetraleurodes perseae

Giant Whitefly, Greenhouse Whitefly, Mulberry Whitefly, Nesting Whitefly, Redbanded Whitefly, respectively. See more at:

https://ipm.ucanr.edu/agriculture/avocado/whiteflies/#gsc.tab=0



Whiteflies. See more at:

https://ipm.ucanr.edu/agriculture/avocado/whiteflies/#gsc.tab=0

Whiteflies suck phloem sap. They excrete honeydew, which collects dust and supports growth of blackish sooty mold fungi that can foul fruit. Honeydew attracts ants, which interfere with the biological control of whiteflies and many other pests. Giant whitefly, greenhouse whitefly, and mulberry whitefly each have hosts in over a dozen plant families. Nesting whitefly prefers citrus, but also infests avocado and some ornamental broadleaf evergreens. Redbanded whitefly has been found only on avocado in California. Whiteflies have many natural enemies, of which parasitic wasps are especially important, and consequently usually are under very good biological control.

References Cited. Chapter 14. Insects.

https://ipm.ucanr.edu/agriculture/avocado/amorbia-western-avocado-leafroller/#gsc.tab=0

https://ipm.ucanr.edu/PMG/P/I-HM-PPER-CD.003.html#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/whiteflies/#gsc.tab=0

https://s3-us-west-2.amazonaws.com/treefruit.wsu.edu/

https://ipm.ucanr.edu/agriculture/avocado/soft-scales/#gsc.tab=0

https://ipm.ucanr.edu/PMG/C008/m008bpcaterpillars.html

https://ipm.ucanr.edu/agriculture/avocado/orange-tortrix/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/neohydatothrips/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/longtailed-mealybug/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/glassy-winged-sharpshooter/#gsc.tab=0

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https://www.bing.com/

https://ipm.ucanr.edu/PMG/P/I-HM-PPER-CD.003.html#gsc.tab=0

Charles Olsen, USDA APHIS PPQ, Bugwood.org

Dyctyospermum scale (Bing.com)

California Red Scale (Bing.com)

https://ipm.ucanr.edu/agriculture/avocado/armored-scales/#gsc.tab=0

References Cited. Chapter 14. Insects - Continued

Native Gray Ants https://www.bing.com

Large Gray Ant Bing.com

https://ipm.ucanr.edu/agriculture/avocado/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/june-beetles/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/grasshoppers/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/fuller-rose-beetle/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/false-chinch-bug/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/european-earwig/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/brown-garden-snail/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/branch-and-twig-borer/#gsc.tab=0

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https://ipm.ucanr.edu/agriculture/avocado/polyphagous-shot-hole-borer-and-kuroshio-shot-hole-borer/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/sixspotted-mite/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/persea-mite/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/omnivorous-looper/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/greenhouse-thrips/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/avocado-thrips/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/avocado-brown-mite/#gsc.tab=0

https://ipm.ucanr.edu/agriculture/avocado/amorbia-western-avocado-leafroller/#gsc.tab=0

https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Insects/

Chapter 15. Rodents.

(https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Pest_Control/Rodents/)

Visit the website above for rodent damage and control.

Wood rat

Red fox squirrel

Meadow mice or voles

Pocket gophers

Ground squirrels

Opossums

Source: Subtropical Fruit Pests by Walter Ebeling. U.C. Press 1959. Citrus Industry, Volume IV, U.C. Press 1978

Chapter 15. Vertebrate Pest Management. Go to: (https://ipm.ucanr.edu/pmg/c008/m008bpvertdmg.html)

Visit the website above for vertebrate damage and control.

Deep chewing on a ripe, fallen avocado fruit (left) and shallow chewing on a green fruit picked from a tree (right), examples of damage by roof rat, Rattus rattus..

Open burrows by California ground squirrel, Otospermophilus sp.

Young avocado shoots chewed by mule deer, Odocoileus hemionus.

Water spraying from a microsprinkler damaged by a California ground squirrel, Otospermophilus sp.

Bark gnawed by rabbits. Voles cause similar damage, but vole gnawing occurs no higher than about 2 inches above ground. Squirrels can chew virtually anywhere on trunks and limbs, while pocket gopher girdling is usually hidden below ground.

Authors: Faber BA, Wilen CA, Eskalen A, Morse JG, Hanson BR, Hoddle MS. Revised continuously. UC IPM Pest Management Guidelines: Avocado. UC ANR Publication 3436. Davis, CA.

Pocket Gophers (Wikipedia.com)

(https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Pest_Control/Rodents/)

Control of Pocket gophers - Thomomys spp. Are destructive to young avocado trees and their control demands continuous vigilance on the part of the grower. Their presence is indicated by a series of rounded surface mounds. They are best controlled by trapping or poison baits. The secret to using traps and poison is to find the burrow running in both directions below the mount 8 to 12 inches deep. Clean out the burrow and place trap or poison in each direction. Cover with paper and soil to exclude light. This is important, for if a gopher sees light, it will push soil ahead and spring the trap or cover the poison.

The author has seen 3-4 year old trees killed by gopher girdling.

Wood Rat (Britannica.com)

Wood Rat (Wikipedia.com)

The woodrat (Neotoma floridana), also known as the woodrat or bush rat, is a pack rat. It constructs large dens that may serve as nests for many generations and stores food in outlying caches for the winter. While widespread and not uncommon, it has declined or disappeared in several areas.

Wood Rat.

(https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Pest_Control/Rodents/)

Wood rat -Neotoma fuscipes (Baird), is the brown-footed wood rat also known as "pack" or "trade" rats. They inhabit the foothills and lower mountains. This species has a body 7 to 8 inches long and a tail 6½ to 7½ inches long. It has a blunt nose, slightly haired ears of medium size, brown fur, and moderately haired tail. This rat builds large, conical nests of sticks and litter on the ground or in trees and buildings.

As with most members of the genus, the Woodrat feeds opportunistically on nuts, seeds, fungi, buds, stems, roots, foliage, and fruits. While the woodrat's nest is typically found on the ground, it is a capable climber and may forage above ground. Woodrats eat about 5% of their body weight in dry mass each day. During the summer months, most feeding is done while foraging. Only small amounts of food are taken back to the den for daytime feeding. Woodrats do not change significantly in weight from autumn to spring. Weight of individual woodrats is not correlated to the kilocalories in their caches.

Woodrats are a common prey item for many predators. Most common predators are the great horned owl, spotted skunk, long-tailed weasel, red fox, raccoon, and the timber rattlesnake, along with other various snakes. Woodrats try to avoid predators by being mostly active at night and hiding in their large dens during daylight. Unweaned pups in dens in particular are commonly taken by snakes.

One of the most common parasites of woodrats are botfly larvae. Adult botflies lay their eggs outside the entrance of the woodrat's den. They then attach themselves to the woodrat's fur when it passes through entrance. Once the eggs hatch, the botfly larvae penetrate the skin and lodge in the woodrat's neck, chest, and abdomen until pupation. The resulting cyst can be 15 mm in diameter but does not seem to cause any obvious discomfort. Botflies infest approximately 16% of the eastern woodrat population.[citation needed]

Raccoons may carry raccoon roundworms, an intestinal parasite. Woodrats may ingest the eggs of the roundworm while foraging at raccoon latrine areas. Larvae migrate to the brain, causing a lack of energy, loss of muscle control, and eventually death. The roundworm is a known mortality factor in woodrats with infection rates of around 75%.

Red Fox Squirrel

Red Fox Squirrel.

(https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Pest_Control/Rodents/)

Red fox squirrel - Sciurus niger refiventer (Geoffroy), is an accidentally introduced species. It feeds on walnuts, avocados, and oranges. It may be trapped with an extra large type of rat trap placed in trees.

Food habits of fox squirrels depend largely on geographic location. In general, fox squirrel foods include mast, tree buds, insects, tubers, bulbs, roots, bird eggs, pine nuts and spring-fruiting trees, avocados, and fungi. Agricultural crops such as corn, soybeans, oats, wheat, and fruit are also eaten.

Meadow Mice or Voles. (Wikipedia.com)

Meadow Mice or Voles.

(https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Pest_Control/Rodents/)

Meadow mice or voles - Microtus are injurious because they gnaw the bark and roots of avocado trees that are surrounded by grass and litter. Their runways may be found in such locations. Mousetraps baited with oatmeal, rolled oats, or bits of apple or carrot may be set in these runways with the triggers of the traps across the runways. Mice running in either direction can then be trapped. When large numbers of mice are present, it may be more advantageous to poison them.

California Ground Squirrel. (Wikipedia.com)

Ground Squirrels.

(https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Pest_Control/Rodents/)

Ground squirrels - Spenrophilus sp. of which there are 17 species may cause damage to avocado orchards by eating fruit, branches, and making burrows near or under trees which expose roots and may direct irrigation water. The most common ground squirrel is the California or Beechey ground squirrel Spermophilus beecheyi. An adult will weigh from 1 to 2 ½ pounds and is tan in color with flecked or mottled fur. Females produce one litter each year, averaging six to eight offspring. They are active in the daytime. Their diet may consist of green herbage in winter and spring and seeds during the summer and fall. They hibernate during winter. Ground squirrels are not repelled by any chemical or physical means. Thus, reductional control through the use of toxic fumigants, poison baits, traps, or shooting is the only effective control measures available. In some counties, the Agricultural Commissioner provides effective poison baits at costs. Note: The Ag Commissioner In Ventura County Does Not Provide Poison Anymore. Bury dead squirrels. Their fleas carry bubonic plague.

Opossums (Wikipedia.com)

Opossums.

(https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Pest_Control/Rodents/)

Opossums - The opossum, Didelphis virginiana, is nocturnal and omnivorous and will, on occasion, develop a taste for avocado fruit in orchards. This gray, long-haired, pointed-nose animal has a prehensile, rat-like tail. It is native to the eastern and south-eastern United States. It was introduced into California for hunting purposes. Opossums are easily caught in box traps, or with a number 2 leg-hold trap, either with baits or trail set in locations where damage occurs. A wide variety of baits may be used, although fish and canned pet food work well.

Source: Subtropical Fruit Pests by Walter Ebeling. U.C. Press 1959. Citrus Industry, Volume IV, U.C. Press 1978.

Deer Damage to Avocado Trees

(Wikipedia.com)

Deer.

(https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Pest_Control/Deer/)

Deer are the largest of our avocado pests and can be a serious problem, particularly where young avocado groves are planted next to uncultivated land inhabited by these animals. A very typical example of deer depredation occurred on several acres of young avocados planted in Ventura County. Since this planting was quite removed from any other orchards and adjacent to a National Forest, the extensive damage was predictable. Deer can nearly completely strip young trees of foliage and sometimes bark. Where populations are high and the summers are dry, the lush foliage of avocados under irrigation is highly attractive. Damage may be sufficiently extensive that small limbs are eaten or broken, causing severe stunting and distortion of the development of a good framework of scaffold branches. When planting new orchards, in remote areas, consideration should be given to potential deer problems.

Build an eight foot deer and rabbit fence, Use repellents or human hair. Use depradation. Have dogs inside the orchard. Check legality for all methods.

References Cited. Chapter 15. Vertebrate Pests.

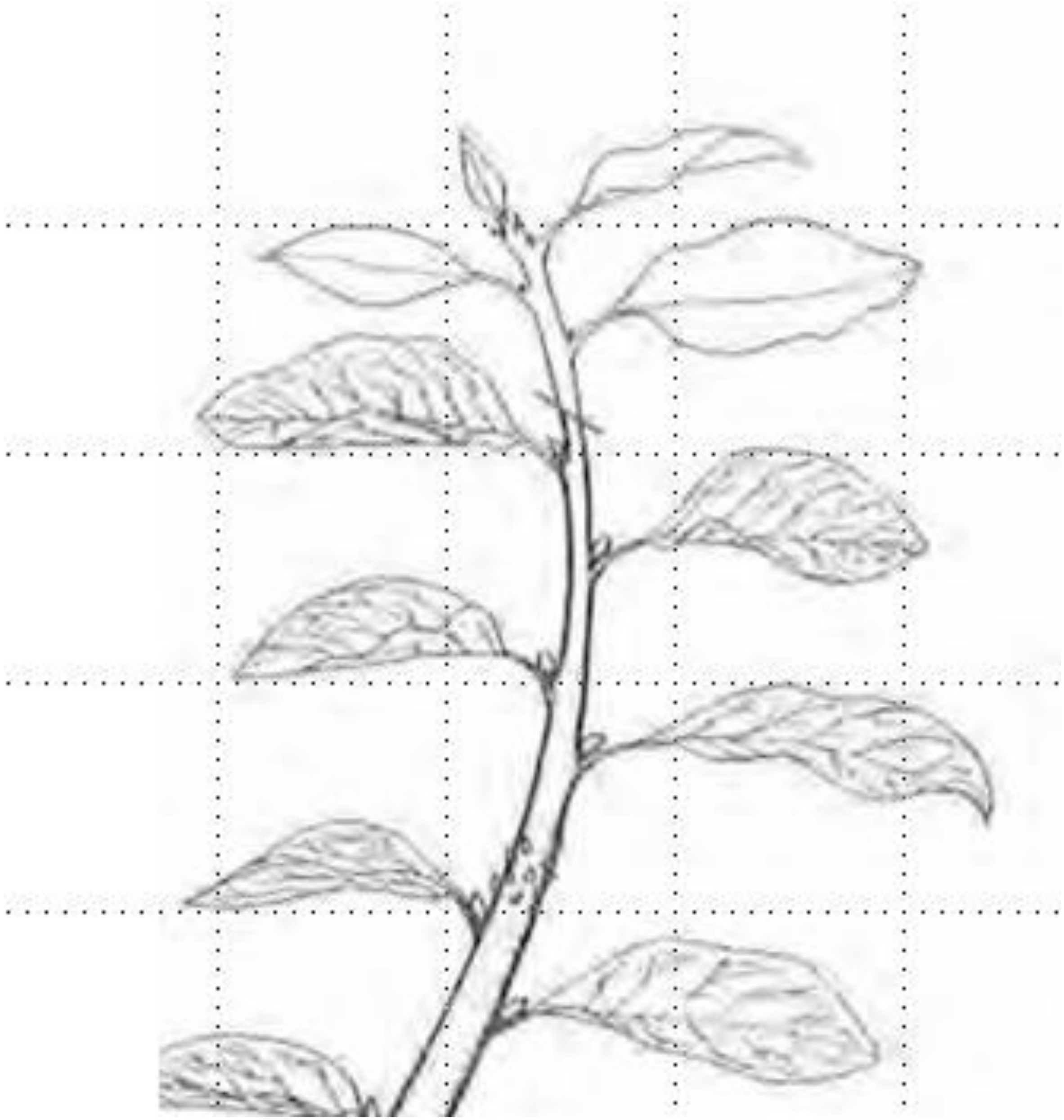
https://ipm.ucanr.edu/pmg/c008/m008bpvertdmg.html

https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Pest_Control/Deer/

https://ceventura.ucanr.edu/Com_Ag/Subtropical/Avocado_Handbook/Pest_Control/Rodents/

Chapter 16. Growth and Development

Bearing Habit for Avocado Trees: Flower clusters develop from preformed enlarged buds in leaf axils of one year shoots. Vegetative shoots later from these flower clusters.



Avocado Flowers (Bing.com)


Avocado
Flowers and new vegetative shoots.
(Bing.com)

Vegetative Growth

In flushes.

2-3 flushes possible, especially on young trees.

Spring flush is the main one.

Bloom Periods for Avocados (Long, 3-4 months)

Hass	March-May
Fuerte	January-April
Bacon	March-May
Zutano	February-April
Reed	March-May

Offbloom-During Other Seasons. Especially in Warm Summer and Fall Weather.

May result in a crop at other seasons.

Causes:

A light spring crop leaving leftover carbohydrates.

Warm weather out of season.

Drought, then adequate moisture.

Shedding of Avocado Leaves

All leaves are shed every year.

When spring growth is well started.

Takes several weeks.

May be all at once if heavy bloom especially for Hass. Whitewash to prevent sunburn of bark.

Leaf margins turn brown ½ inch or more inward.

Do not rake up leaves. They act as a natural mulch under trees.

Cultural Practices to Help Fruit Set, Alternate Bearing, and/or Small Fruit Size Problems:

Fruit thinning by hand. Has worked experimentally but not commercially.

Girdling. Successful on Fuerte and Hass.

Attempt on trial basis first.

Girdle only 1/3 of the limbs changing limbs every year.

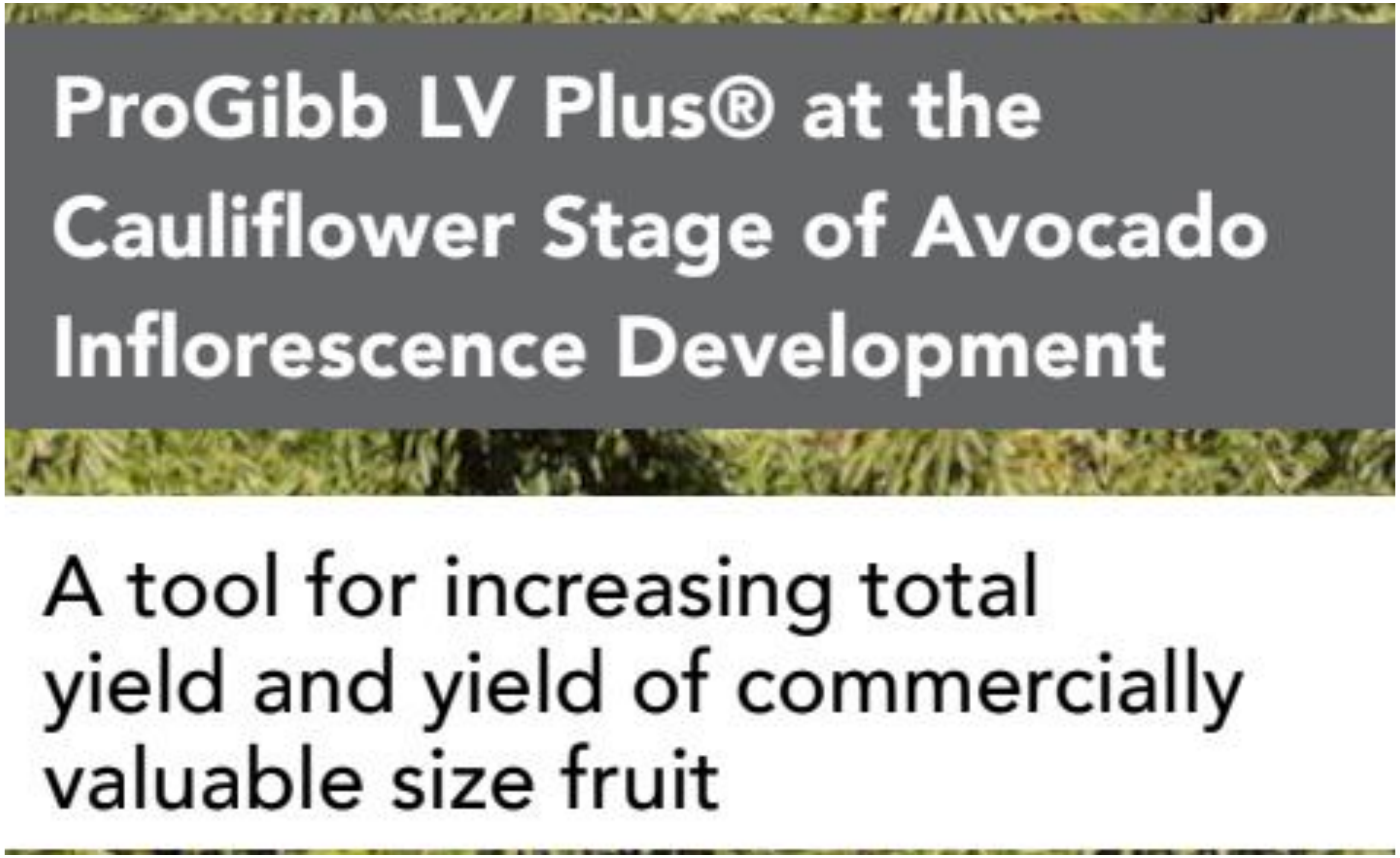
Done in November.

Remove 3/8 – ½ inch ring of bark all around a limb with girdling knife.

Only to healthy, mature trees.

Progibb growth regulator may lessen alternate bearing of Hass avocado by increasing total yield and yield of commercially valuable sized fruit. See the label on the next page.

Pro Gibb on Avocados.



https://mail.google.com/mail/u/0/#inbox/FMfcgzQXJGjPVbddGTWhLHZkxVWVCnWT?projector=1&messagePartId=0.3

Number of Years to Commercial Bearing

Hass, Bacon, Zutano: 3 years

Others: 5 years

Seedlings: Several years

Longevity of Trees (Productive Life)

Avocados 25-50 Years

FRUIT DROP (Koch, 1983) In all varieties of avocados there are two periods during the year when a certain percentage of the fruit that has set will drop. This is particularly evident during years when there is a very heavy set of fruit. "June drop" has been identified in other fruiting trees as well as avocados. At this time, many pea-sized fruits will be found on the ground. Later, after the fruit has matured to walnut on up to lemon size, there is another period when a lesser amount of fruit will drop, usually during the month of August. Any estimates of the crop for the following harvest year should be made after the August drop, which is the last drop that can be expected before the fruit matures. The reasons for these two drops are not well understood. The June drop may be due in some way to improper pollination when the nights were too cold for the pollen to be effective. The August drop is probably due to a self-thinning by the tree, which may have set more fruit than it can comfortably carry. When these dropped fruits are cut open, the seed is black and dead – hence the fruit will not mature further and is aborted. The Hass variety is particularly subject to fruit drop. In any event, fruit drop is no cause for concern because the tree will still carry a good crop to maturity in spite of the drop. [Maintain adequate irrigation to lessen June drop. Harvest if fruit are mature to prevent mature fruit drop.]

Other Avocado Tree Problems

(California Avocado Commission)

Alternate Bearing. Alternating heavy and light crops. Fruit too small in heavy crop year. Crop too small in light crop year.

What spurs alternate bearing cycles? Off crops can be caused by: Climactic events — freezes, low or high temperatures. Water-deficit stress during bloom or fruit set — causes low flower numbers or excessive flower and/or fruit drop. Under fertilization — causes excessive fruit/flower drop (abscission). Over pruning — results in low flower or fruit numbers and excessive vegetative shoot growth. On crops can be caused by: Excessive fruit set. Excessive fruit retention.

Solutions: Never prune avocado trees heavily.

Girdling in the light crop year may lessen alternate bearing.

Control of Growth and Development

Girdling is a process of cutting through and removing the bark in a circular pattern around one third of the limbs per year to increase productivity in many fruit trees, including the avocado. It is usually recommended in November or December in California. Girdling is examined as a method of improving avocado yield, eliminating biennial bearing and increasing Hass fruit size in particular. Girdling done just prior to blossoming or at any time during approximately the first third to half of the period of bloom markedly increases the set and yield of normal fruits. A 2 centimeter girdle is recommended. (Bing.com)

Girdling Research at CalPolySLO (McNeil and Parsons, 2003)

Abstract. Sixteen trees each of mature Hass avocado trees were treated with 2 cm (.5 in) girdling treatments prior to two light bloom springs which would result in "off" year crops: 1. A December girdle, 2. A February girdle, 3. An ungirdled control. One-third of the limbs were girdled on each tree, changing limbs each treatment year. December girdles were performed in 1995 and 1997. February girdles were performed in 1996 and 1998. Fruit number data was taken for three seasons, two "off"years (1997 and 1999) after girdling and one "on" year (1998) without girdling. The December girdling time averaged 111 more fruit per tree than the control trees for the three years of the study. The February girdling time averaged 80 more fruit per tree than the control trees for the three years. Fruit size was slightly smaller for both December and February girdled trees for the 1999 crop.

Conclusion (McNeil and Parsons, 2003)

The main purpose of this study was to determine if the practice of girdling would have a positive effect on the production of the Hass avocados in their lag ("off") years.

Girdling in both December and February did induce larger overall (total) crops for the three years of the study. The December girdle was the most effective treatment for the three years of the study followed by the February girdle, and lastly the ungirdled trees.

The December girdle time increased the crop in both "off" crop years (1997 and 1999) and even in the "on" crop year (1998). The February girdle time increased the crop one "off" year (1997) and the "on" year (1998).

The December girdling time averaged 111 more fruit per tree than the control trees for the three years of the study. The February girdling time averaged 80 more fruit per tree than the control trees for the three years. Fruit size was slightly smaller for both December and February girdled trees for the 1999 crop.

Prices per pound for 1997, 1998, and 1999 were $.8564, $1.2109, and $1.0571 for a three year average of $1.0414 per pound. Assuming 8 oz fruit 111 more fruit would weigh 55.5 lb. 80 more fruit would weigh 40 lb. Additional income per tree would be $57.80 for 111 fruit, $41.66 for 80 fruit for each tree. 20 x 20 spacing is 109 trees per acre. Additional income per acre would be $6300.20 total for 111 fruit more per tree, $4534.4 total for 80 more fruit per tree for the three years.

Girdling is therefore profitable. $2100.66 more per acre per year for the December girdle, $1511.47 more per acre per year for the February girdle. The December girdle would yield 263,652.75 more pounds for California's 47,505 bearing acres. Which would be $997,918.53 more dollars.

Robert J. McNeil and Gregory Parsons, CalPolySLO

Girdling of Avocado Trees

GIRDLING, A MEANS TO INCREASE AVOCADO FRUIT PRODUCTION
R. L Ticho Fruit Crops, Ministry of Agriculture, Israel. California Avocado Society 1970-71 Yearbook 54: 90-95.

Girdling of avocado trees is very useful and effective in Israel (Ticho, 1970). The 1970/71 avocado crop in Israel was estimated at 15,000,000 lbs; about 2,500,000 lbs. were traced to the effect of girdling.

http://avocadosource.com/CAS_Yearbooks/CAS_54_1970/CAS_1970-71_PG_090-095.pdf

McNeil, Robert J. and Parsons, Gregory. 2003. GIRDLING OF HASS AVOCADO TREES TO INCREASE FRUIT YIELD AND INCOME IN “OFF” YEARS IN A CALIFORNIA COASTAL VALLEY. Proceedings V World Avocado Congress. 2003. pp. 263-265. CalPolySLO.

Avocado Girdling Knife 2 cm (Bing.com)

Girdled Avocado Tree Limb 2 cm. Healed on the right. (Bing.com)

GIRDLING OF THE FUERTE AVOCADO, Persea americana Mill., TO INCREASE FRUIT SET AND YIELD IN A COOL CALIFORNIA COASTAL AREA. Vincent Ianaro and Robert J McNeil. CalPolySLO. 1992.

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GIRDLING OF THE FUERTE AVOCADO, *Persea americana* Mill., TO INCREASE FRUIT SET AND YIELD IN A COOL CALIFORNIA COASTAL AREA. Vincent Ianaro and Robert J McNeil. CalPolySLO. Hortscience 27:6. 1992.

The Fuerte avocado cultivar is known to be an alternate and inconsistent producer of avocados in cool coastal areas and hot interior areas of California because of its sensitivity to such extremes of climate during its bloom and fruit setting periods. This study attempted to increase fruit set and yield of this cultivar in a cool central coast area by applying a three-eighths inch wide girdle to one large limb, equivalent to one-third of the tree, on each of five 43-year-old trees. A double bladed girdling knife was used to remove the bark all around each limb. Another equal sized limb on each tree was used as the control. Girdling was completed on December 15. Girdled limbs had means of 42.6 more pounds which was 186.8% more fruit yield as compared to control limbs. Girdled limbs also had means of 89 more fruit which was 222.5% more fruit by count than control limbs. Fruit on girdled limbs was smaller in size (8.1 oz. average) than that on control limbs (9.1 oz. average) but was still of an acceptable size to bring good prices.

Growth Regulators for California Avocados

Three major areas of opportunities for control of development and growth regulation by plant growth regulators in avocado are vegetative growth control, floral induction, and fruit set and retention (Bing.com) and ripening.

GA3 and NAA are now registered for use on California avocados (Dr. Carol Lovatt, Professor Emeritus, UC Riverside, Personal Communication, 2024). And ethylene for ripening.

Tre-Hold Sprout Inhibitor A-112 Plant Growth Regulator. Amvac.

Tre-Hold® Sprout Inhibitor A-112 controls sprouting or sucker growth on avocados, mamey sapote, mangoes, olives, pomegranates, and woody ornamentals.

Features

Controls branch growth in orchards, residential areas, and areas where tree branch growth may be hazardous, such as power lines.

For commercial/agricultural use only: not intended for residential use.

Tre-Hold® A-112
SPROUT INHIBITOR

Controls Sprouting or Sucker Growth on Avocados, Mamey sapote, Mangoes, Olives, Pomegranate, and Woody Ornamental Plants

For Commercial/Agricultural Use Only: Not Intended For Residential Use

ACTIVE INGREDIENT:
1-Naphthaleneacetic acid, ethyl ester 15.1%
INERT INGREDIENTS: 84.9%
Total 100.0%
*This product contains petroleum distillate
1-Naphthaleneacetic Acid (NAA) equivalent is 1 lb./gal. or 13.2% by weight.

KEEP OUT OF REACH OF CHILDREN
CAUTION

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.
(If you do not understand the label, find someone to explain it to you in detail.)

FIRST AID	
If swallowed	• Immediately call a poison control center or doctor. • Do not induce vomiting unless told to do so by the poison control center or doctor. • Do not give any liquid to the person. • Do not give anything by mouth to an unconscious person.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
If in eyes	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
If inhaled	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. • Call a poison control center or doctor for further treatment advice.

EMERGENCY INFORMATION

Have the product container or label with you when calling a poison control center or doctor, or going for treatment.
FOR THE FOLLOWING EMERGENCIES, PHONE 24 HOURS A DAY:
For Medical Emergencies phone 888-681-4261
For Transportation Emergencies, including spill, leak or fire, phone: CHEMTREC® 800-424-9300
For Product Use Information phone: AMVAC® 888-462-6822

NOTE TO PHYSICIAN

If ingested: Probable mucosal damage may contraindicate the use of gastric lavage. Measures against circulatory shock, respiratory depression and convulsion may be needed.
Contains petroleum distillate - vomiting may cause aspiration pneumonia.

EPA Reg. No. 5481-429 EPA Est. No. ___________
Net Contents: ___________

TRE-HOLD SPROUT INHIBITOR A-112		
2.5 fl. oz.	29.5 fl. oz.	1 quart
10.0 fl. oz.	118.0 fl. oz.	1 gallon
4.0 gallons	46 gallons	50 gallons

For marking purposes, white latex paint may be substituted for an equal volume of water as indicated below. The white paint also provides protection from sun scald damage in thin barked trees or shrubs.

EXAMPLES FOR PREPARATION OF APPROXIMATELY 1% A.I. (EXPRESSED AS NAA ACTIVE INGREDIENT) WITH LATEX PAINT		
AMOUNT OF TRE-HOLD SPROUT INHIBITOR A-112	AMOUNT OF LATEX PAINT	ADD WATER TO MAKE TOTAL VOLUME OF
2.5 fl. oz.	4 to 15 fl. oz.	1 quart
10.0 fl. oz.	15 to 60 fl. oz.	1 gallon
4.0 gallons	5 to 20 gallons	50 gallons

Use the higher rate of white latex paint where bark damage from sun scald is likely to be most severe. Be sure the paint used is not harmful to trees.

APPLICATION INSTRUCTIONS

OLIVES - TRUNK BASAL SPROUTS AND ROOT SUCKERS

(Do not treat scaffold branches or pruning cuts on olive trees). Prune off existing sprouts or suckers and allow new sprout to regrow. Treat with a 1% solution of Tre-Hold Sprout Inhibitor A-112 when sprouts are not more than 10 inches tall. Apply with a brush, small hand-held sprayer or back pack sprayer. Tre-Hold Sprout Inhibitor A-112 will control new sprout growth of olives, but will not control old woody sprouts. Do not treat during olive bloom or fruit set. Limit treated areas to 10% of the plants total bark surface. Do not apply more than 4.25 gallons of spray mix per acre per year.

Tre-Hold Sprout Inhibitor A-112 Use Directions for Avocado, Mamey Sapote and Mango trees

Use Tre-Hold Sprout Inhibitor A-112 on pruned branches or limbs to maintain overall tree architecture or on trees which have been severely cut back (stumped).

Dosage: Tre-Hold Sprout Inhibitor A-112 should be diluted in water or a mixture of water and white latex paint to make an approximate 1.1% (w/w) final concentration of active ingredient.

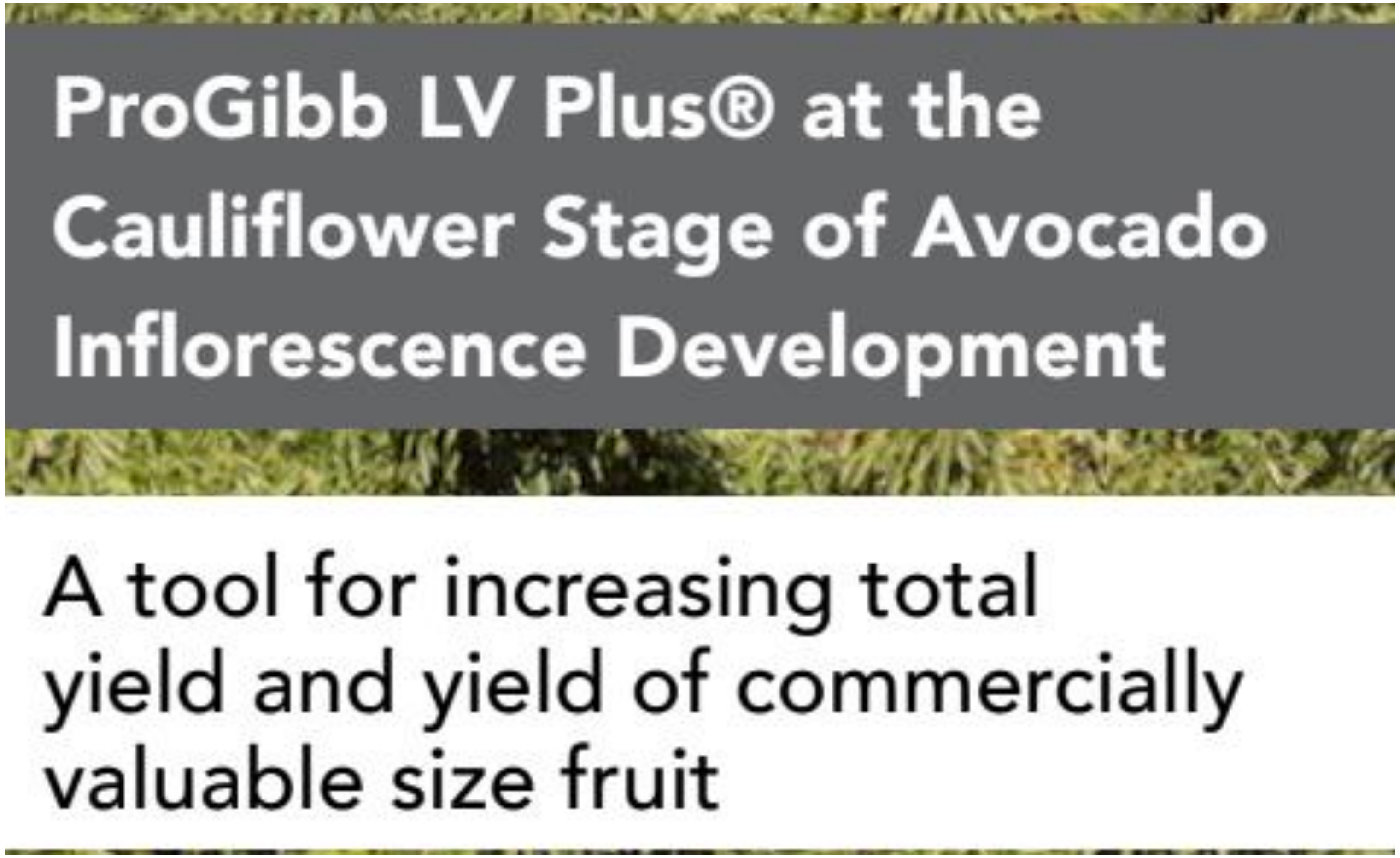
Tre-Hold Sprout Inhibitor A-112 should first be added to water and then the solution added to the latex paint. Mix well.

DIRECTIONS TO PREPARE A 1.15% A.I. (NAA) WHITE LATEX PAINT MIXTURE		
AMOUNT OF TRE-HOLD SPROUT INHIBITOR A-112	AMOUNT OF WHITE LATEX PAINT	ADD WATER TO MAKE TOTAL VOLUME OF
2.8 fl. oz.	4-15 fl. oz.	1 quart
11 fl. oz.	15-60 fl. oz.	1 gallon
4.5 gallons	5-20 gallons	50 gallons

Method of Application: Prune branches and remove excessive sprouts or dead and diseased limbs. When a tree is being stumped or severely pruned ensure proper cuts are made at the right angles. Apply TreHold Sprout Inhibitor A-112 mixture with a small hand-held sprayer equipped with a directed nozzle, brush, sponge or paint roller or other suitable equipment within a few days after pruning operations have been completed. Do not allow the mixture to splash or drip on to other parts of the tree at the time of application.

Frequency/Timing of Applications: Two applications may be made per year with a minimum of 45 days between treatments. The Preharvest Interval (PHI) is 10 days.

Pro Gibb on Avocados.



https://mail.google.com/mail/u/0/#inbox/FMfcgzQXJGjPVbddGTWhLHZkxVWVCnWT?projector=1&messagePartId=0.3

dpr

ulie Henderson
Director

Department of Pesticide Regulation

Gavin Newsom
Governor

Yana Garcia
Secretary for
Environmental Protection

February 15, 2023

FIFRA 24(c) Special Local Need Label (SLN)
For distribution and use only in the state of California

For Use on Avocados to Increase Fruit Size and Yield.

ProGibb LV Plus Plant Growth Regulator Solution

EPA Reg. No.: 73049-498 **SLN #** CA-180001

Manufacturer: Valent BioSciences LLC
870 Technology Way
Libertyville, Illinois 60048

This label expires and shall not be distributed or used in accordance with this SLN registration after <u>December 31, 2025.</u>

DIRECTIONS FOR USE

DIRECTIONS FOR USE

- It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
- This state-specific Section 24(c) labeling must be in the possession of the user at the time of application.
- Follow all applicable directions, restrictions, and precautions on the EPA registered label for ProGibb LV Plus Plant Growth Regulator Solution (EPA Reg. No. 73049-498) and this label.

Location: Statewide

Crop/Site/Commodity: Avocados

Target Pest/Problem: Increase fruit size and yield

Dosage: For Ground - Use 12.5 fluid ounce of product in 100 gallons of water per acre.
For Air - Use 12.5 fluid ounce of product in 75 gallons of water per acre.

Dilution Rate: See "Dosage" above.

Method of Application: Ground or Air

Frequency/Timing of Application: Only one application per year. Apply at cauliflower stage of inflorescence development. Product is most effective when used On-crop years but may not be effective on Off-Crop years.

Restricted Entry Interval (REI): 4 hours

Preharvest Interval (PHI): 0 Days

Other Requirements: None

Specific Use Restrictions: Do not apply through any type of irrigation systems.

Valid until withdrawn, suspended or cancelled by the United States Environmental Protection Agency (USEPA), the manufacturer, the 24(c) registrant, or the Department of Pesticide Regulation, or expires.

The County Agricultural Commissioner's (or designee's) signature must be obtained prior to this use. This does not constitute a recommendation of the Department of Pesticide Regulation and will not prevent quarantine action if illegal residues are found on or in the crop.

To the extent consistent with applicable law, neither the Department nor the county agricultural commissioner, makes any warranty of merchantability, fitness of purpose, or otherwise, expressed or implied, concerning the use of a pesticide in accordance with these provisions. The user and/or grower acknowledge the preceding disclaimer.

Do not use in mixture with other pesticides unless provided for in the labeling. Trial on a small area to check out unanticipated problems is suggested.

24(c) Registrant: California Avocado Commission
12 Mauchly, Suite L
Irvine, California 92618
949-341-1955

USEPA SLN No. CA-180001

John E. Inouye
Senior Environmental Scientist
Pesticide Registration Branch
(916) 324-3538
E-mail: jinouye@cdpr.ca.gov

COUNTY AGRICULTURAL COMMISSIONER'S SIGNATURE

____

Date: __________

USER'S SIGNATURE ________________________

California Avocado Commission, Plant Growth Regulators

California avocado growers must increase yield, including fruit size, and/or reduce production costs to remain competitive in the US market, which now receives fruit from Mexico, Chile, New Zealand, Dominican Republic and an increasing number of other countries (http://www.ers.usda.gov/Data/Fruit VegPhyto/Data/fr-avocados.xls). Despite the popularity, the ‘Hass’ cultivar (Persea americana Mill.) is known to be problematic with regard to fruit retention, fruit size and alternate bearing. Plant growth regulators (PGRs) are powerful, cost-effective tools for increasing yield of commercially valuable large size fruit and mitigating alternate bearing in the field. [At the present time, 2024, Tree Hold and Pro Gibb are registered for use on avocado, and Ethylene for ripening]. The goal of my research program is to provide growers with a basic understanding of 'Hass' avocado tree phenology and physiology and the tools to increase net income per acre for growers of the 'Hass' avocado in California. To meet this goal we are developing fertilization and plant growth regulator (PGR) strategies to increase total yield and yield of commercially valuable large size fruit. For the PGR strategies we are simultaneously collecting the efficacy data necessary to satisfy the requirements of the California Department of Pesticide Regulation (DPR) to have the successful plant growth regulators added to an existing label so that they can be legally used in avocado production in California. Note that PGRs are considered pesticides. The specific objectives of this research are: (1) to increase yield by annually increasing the number of more highly productive sylleptic shoots in the canopy; (2) to increase yield by increasing fruit retention during June drop; (3) to increase fruit size; and (4) to collect dose response data as the next step toward adding avocado to the label for GA3. To meet these objectives, three separate field projects are being conducted.

PGR Strategies to Increase Yield of ‘Hass’ Avocado
Carol Lovatt UC Riverside Jess Ruiz - Irvine Company, Gus Gunderson - Limoneira Company 2008 Production Research Report Management and Physiology California Avocado Commission

https://www.californiaavocadogrowers.com/sites/default/files/PGR-Strategies-to-Increase-Yield-of-%E2%80%98Hass%E2%80%99-Avocado-2008-Report.pdf

California avocado growers must increase yield, including fruit size, and/or reduce production costs to remain competitive in the US market, which now receives fruit from Mexico, Chile, New Zealand, Dominican Republic and an increasing number of other countries (http://www.ers.usda.gov/Data/Fruit VegPhyto/Data/fr-avocados.xls). Despite the popularity, the ‘Hass’ cultivar (Persea americana Mill.) is known to be problematic with regard to fruit retention, fruit size and alternate bearing. Plant growth regulators (PGRs) are powerful, cost-effective tools for increasing yield of commercially valuable large size fruit and mitigating alternate bearing in the field. At the present time, no plant growth regulators are registered for use on avocado. The goal of my research program is to provide growers with a basic understanding of 'Hass' avocado tree phenology and physiology and the tools to increase net income per acre for growers of the 'Hass' avocado in California. To meet this goal we are developing fertilization and plant growth regulator (PGR) strategies to increase total yield and yield of commercially valuable large size fruit. For the PGR strategies we are simultaneously collecting the efficacy data necessary to satisfy the requirements of the California Department of Pesticide Regulation (DPR) to have the successful https://www.californiaavocadogrowers.com/sites/default/files/PGR-Strategies-to-Increase-Yield-of-%E2%80%98Hass%E2%80%99-Avocado-2008-Report.pdf

plant growth regulators added to an existing label so that they can be legally used in avocado production in California. Note that PGRs are considered pesticides. The specific objectives of this research are: (1) to increase yield by annually increasing the number of more highly productive sylleptic shoots (Fig. 1) in the canopy; (2) to increase yield by increasing fruit retention during June drop; (3) to increase fruit size; and (4) to collect dose response data as the next step toward adding avocado to the label for GA3. To meet these objectives, three separate field projects are being conducted.

https://www.californiaavocadogrowers.com/sites/default/files/PGR-Strategies-to-Increase-Yield-of-%E2%80%98Hass%E2%80%99-Avocado-2008-Report.pdf

Benefits of the research to the industry (includes achievements and future prospects) Objective 1. The results of this research provide a PGR strategy (GA3 at 100 mg/L applied in July) for increasing bud break and development of the summer (sylleptic) vegetative shoot flush during a heavy on-crop year, the first step in mitigating alternate bearing, and provide some insight into the type of PGR and timing of the PGR application necessary to increase bud break in spring. The fact that a February application of Typy at 50 mg/L is more effective than a February application of GA3 at 100 mg/L indicates a need to supply cytokinin at this time. This information will be used in the final phase of our research on alternate bearing. Objective 2 and 3. The results of this research demonstrated that 2,4-D significantly increased the 4 year average yield of commercially valuable large size fruit (packing carton 60 + 48 + 40) by 2,091/110 trees/acre/year. The cost of 2,4-D (CitrusFix® AMVAC Corp.) to achieve the net increase in yield of large size fruit was $15/acre/year (not including the cost of application which will vary widely from grower to grower). I am working with the Production Research Committee and AMVAC, manufacturer of CitrusFix, to obtain a 24 (c) supplemental label to use 2,4-D to increase the yield of commercially valuable large size fruit of 'Hass' avocado and 'Hass' hybrids so that 2,4-D will hopefully be available for the growers to use this spring. Additional research demonstrating the ability of 2,4-D to increase yield of commercially valuable large size fruit in a second orchard in a different avocado-growing area of the state and a dose response to 2,4-D are still required, but in the mean time 2,4-D will possibly be available to growers. Objective 4. In previous research, the potential of GA3 to increase grower income was demonstrated in two different avocado-growing areas of the state. Demonstrating that yield parameters respond incrementally to differences in the amount of GA3 applied (a dose response) in orchards in two different avocado-growing areas of the state is the critical final step in adding avocado to a commercial GA3 label.

https://www.taylorfrancis.com/chapters/edit/10.1201/9781003300342-5/plant-growth-regulators-avocado-panda-kavita-pradhan-tarai India

The discovery of compounds such as gibberellins inhibitors which act in preventing the synthesis of high levels of gibberellins has been reported to limit the vigorous vegetative growth phase in avocado. Three major areas of opportunities for control of development and growth regulation by plant growth hormones in avocado are vegetative growth control, floral induction, and fruit set and retention.

By Tridip Kumar Hazarika

Book

Plant Growth Regulators in Tropical and Sub-tropical Fruit Crops

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https://www.agric.wa.gov.au/avocados/plant-growth-regulators-avocado-production-review. Australia.

Avocado trees are very vigorous and can rapidly overgrow their permitted space in the orchard. Additionally their excessive vegetativeness at the expense of generativeness is believed to be responsible for limiting fruit set and yield. Growth regulators have been developed for use in avocados to minimize vegetative growth and to support greater fruitfulness of the avocado tree.

Avocados trees have characteristic vegetative flushes in spring, summer and autumn. These flushes combined can create up to a metre or more of vegetative growth in one growing season. Avocados are also characterised by poor fruit set which has been partly attributed to a relationship between flowering time and the growth of these substantial vegetative flushes. Shortly after flowering and fruit set the first spring flush begins growing. Competition between the newly set fruit and the developing leaf flush was first suggested as being involved in poor fruit set in 1979 and again in 1983.

https://www.agric.wa.gov.au/avocados/plant-growth-regulators-avocado-production-review

Research has found that partially limiting the spring flush is beneficial in maximising fruit set through techniques such as delaying or reducing nitrogen application during the flowering/growth flush stage, nipping off the shoot apical bud, girdling, and finally by the application of plant growth regulators. There are two growth regulators which can be used by Western Australian avocado growers; Paclobutrazol and Uniconazole.

Research in the plant growth regulator paclobutrazol started in the late 80s and early 90's with efforts on the varieties 'Hass' and 'Fuerte'. Research only began after good methods had been developed to manage phytophthora root rot. Paclobutrazol caused a significant reduction in the growth of the spring flush and also significantly increased the proportion of dry matter going into the fruits whilst reducing dry matter going to the leaves and stems. Fruit retention was also improved by the application of paclobutrazol as a spray or as an injection (Kremer-Kohne, 1987). The improved retention of fruit in that particular piece of research was permanent and was not nullified by summer fruit drop. Some other research found that in high yielding trees summer fruit drop nullified the effect of increased fruit retention (Wolstenholme, Whiley and Saranah, 1990).

https://www.agric.wa.gov.au/avocados/plant-growth-regulators-avocado-production-review

Interestingly while some research has not shown yield increases due to paclobutrazol use in a one off season the benefit appears to come in higher yields in off years resulting in higher cumulative yield compared to the control. In on-years a carbohydrate stress was suggested to explain how the tree is limited by resources and thus unable to support the larger fruit set caused by paclobutrazol. In off-years however the tree does not have this stress and thus can carry more fruit (Wolstenholme, Whiley and Saranah, 1990). Research in Israel provides extra evidence to support this hypothesis with trees with higher yields responding less to paclobutrazol (Adato and Gazit, 1974). Smaller applications of paclobutrazol (1.25 g/l and 0.62 g/l) by Whiley et al. (1992) saw the greatest cumulative yield of 350-400 kilograms per tree compared to approximately 250kg for the control tree (Whiley, Saranah and Wolstenholme, 1992). Current label rates are in the range of the above values and need to be followed to have the best effect.

https://www.agric.wa.gov.au/avocados/plant-growth-regulators-avocado-production-review

Aside from slight improvements in yield the greatest benefit from using growth regulators such as paclobutrazol are their ability to manage tree vigour and effectively induce a dwarfing effect on an otherwise very vigorous tree. A South African trial used Paclobutrazol to minimize tree size in an 800 tree per hectare high density planting with success (Kohne and Kremer-Kohne, 1992).

Some later research also measured the impact paclobutrazol had on calcium levels in the fruit; calcium in the fruit is important for post-harvest purposes with higher calcium levels being beneficial for reducing post-harvest damage to the fruit and improving shelf life. The use of paclobutrazol was found to increase fruit calcium levels for eight weeks after fruit set but returned to the same level as the control by the 10th week (Whiley, Saranah and Wolstenholme, 1992).

https://www.agric.wa.gov.au/avocados/plant-growth-regulators-avocado-production-review

Research into Uniconazole in avocados began in 1998 and resulted in increases in fruit size, which was described by the authors at the time as being conducive to a more valuable crop, despite there not being a yield increase. Average fruit size of hass was increased from 221g to 275g by the application of uniconazole at the mid-bloom. Application of uniconazole to regrowth following pruning was also able to increase flowering. The research also described how the fruit shape was changed to a more round shape (H.D. Erasmus, 1998).

The ‘rounding’ effect of growth regulator is well known and reported in literature (Brogio et al., 2018). Some people do not prefer the round shape of treated avocados over the natural pear shape. Anecdotally some growers have reported that the effect can be managed by using the correct rate of growth regulator. Either way, the positive benefits of growth regulator use-greater cumulative yield, larger fruit, and particularly the reduction in vegetative vigour-account for the change in fruit shape and justify their use in a productive avocado orchard.

https://www.agric.wa.gov.au/avocados/plant-growth-regulators-avocado-production-review

There is an important disclaimer that needs to be added to the research reviewed above. All of the above research has been done in climates that are more tropical than the climate of South West Western Australia. The colder winters in Western Australia mean that during spring checking the growth of that first spring flush could potentially be damaging to the trees ability to collect valuable carbohydrates to contribute to the trees survival. It was described earlier how paclobutrazol applied to heavily loaded trees did not lead to yield increases as the tree was already resource limited. After a cool winter local experience appears to have shown that trees are short on resources and therefore the growth regulator may not have the desired effect. Unfortunately in California, which has a similar climate, there has not been sufficient or notable research into paclobutrazol or uniconazole with efforts instead going towards gibberellic acid (Lovatt, 2005). In fact some unpublished research by Carol Lovatt in California found that uniconazole had a detrimental effect on crop yield.

https://www.agric.wa.gov.au/avocados/plant-growth-regulators-avocado-production-review

To balance that out, in Chile/Peru-which also has a similar climate- both uniconazole and paclobutrazol are both very popular. Some research presented at the 8th world avocado congress in Peru in 2015 saw slightly better yields from paclobutrazol use (26.21 t ha-1) to the control (23.34 t ha-1) with a reduction in shoot length from 46.5 cm to 34.5 cm. it is also important to note that the highest yield was observed with the lowest dose of paclobutrazol, higher rates saw large yield reductions with the highest rate resulting in 17.13 t ha-1 being produced. The higher rates likely had too extreme an effect on the plant and badly reduced its ability to produce carbohydrates to grow the crop. Therefore the rate needs to be correct for a good effect.

The use of the above growth regulators is regulated by the Australian Pesticides and Veterinary Medicine Association (APVMA). As of the time of writing Uniconazole is registered for use in avocado while paclobutrazol can only be used with a minor use permit. Information about registration and permits can be found on PUBCRIS.

Ethylene Treatments to Ripen Avocados in California. (Bing.com)

Treatment with 100 ppm ethylene at 20°C (68°F) for 48 hours (early-season fruits), 24 hours (mid-season fruits), or 12 hours (late-season fruits) induces avocados to ripen in 3-6 days, depending on cultivar and maturity.

See more at https://postharvestacademy.net/uploads/3/4/4/6/34466629/avocado_ripening_manual.pdf

Avocado Postharvest Ripening Manual by Charles S Whitehead

Ethylene for Avocados (Bing.com)

Ethylene gas plays a crucial role in the ripening process of avocados. It's a natural plant hormone that accelerates ripening, ensuring your avocados reach their peak flavor and texture.

https://www.catalyticgenerators.com/avocado-ripening:

Please note that avocados produce more heat than bananas! Cooling may be slower than is needed when using banana rooms to ripen avocados.

Early season avocados may take longer to ripen than middle to late season ones.

Mature green avocados should be shipped at 41-51°F (5 to 10.5°C, pulp temperature). Before ripening begins, the fruit pulp temperature should be raised to 65-68°F (18-20°C). If not using pressurized ripening rooms, air stack the boxes (at least 2" / 50 mm between boxes) to have proper air circulation. Leave 1½ feet / 0.5 m between walls and pallets and at least 6 inches / 150 mm between pallets.

Once the fruit pulp temperatures stabilize, place a Catalytic Generator in the room, fill it with Ethy-Gen® II Concentrate. Apply 100 ppm ethylene; exposure time is dependent upon season of harvest, age of fruit, and maturity level at harvest. Use the recommendations below as a guide, and make sure to check avocado firmness (here's where to find avocado firmness testers: QA Supplies) to know when to stop ethylene application:

Early season fruit: 36-48+ hours

Mid-season fruit: 24-36 hours

Late season fruit: 12-24 hours.

To achieve 100 ppm, the generator setting will depend on the size of the ripening room. See Operating Instructions.

Please note that all rooms vary in terms of how air-tight they are, so if more precise PPM determination is required, air testing for ethylene PPM levels is recommended.

Humidity
Humidity is very important. It should be maintained at 90-95%.

Carbon dioxide (CO_2)
Carbon dioxide (CO_2) will build up during ripening. Anything above 1% may retard ripening or cause “checkerboard” ripening within the room. If automatic ventilation is not in place, be sure to vent approximately every 12 hours by opening the doors for 20 minutes even while applying ethylene.

Pulp Temperature
Check pulp temperature at least twice per day and maintain proper pulp temperature.

The fruit should be ready to ship within 3-6 days depending on the season, pulp temperature and degree of firmness. Ripened fruit may have the stem end button become more pliable indicating the softness process is beginning.

Once ripening has reached the desired degree of firmness, lower the pulp temperature to 40-42°F (4.5 to 5.5°C).

CAUTION: Do not hold mature green, unripe avocados at pulp temperature below 40°F / 4.5°C. Chilling injury will occur, and the longer avocados are held at low temperatures, the more severe the injury that will be caused. Chilling causes grayish-brown discoloration of the skin and flesh. If chilled before ripening, the fruit will not ripen properly. Ripened avocados are less susceptible to chill damage; they can be stored as low as 36°F (2°C).

For more information on avocados and other fruits, please visit the web site of UC Davis Postharvest Technology Center. A great resource for any Fruit Ripener is a publication from UC Davis entitled "Fruit Ripening & Ethylene Management."

These recommendations were amassed from a diverse number of sources for use by clients of Catalytic Generators, LLC. While we have made great effort to provide accurate and current ripening techniques, Catalytic Generators makes no warranties regarding these recommendations or the applicability of such information to a particular ripening operation. Please note that we do not provide these recommendations as a replacement for technical ripening experts; if having ripening problems or starting a ripening program, we suggest that professionals be consulted.

How to Ripen an Avocado. Go to this website:

https://californiaavocado.com/how-to/how-to-ripen-an-avocado/

Postharvest Considerations

https://www.theproducenerd.com/2016/10/avocado-harvest-packing/

Avocados do not ripen on the tree and are harvested hard. The most important factors that handlers deal with between packing and the avocados arriving at the store is the storage temperature and the ethylene treatment. There are set temperature storage ranges for avocados, which differ based on the specific avocado cultivar, and are important to follow to prevent any internal issues caused by too cold of temperature storage, or too quick ripening caused by too warm of temperatures. The ethylene treatment is used to help initiate the ripening process in avocados.

Measuring Avocado Firmness

http://avocadosource.com/wac4/wac4_p389.pdf

Firmness is an important characteristic of avocado fruit as it is the most reliable method of determining if the fruit is ripe to eat. A range of different methods are available to assess firmness of avocados; Firmometer, 2 mm deformation of whole fruit, puncture tests using Effegi probes and conical probes (Chatillon), and gentle handsqueezing of the fruit. The Firmometer, originally developed in South Africa and modernised in N.Z. (called the Anderson Firmometer), is increasingly being used by the N.Z. avocado industry as a tool to measure firmness. The aim of this study was to identify the most appropriate method of measuring 'Hass' avocado firmness at both the firm (at harvest) and soft (eating ripe) stages. As squeezing the fruit by hand is the most common method employed to measure avocado firmness, all the tests were compared to this. The Firmometer had the closest relationship with hand firmness (R2 = 0.93) across the entire firmness range. Use of a 200 g weight rather than a 300 g weight on the Firmometer allowed greater measurement sensitivity of softer fruit.

Avocado Institute of Mexico. Go to this website: https://avocadoinstitute.org/avo-journey/commitment-to-quality-and-food-safety/how-avocados-are-tested-for-optimal-flavor-and-consistency-before-export-

Florida Avocados, Shipping Point and Market Inspection Instructions: Go to:

https://www.ams.usda.gov/sites/default/files/media/AvocadoFloridaInspectionInstructions.pdf

This USDA information applies to Florida, California, Texas, Hawaii, and Puerto Rico and all other states in the USA.

Fruit Firmness Testing Equipment:

https://www.ipt.us.com/wp-content/uploads/2012/03/Wagner-Pressure-Test.pdf

	FT MODEL	TIP SIZE	HARVEST	SHIP
AVOCADO *AGUACATE*	**40**	**1/4" [6 mm]**	30 - 32 lbf [14 - 15 kgf]	18 - 22 lbf [8 - 10 kgf]

Long Distance Controlled Atmosphere of Avocados: Go To: http://avocadosource.com/temp/OLD%20WAC%20II/WAC2_p463.htm

Abstract. Low temperature storage is essential for long-distance transport of avocados but results in chilling injury if the temperature is too low and physiological disorders and waste, if the temperature is too high. Controlled atmosphere (CA) storage can extend storage life, maintain quality, drastically reduce chilling injury and allow storage at lower temperatures.

Optimum CA conditions for avocado fruit. Best results are obtained by storing avocados at 2% to 5% oxygen and up to 10% carbon dioxide (Eksteen and Truter, 1983; Kader, 1989). Optimum storage temperatures vary between 4.4C and 13C (Hardenburg et al., 1986). The average optimum for South African grown avocados is 5.5C but Vorster et al (1990) have found that a temperature management system whereby the transit temperature is reduced from 7.5C to as low as 3.5C gives best results for long-distance transport.

The relative humidity in the storage atmosphere should preferably be in the 90% to 95% range because it was found that moisture loss may increase chilling injury (Bower and Cutting, 1987). The avocado being a climacteric fruit should be stored and transported at very low ethylene levels in the atmosphere to reduce early softening. Efficient ethylene removal systems are, however, still under development (Heap, 1989). Continued on website.....

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https://www.taylorfrancis.com/chapters/edit/10.1201/9781003300342-5/plant-growth-regulators-avocado-panda-kavita-pradhan-tarai

http://avocadosource.com/temp/OLD%20WAC%20II/WAC2_p463.htm

California Avocado Society 2005 Yearbook
88:81-91
Plant Growth Regulators for Avocado Production
Carol J. Lovatt
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http://avocadosource.com/CAS_Yearbooks/CAS_88_2005/CAS_2005_V88_PG_81-91.pdf Lovatt/Plant Growth Regulators/Avocados.

Background

Plant growth regulators (PGRs) are the most powerful tools for manipulating tree growth and yield in an existing orchard. A quick review of current commercial uses of PGRs in apple, citrus, stone fruit, nut, kiwi, and grape production provides insight into the physiological processes that can be influenced to the economic benefit of growers. PGRs are used successfully to manipulate flowering. Benzyladenine (6 benzylaminopurine, BA) causes early bud break in numerous tree crops and increases floral bud retention of pistachio (Lovatt and Ferguson, 1999). Gibberellic acid (GA3) inhibits or delays flowering in deciduous tree crops (Sedgley, 1990) and citrus if applied before irreversible commitment to flowering (Lord and Eckard, 1987). After this developmental stage, GA3 is without effect on many crops including coffee (Schuch et al., 1990) and mango (Kachru et al., 1972).

http://avocadosource.com/CAS_Yearbooks/CAS_88_2005/CAS_2005_V88_PG_81-91.pdf Lovatt/Plant Growth Regulators/Avocados.

PGRs are used to manipulate fruiting. The powerful synthetic diphenylurea-type cytokinin 1-(2-chloro-4-pyridynl)-3 -phenylurea (forchlorfenuron, CPPU), the synthetic auxin 2,4-dichlorooxyacetic acid (2,4-D) and GA3 all have the capacity to stimulate parthenocarpic fruit development in various crops. GA3, BA, CPPU, 2,4-D and the powerful synthetic auxin 3,5,6-trichloropyridyloxyacetic acid (3,5,6-TPA) stimulate fruit growth directly to increase fruit size, but with the caveat that a PGR may be more effective on some crops than on others. GA3, 2,4-D and aminoethoxyvinylglycine (AVG) reduce early drop, which occurs during the initial fruit set period, June drop and preharvest drop of mature fruit. In contrast, ethylene-releasing compounds, such as 2 chloroethyl phosphonic acid (ethephon, CEPA), the auxin naphthalene acetic acid (NAA), and even BA at high concentration are used to induce flower or fruit abscission to reduce fruit number and indirectly increase fruit size.

http://avocadosource.com/CAS_Yearbooks/CAS_88_2005/CAS_2005_V88_PG_81-91.pdf Lovatt/Plant Growth Regulators/Avocados.

PGRs are used to manipulate fruit quality both in the orchard and in the packinghouse. Ethephon can be used preharvest to advance color development and fruit maturation (ripening), whereas GA3 delays color development and maturity in tree crops, including citrus. Ethephon is also used to loosen fruit to increase the efficiency of mechanical or hand harvesting of nut crops, olives, cherries, plums and citrus (Jaumien and Rejman, 1978; Knapp, 1981; Metzidakis, 1999). The PGRs abscisic acid (ABA), 2,3,5 triiodobenzoic acid (TIBA) and methyl jasmonate have also been shown to increase fruit loosening in citrus (Burns et al., 2003; Kender et al., 2001; Hartmond et al., 2000). Ethylene-releasing compounds are also used postharvest to enhance color development and ripening.

http://avocadosource.com/CAS_Yearbooks/CAS_88_2005/CAS_2005_V88_PG_81-91.pdf Lovatt/Plant Growth Regulators/Avocados.

PGRs can also be used to manipulate vegetative shoot development, with GA3 stimulating vegetative shoot growth and prohexadione-calcium, paclobutrazol and uniconazole restricting canopy growth. The latter two are used in avocado production in Australia to retard vegetative regrowth after pruning. Plant Growth Regulators and the Avocado. The avocado is a relatively new crop compared to apples, citrus and grapes. As a result, avocado PGR research is less advanced. Notably, a number of factors have further delayed progress towards commercialization of PGR strategies for avocado production in California. With the limited amount of avocado acreage, manufacturers are reluctant to make the financial investment in the research and development necessary to register a PGR for use on avocados. Moreover, simple adoption of PGR strategies from other crops is precluded because the avocado frequently responds differently to PGRs than other crops. PGR responses unique to the avocado include: (1) GA3 stimulated precocious floral shoot development; (2) BA increased fruit set when applied in April or May, but when applied at the same concentration in June, BA increased fruit abscission;

http://avocadosource.com/CAS_Yearbooks/CAS_88_2005/CAS_2005_V88_PG_81-91.pdf Lovatt/Plant Growth Regulators/Avocados

(3) AVG increased fruit set when applied in April or May, but was without effect in June; (4) AVG stimulated vegetative shoot growth, a novel response to AVG; (5) prohexadione-calcium inhibited growth of the vegetative shoot apex of indeterminate floral shoots, but not the growth of vegetative shoots; and (6) prohexadione-calcium applied three times at 250 mg/L increased the length to width ratio of fruit from 1.4 for the untreated control to 2.1 (Garner, 2004). In addition, due to poor uptake by avocado leaves, higher PGR concentrations are required to elicit a response than those typically used for other crops. Thus, the nature of the avocado necessitated research to determine such basics as which PGR to apply, at what concentration and when. In addition, obtaining consistent results is difficult due to alternate bearing and the presence of two crops on the tree for increasing lengths of time up to 6 months.

http://avocadosource.com/CAS_Yearbooks/CAS_88_2005/CAS_2005_V88_PG_81-91.pdf Lovatt/Plant Growth Regulators/Avocados

Current Investigations of PGRs for Avocado. Our research results provide evidence of several promising PGR strategies for avocado. GA3 (25 mg/L) applied at the cauliflower stage of inflorescence development (~March) increased total yield in both kilograms and number of fruit per tree and increased the yield of commercially valuable large size fruit (packing carton sizes 60, 48, and 40; fruit weighing 178-212 g/fruit, 213-269 g/fruit, and 270-325 g/fruit, respectively) in both kilograms and number per tree. Statistically, the yield effects of GA3 were only significant for the on crop-year, but due to positive numerical increases in both yield parameters in the off-crop year, the treatment had a statistically significant effect on total yield and packout of large size fruit when averaged across the 2 years of the study or as 2-year cumulative yield (Table 1). For the growers of the Hass avocado in California, this GA3 treatment translates to a 2-year cumulative net increase of 3,771 lbs more fruit per acre (110 trees per acre) than the untreated control. Moreover, 68% of the net increase in yield was large size fruit. This GA3 treatment resulted in a 2-year cumulative net

http://avocadosource.com/CAS_Yearbooks/CAS_88_2005/CAS_2005_V88_PG_81-91.pdf Lovatt/Plant Growth Regulators/Avocado.

increase of 2,571 lbs per acre of fruit of packing carton sizes 60, 48 and 40 over that of the control. In a second study, GA3 (25 mg/L) applied at the end of June - beginning of July increased total yield as both kilograms and number of fruit per tree and also yield of commercially valuable large size fruit (packing carton sizes 60, 48, and 40) as kilograms and number per tree. As in the previous experiment, both GA3 effects were only statistically significant in the on-crop year, but were statistically significant when averaged across both the on- and off-crop years and as 2-year cumulative yield (Table 2). Per acre, this second GA3 treatment resulted in a 2-year cumulative net increase of 6,579 lbs more fruit than the untreated control, of which 83% were large size fruit. This GA3 application resulted in a 2-year net increase of 5,490 lbs more fruit of packing carton sizes 60, 48 and 40 per acre than the control. This application time was selected because it is prior to the periods of June drop for the current crop (Garner, 2004), exponential increase in fruit size for the current crop and abscission of mature fruit (Garner, 2004), and development of the summer vegetative flush (Salazar García et al. 1998) , which we now know is critical to the

http://avocadosource.com/CAS_Yearbooks/CAS_88_2005/CAS_2005_V88_PG_81-91.pdf Lovatt/Plant Growth Regulators/Avocado.

floral intensity of the return bloom (Lopez, Jimenez and Lovatt, personal communication), but also sufficiently before inflorescence initiation for next year s crop, which occurs at the end of July – beginning of August, to not interfere with phase transition (Salazar-García et al. 1998) In addition to GA3, in a third experiment BA (25 mg/L) applied at anthesis and a combined treatment of GA3 (25 mg/L) applied in mid-July followed by application of prohexadione-calcium (125 mg/L) 30 days later significantly increased the kilograms and number of large size fruit of packing carton sizes 40 (270-325 g/fruit) and 36 (326354 g/fruit) per tree and the combined pool of fruit of packing carton sizes 40, 36 and 32 (270-397 g/fruit) per tree averaged across the 3 years of the study (Table 3) and as 3 year cumulative yield. The net increase in yield of fruit of packing carton sizes 40, 36 and 32 was 1,317 and 1,232 lbs per acre per year for 3 consecutive years for BA and GA3 followed by prohexadione-calcium, respectively.

http://avocadosource.com/CAS_Yearbooks/CAS_88_2005/CAS_2005_V88_PG_81-91.pdf Lovatt/Plant Growth Regulators/Avocado.

It should be noted that for all experiments reported here, no PGR had a negative effect on any fruit quality parameter evaluated. We routinely quantified the effect of each PGR treatment on the number of days to ripen at 22 ± 2 °C. When ripe, we measured seed length and width and flesh width from seed to peel. In addition, external and internal fruit quality was evaluated for abnormalities, discoloration and decay. Vascularization (presence or absence of vascular bundles and associated fibers) of the flesh was also determined. The above fruit quality parameters were rated on a scale from 0 (normal) to 4 (high incidence of abnormalities, discoloration, decay or vascularization; all four quadrants of the fruit affected).
To meet the requirements of the state DRP for proof of efficacy, we must successfully reproduce the results of the four PGR strategies in a second study in a new Hass orchard in a different avocado growing-area of California than for previous studies.

http://avocadosource.com/CAS_Yearbooks/CAS_88_2005/CAS_2005_V88_PG_81-91.pdf Lovatt/Plant Growth Regulators/Avocado.

For each strategy we also need to demonstrate that total yield and yield of large size fruit increase with increasing PGR concentration. Thus, in all cases, PGR effects on yield, fruit size distribution and fruit quality must be determined. Since GA3 is exempt from tolerance by the Federal EPA, once we have satisfied the efficacy data requirements of the state DPR, we are in a position to pursue having a manufacturer add the use of GA3 on avocado to an existing GA3 label. Similarly, since an exemption for use of BA on apple and pistachio is under consideration, it may be possible to include avocado once efficacy requirements are met. Additionally, manufacturers of GA3 and BA are showing interest in our results but obviously must wait for the efficacy data demonstrating a dose response and reproducibility in a second orchard. Within 3 to 4 years one or more PGR should be available for use in commercial avocado production in California.

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Chapter 17 Avocado Production in Other States, Florida, Texas, Hawaii, Puerto Rico.

Florida Avocado Production
https://www.flgardening.com/growing-avocados-in-florida/

Avocados grow best in warm climates. The southern and central parts of the state will have the best luck growing avocado trees. Those in north Florida will have to provide protection and choose cold-tolerant varieties. These can become large trees. Plant in an area with enough space, full sun, and well-draining soil. Avocados don't mind Florida's natural soil.

Avocados are tropical plants and prefer warm weather, rain and lots of sun. Most of Florida has plenty of this. There are a lot of varieties of avocados that we can grow here in Florida, your standard 'Hass' avocado is just the tip of the iceberg.

University of Florida growing avocados - Search (bing.com)
CIR1034/MG213: Avocado Growing in the Florida Home Landscape (ufl.edu)

AVOCADO GROWING IN THE FLORIDA HOME LANDSCAPE

Jonthan H. Crane, Carlos F. Balerdi, and Ian Maguire

Scientific Name: *Persea americana* Miller

Common Names: avocado, avocado-pear, aguacate (Spanish)

Family: Lauraceae

Origin: Avocados are indigenous to tropical America. Three ecological races—Mexican, Guatemalan, and West Indian—are recognized.

Distribution: Avocados are grown in tropical and subtropical areas of the world. In Florida, commercial production is primarily in Miami-Dade and Collier Counties, however, small plantings and isolated trees are found in warm locations throughout the state.

History: Avocados have been cultivated in tropical America since pre-Columbian times. The first recorded importation into Florida was in 1833 and into California in 1856.

Importance: One of the important fruits in the American tropics, the avocado is grown commercially in many areas of the world including Mexico, Brazil, Dominican Republic, Australia, Israel, Chile, tropical Africa, Spain, and Indonesia. In the U.S. avocados are produced in California, Florida, Puerto Rico, Hawaii, and Texas.

https://blogs.ifas.ufl.edu/stlucieco/2021/08/03/growing-avocado-in-florida/

Growing Avocado in Florida

Scientific Name: Persea americana Miller

Common Names: avocado, avocado-pear, aguacate (Spanish)

Origin: Avocados originated from tropical America. However, we have three ecological races: Mexican, Guatemalan, and West Indian.

Climate: Avocado best grows in tropical and subtropical areas of the world. In Florida, commercial growers can be seen in Miami-Dade and Collier Counties, however, isolated trees are in warm locations throughout the State. In general, avocado likes warm areas such as the southeast and southwest coasts of Florida. If you live in south Florida, West Indian varieties are best adapted to a tropical climate and frost-free areas of the subtropics. Mexican and Guatemalan x Mexican varieties can tolerate cold climates better than West Indian varieties.

Cold Hardy Florida Avocados for Northern Florida https://floridafruitgeek.com/cold-hardy-avocados/

Holland (Opal, Lila) Cold hardy.

Del Rio Hardy to 15 F.

May Cold hardy.

Wilma (Brazos Belle) Cold hardy. 15 F.

Gloria Cold hardy.

Gainesville Cold hardy.

Hybrids (Mex X West Indian):

Brogden - Cold Hardy. 26-28 F.

Winter Mexican - Cold hardy. Low 20’s F.

Other Cold Hardy Varieties: ‘Martin‘, ‘Joey‘, ‘Poncho‘/’Pancho’, ‘U-la-la‘, ‘Mexicola‘, and ‘Mexicola Grande‘. They will add to website later.

Joey. Cold Hardy. 15 F.

Mexicola Hardy to 20 F.

Mexicola Grande Hardy to 20-22 F.

Lula 27 F.

https://blogs.ifas.ufl.edu/stlucieco/2021/08/03/growing-avocado-in-florida/

Varieties: Cold tolerant varieties: Brogdon, Tonnage, Lula, Marcus, Hall, Monroe, Reed, Brookslate. Recommended for home planting: Donnie, Dupuis, Simmonds, Nadir, Russell, Brogdon, Monroe, Brookslate, Reed, Booth 7. Reed is not cold tolerant (McNeil, Personal comment. 2024).

Propagation: Avocado must be propagated vegetatively (grafting). Cleft grafting and veneer grafting are two preferred methods in Florida. The best time for grafting is during cooler months from November through February. Typically, seedlings of 'Lula' and 'Waldin' are used as rootstocks in Florida.

Fertilizer: Young trees should be fertilized every 1 to 2 months during the first year. You can start with ¼ lb of fertilizer and increase it to 1 lb per tree. For older trees, 3 or 4 applications per year in amounts proportionate to the increasing size of the tree are sufficient. One available fertilizer mix for avocado is 6-6-6-2 (N- P- K- MG).

Irrigation: Newly planted avocado trees should be well watered every other day for the first week. Mature trees should be watered more often during prolonged dry periods.

Florida Avocado Cultivars

https://blogs.ifas.ufl.edu/stlucieco/2021/08/03/growing-avocado-in-florida/

Varieties: Cold tolerant varieties: Brogdon, Tonnage, Lula, Marcus, Hall, Monroe, Reed, Brookslate. Recommended for home planting: Donnie, Dupuis, Simmonds, Nadir, Russell, Brogdon, Monroe, Brookslate, Reed, Booth 7.

Note: Reed is not cold tolerant, sensitive at 30 F. (R. McNeil, personal comment, 2024.)

Lula freezes at 27 F.

Brogdon at 26-28 F.

Florida Avocado Cultivars

Commercial Cultivars: Brogdon, Tonnage, Lula, Marcus, Hall, Monroe, Reed, Brookslate. Recommended for home planting: Donnie, Dupuis, Simmonds, Nadir, Russell, Brogdon, Monroe, Brookslate, Reed, Booth 7.

Brogdon

Tonnage

Lula

Marcus

Hall

Monroe

Reed

Brookslate

Key for next two tables:

1 Race: W--West Indian; G--Guatemalan; M--Mexican; CH--Complex Hybrid.

2 Season of maturity may not correspond with legal maturity.

3 Cold tolerance rating.

4 Scab susceptibility: R--resistant; MS--moderately susceptible; S--susceptible.

5 Recommendation for home planting: Y, yes; N, no, and M, maybe.

6 'Lula' is susceptible to scab however in the home landscape this may not be a problem.

Recommended for Home Planting

Donnie
Dupuis
Simmonds
Nadir
Russell
Brogdon
Monroe
Brookslate
Reed
Booth 7

Key for next two tables:
1 Race: W--West Indian; G--Guatemalan; M--Mexican; CH--Complex Hybrid.
2 Season of maturity may not correspond with legal maturity.
3 Cold tolerance rating.
4 Scab susceptibility: R--resistant; MS--moderately susceptible; S--susceptible.
5 Recommendation for home planting: Y, yes; N, no, and M, maybe.
6 'Lula' is susceptible to scab however in the home landscape this may not be a problem.

Variety	Race[1]	Season of maturity[2]	Flower type	Fruit wt. (oz)	Fruit color	Cold tol.[3]	Production	Scab susc.[4]	Rec.[5]
Donnie	W	May 21 -- June 31	A	12--20	Green	Low	Moderate	R	Y
Dupuis	W	June 15 -- July 31	A	12--24	Green	Low	Low	R	Y
Simmonds	W	June 25 -- Sept. 15	A	16--34	Green	Low	Moderate	R	Y
Nadir	GW	July 1 -- Aug. 15	A	10--22	Green	Low	Moderate	R	Y
Russell	W	July 1 -- Aug. 31	A	16--24	Green	Low	Moderate	R	Y
Brogdon	CH	July 15 -- Sept. 15	B	8--12	Purple	High	Moderate	MS	Y
Brookslate	GW	Jan. 14 -- March 7	A	10--22	Green	High	High	R	Y
Reed	G	Dec. 14 -- March 7	A	8--18	Green	Moderate	High	R	Y
Booth7	GW	Oct. 15 -- Dec. 15	B	10--20	Green	Moderate	High	MS	Y
Monroe	GW	Dec. 1 -- Feb. 15	B	24--40	Green	Moderate	High	MS	Y

Variety	Race[1]	Season of maturity[2]	Flower type	Fruit wt. (oz)	Fruit color	Cold tol.[3]	Production	Scab susc.[4]	Rec.[5]
Brogdon	CH	July 15 -- Sept. 15	B	8--12	Purple	High	Moderate	MS	Y
Tonnage	G	Sept. 15 -- Oct. 15	B	14--24	Green	High	Moderate	MS	N
Lula[6]	GW	Oct. 1 -- Feb. 15	A	14--24	Green	High	High	S	M
Marcus	GW	Oct. 15 -- Nov. 30	B	18--48	Green	High	Moderate	R	N
Hall	GW	Nov. 15 -- Feb. 1	A	12--18	Green	High	Low	MS	N
Monroe	GW	Dec. 1 -- Feb. 15	B	24--40	Green	Moderate	High	MS	Y
Reed	G	Dec. 14 -- March 7	A	8--18	Green	Moderate	High	R	Y
Brookslate	GW	Jan. 14 -- March 7	A	10--22	Green	High	High	R	Y

Florida Commercial Cultivars next eight slides.

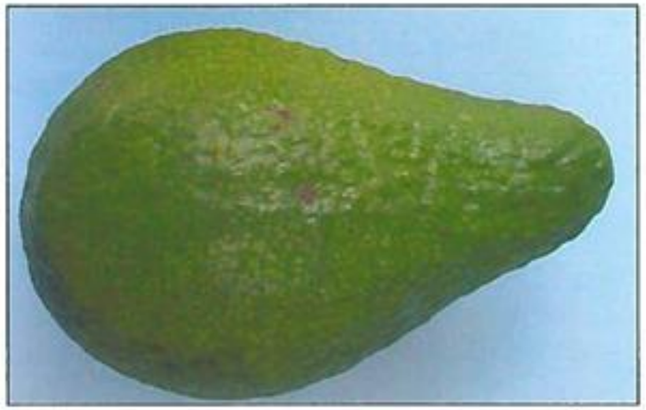
Brogdon
Tonnage
Lula
Marcus
Hall
Monroe
Reed
Brookslate

Brogdon (purple) avocado. 8-12 oz. Smooth skin. 26-28 F cold tolerance. Moderate production. B type flower.

(https://floridafruitgeek.com/cold-hardyavocados/)(https://shuncy.com/article/brogdon-avocado-tree)

Tonnage.
14-24 oz. Dark Green. Slightly rough. Moderate Production. B type flower. High cold tolerance. (Floridaavocadovarieties.pdf)(USDA)

Variety: TONNAGE



Size: medium; **Shape:** pear with neck; **Stem Attachment:** centered, thin and always has a slight indentation like a V; **Skin:** dark green, slightly rough, some yellow streaks; **Pulp:** moderately thin, greenish yellow; **Seed:** medium large, loose; **Season:** August - September

Lula.
14-24 oz. Green.
Slightly rough.
Cold tolerant,
27 F.
A type flower.
High production.
(FloridaAvocadoVarieties.pdf)(USDA)

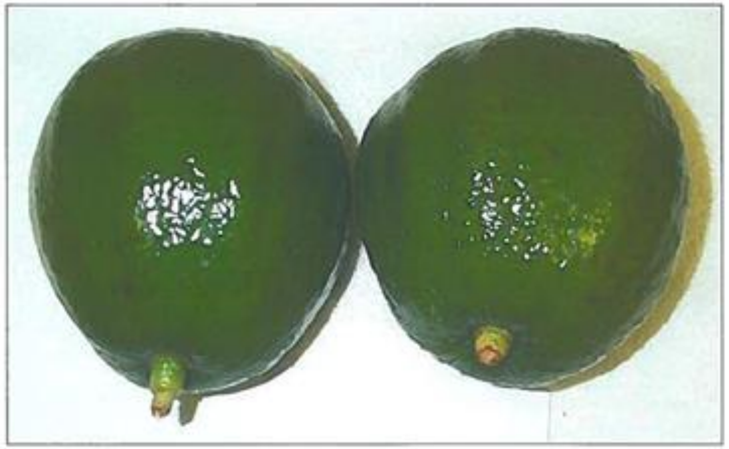
Variety: LULA

Size: medium; **Shape:** pear, short neck;
Stem Attachment: centered, thin; **Skin:** dark green, slightly rough; **Pulp:** greenish yellow, thin; **Seed:** tight to slightly loose;
Season: October - January

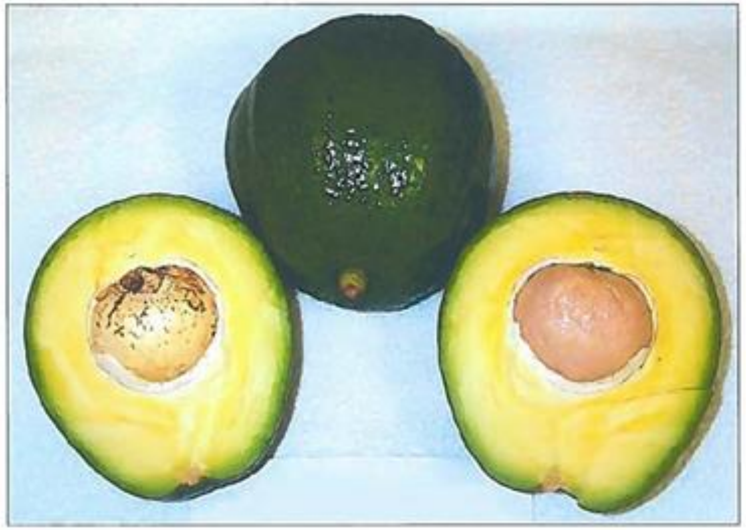
Lula Avocado. Green. Slightly rough. Cold tolerant. 27 F. A type flower. High production. 14-24 oz (Bing.com)

Marcus. Cold tolerant. 18-48 oz. Green. Slightly rough.
B type flower.
(FloridaAvocadoVarieties.pdf)(USDA)

Variety: MARCUS



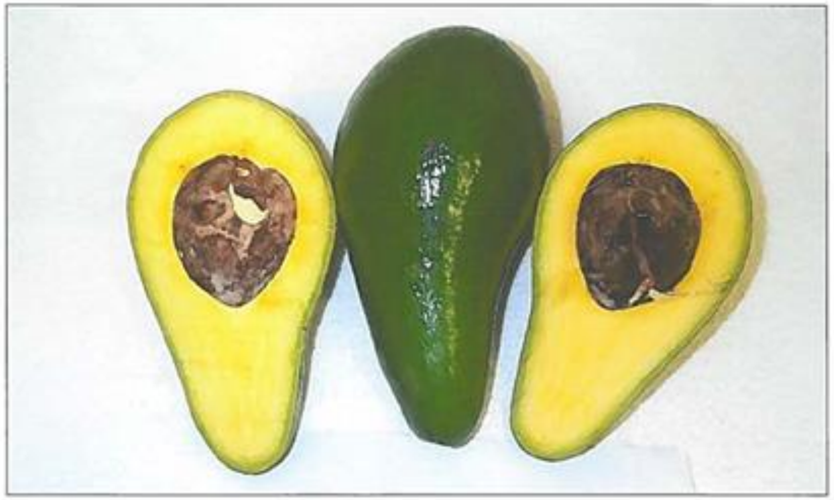
Size: very large (can weigh up to 4 lbs.);
Shape: oval; **Stem Attachment:** centered, thick;
Skin: dark green, with ribs, slightly rough;
Pulp: yellow and very thick; **Seed:** small tight seed for its size;
Season: September - November



Hall. 12-18 oz.
Green. Smooth.
Cold tolerant.
Low production.
A type flower.
(FloridaAvocadoVarieties.pdf)(USDA)

Variety: HALL

Size: large; **Shape:** long necked pear;
Stem Attachment: offset, thick; **Skin:** dark green, smooth;
Pulp: thick and yellow; **Seed:** medium, tight;
Season: October - December



Brookslate.
10-22 oz. Green.
Rough. Cold
tolerant. High
production.
A type flower.
(Floridaavocadova
rieties.pdf)(USDA)

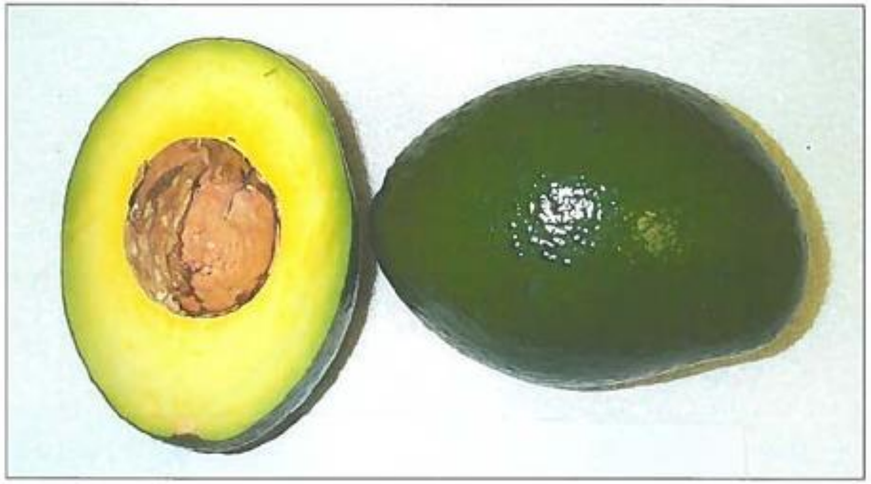
Variety: BROOKS LATE

Size: Large; **Shape:** round, blossom end off set;
Stem Attachments: centered to medium; **Skin:** green, rough;
Pulp: very yellow; **Seed:** large, tight;
Season: December - February

Monroe.
24-40 oz. Green.
Slightly rough.
Moderate cold tolerance. High production.
B type flower.
(FloridaAvocadoVarieties.pdf)(USDA)

Variety: MONROE

Size: large; **Shape:** oval; **Stem Attachment:** offset, thick, blossom end squared off; **Skin:** dark green to green, slightly rough; **Pulp:** yellow, thick; **Seed:** small, tight; **Season:** November - January

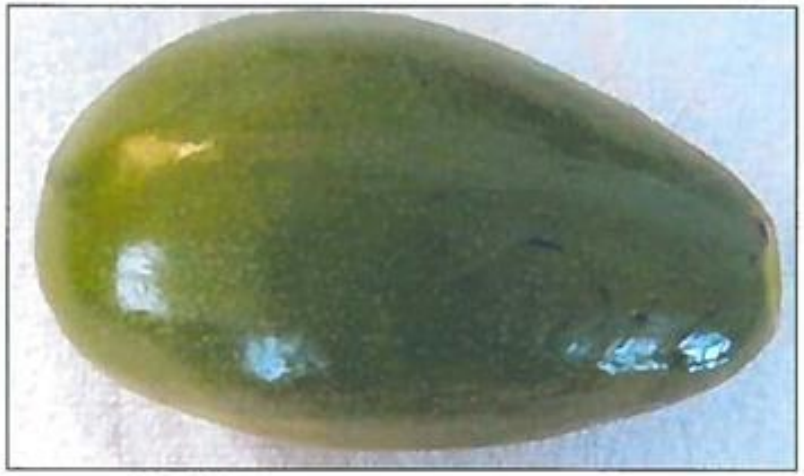


Reed Avocado
8-18 oz Green.
Slightly pebbly.
Productive.
Tender to frost,
30 F. A type
flower.
(Bing.com)

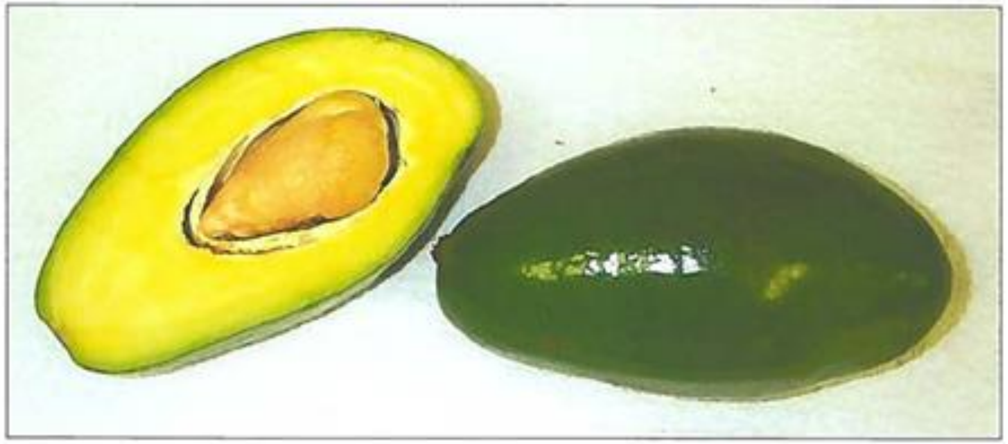
Recommended for Home Planting in Florida. Next 10 slides.

Donnie.
12-20 oz/ Green.
Smooth. Low cold tolerance.
Moderate production.
A type flower.
(FloridaAvocadoVarieties.pdf)(USDA)

Variety: DONNIE

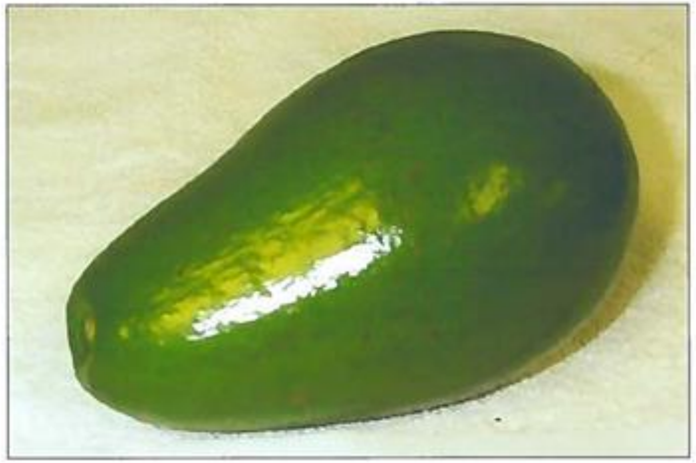


Size: large; **Shape:** elongated pear, stem offset;
Stem Attachments: offset, medium; **Skin:** green, smooth;
Pulp: medium yellow; **Seed:** medium, slightly loose;
Season: May thru mid August



Dupuis.
12-24 oz.
Green. Smooth.
Low cold tolerance. Low production.
A type flower.
(FloridaAvocadoVarieties.pdf)(USDA)

Variety: DUPUIS

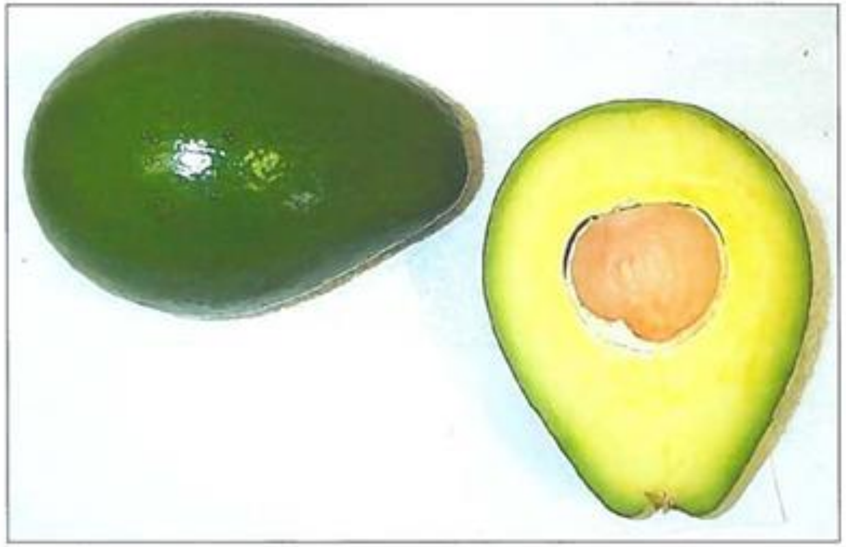


Size: large; **Shape:** elongated pear; **Stem Attachment:** offset, medium thin; **Skin:** smooth, green; **Pulp:** medium, deep yellow; **Seed:** medium fair, slight or slightly loose; **Season:** June - August

Nadir.
10-22 oz. Green.
Fairly rough. Low cold tolerance.
A type flower.
Moderate production.
(FloridaAvocadoVarieties.pdf)(USDA)

Variety: NADIR

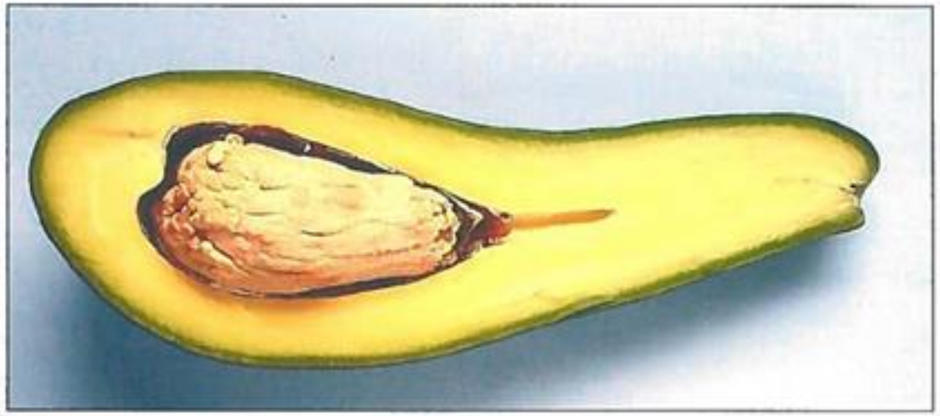
Size: small, medium to slightly large; **Shape:** egg shaped pear; **Stem Attachment:** offset, medium thick; **Skin:** dark green, fairly rough; **Pulp:** light yellow or yellow thick; **Seed:** small, tight; **Season:** June - September



Russell.
16-24 oz. Green.
Smooth. Low cold
tolerance.
Moderate
production.
A type flower.
(FloridaAvocadoVarieties.pdf)(USDA) .

Variety: RUSSELL

Size: large; **Shape**: very long, thick necked pear; **Skin**: green and smooth; **Pulp**: thick at neck, yellow; **Stem Attachment**: thin centered; **Seed**: medium, long, pointed, slightly loose to tight; **Season**: July, August



Simmonds. 16-34 oz. Green. Smooth. Low cold tolerance. Moderate production. A type flower. (FloridaAvocadoVarieties.pdf)(USDA) .

Variety: SIMMONDS

Size: large; **Shape:** thick necked pear;
Stem Attachment: offset, thin;
Skin: green to light green, smooth;
Pulp: yellow, medium thick; **Seed:** medium, loose;
Season: June - August

Brogdon (purple) avocado. 8-12 oz. Smooth skin. 26-28 F cold tolerance. Moderate production. B type flower.

(https://floridafruitgeek.com/cold-hardyavocados/)(https://shuncy.com/article/brogdon-avocado-tree)

Brookslate.
10-22 oz.
Green. Rough.
Cold tolerant.
High production.
A type flower.
(Floridaavocadovarieties.pdf)(USDA)

Variety: BROOKS LATE

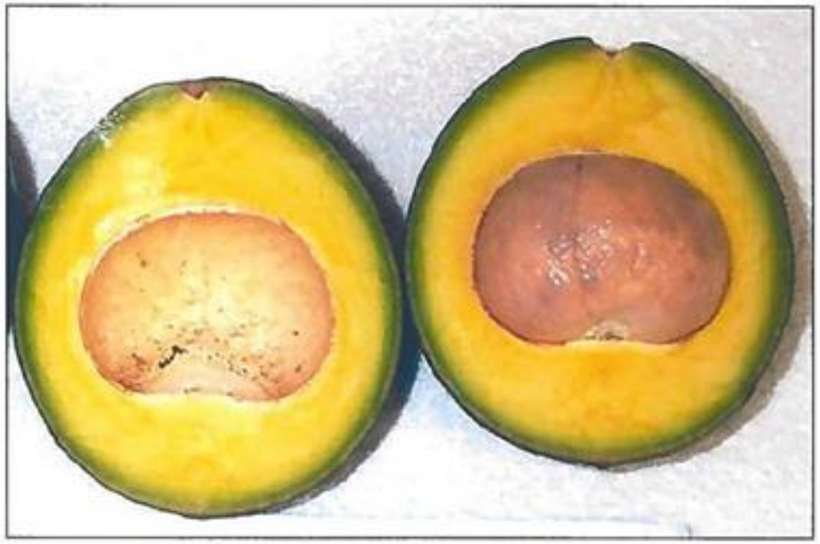
Size: Large; **Shape:** round, blossom end off set;
Stem Attachments: centered to medium; **Skin:** green, rough;
Pulp: very yellow; **Seed:** large, tight;
Season: December - February

Reed Avocado
8-18 oz Green.
Slightly pebbly.
Productive.
Tender to frost,
30 F. A type
flower.
(Bing.com)

Booth 7.
10-20 oz. Green.
Slightly rough.
Moderate cold tolerance. High production.
B type flower.
(Floridaavocadovarieties.pdf)(USDA)

Variety: BOOTH 7

Size: medium; **Shape:** rounded; **Stem Attachment:** centered, medium thick; **Skin:** dark green, slightly rough;
Pulp: yellow, medium thick; **Seed:** medium tight & wide;
Season: October - December

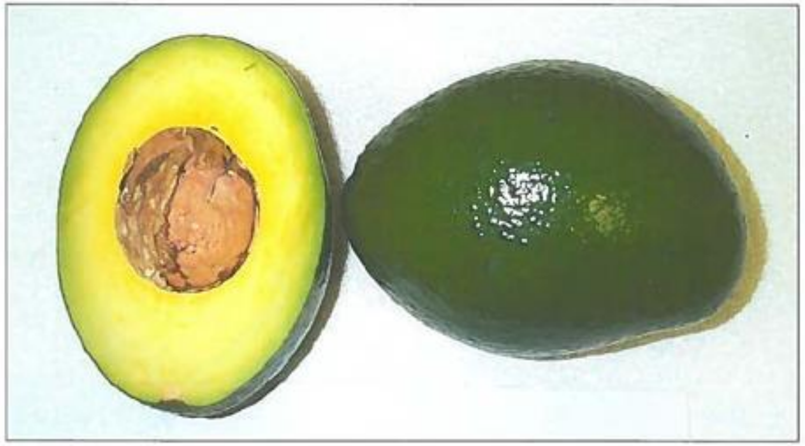


Monroe.

24-40 oz. Green. Slightly rough. Moderate cold tolerance. High production.
B type flower.
(FloridaAvocadoVarieties.pdf)(USDA)

Variety: MONROE

Size: large; **Shape:** oval; **Stem Attachment:** offset, thick, blossom end squared off; **Skin:** dark green to green, slightly rough; **Pulp:** yellow, thick; **Seed:** small, tight; **Season:** November - January



Cold Hardy Florida Avocados for Northern Florida https://floridafruitgeek.com/cold-hardy-avocados/

Holland (Opal, Lila) Cold hardy.

Del Rio Hardy to 15 F.

May Cold hardy.

Wilma (Brazos Belle) Cold hardy. 15 F.

Gloria Cold hardy.

Gainesville Cold hardy.

Hybrids (Mex X West Indian):

Brogden - Cold Hardy. 26-28 F.

Winter Mexican - Cold hardy. Low 20's F.

Other Cold Hardy Varieties: 'Martin', 'Joey', 'Poncho'/'Pancho', 'U-la-la', 'Mexicola', and 'Mexicola Grande'. They will add to website later.

Joey. Cold Hardy. 15 F.

Mexicola Hardy to 20 F.

Mexicola Grande Hardy to 20-22 F.

Lula 27 F.

Holland Avocado (Opal/Lila). 7 oz. Green. Smooth. Cold hardy.

(https://floridafruitgeek.com/cold-hardy-avocados/)

Holland Avocado (Opal/Lila). 7 oz. Green. Cold Hardy. (https://floridafruitgeek.com/cold-hardy-avocados/)

Medium sized, pear-shaped fruits, about 7 oz (200 g) that stay green at maturity. This variety was selected in Texas, where it has long been named either 'Opal' or 'Opal Holland'. At some point a large commercial nursery started propagating this variety and gave it their own name: 'Lila'. This variety has some of the largest fruits of any of the Mexican types we grow here in North Florida, with good size, flavor, and seed-to-flesh ratio. Fruits are somewhat susceptible to anthracnose in this area, which causes sunken black spots on the fruits that need to be cut out before serving.

Fruiting season for 'Opal' in North Florida is July to September.

Del Rio (Pryor, Fantastic) Avocado Cold hardy. 15 F. Green. 3-4 oz. Mild anise taste.

(https://floridafruitgeek.com/cold-hardy-avocados/)

Del Rio Avocado (Pryor, Fantastic). Green. Hardy to 15 F. 3-4 oz. Mild anise taste.

(https://floridafruitgeek.com/cold-hardy-avocados/)

‘Del Rio’ trees have a particularly upright growth habit, and can grow into very tall trees, which can make fruit harvesting a challenge. Regular pruning to maintain height can keep the fruits within easy reach for harvesting. Fruiting season is July through October around here in North Florida.

‘Del Rio’ has smaller, rounded to pear-shaped fruits that stay green at maturity. Fruit size is three to four ounces (80-110 grams). All the Mexican breeds of avocado have a high oil content and rich flavor, but ‘Del Rio’ seems to have the highest oil content and richest flavor of the bunch.

‘Del Rio’ seems to be the most cold-tolerant of any of these varieties – we’ve seen trees of this cultivar handle freezes of about 15F (-9C) with little damage, and they still produced a crop of fruit the next year. The original tree is located in Del Rio, Texas.

It has a mild anise taste.

May Avocado. 4-5 oz. Cold hardy. Black. Crack at the base. Uneven ripening.

(https://floridafruitgeek.com/cold-hardy-avocados/)

May Avocado. Black. 4-5 oz. Cold Hardy. Crack at the base. Uneven ripening.

https://floridafruitgeek.com/cold-hardy-avocados/

‘May’ fruits are medium-sized, 4-5 ounces (110-140g), oval to pear-shaped, turn black at maturity, and have excellent flavor.

Occasionally, ‘May’ fruits develop cracking at the base of the fruit, which can cause uneven ripening – the bottom of the fruit gets ripe and soft while the top is still firm. That might be related to the conditions of extreme humidity in our area (North Florida).

Fruiting season for ‘May’ here is July to September.

Wilma (Brazos Belle). Black. Cold Hardy. 15 F. Long neck. Susceptible to anthracnose. Fruit drop. Productive.

https://floridafruitgeek.com/cold-hardy-avocados/

‘Wilma’ has long, skinny fruits that turn black at maturity. Trees of this variety grow well here in North Florida and sets lots of fruit, but the fruits seem particularly susceptible to anthracnose, which makes most of the fruits drop off prior to maturity. ‘Wilma’ might be better suited to climates with drier, less humid summers than we experience here in North Florida. We do get some fruits of this type to ripen here, and they are rich and tasty.

Like other Mexican types, the tree’s leaves smell like licorice. People have grown this variety locally in Texas for many years under the name ‘Wilma’, but in the last decade a big nursery started propagating this type and selling the trees to big-box stores under their own trademarked name, ‘Brazos Belle,’ so you can sometimes find it under that name – but it is ‘Wilma’.

Unlike most other Mexican varieties, in ‘Wilma’ fruits the seed tends to be loose inside the fruit, so if you shake the fruits you can hear the seed rattling inside. Fruiting season for ‘Wilma’ is September.

Wilma avocado (Homesteadandchill.com)

Wilma (Brazos Belle) Avocado. Cold hardy. 15 F. Black. Long neck. Productive. Susceptible to anthracnose. Fruit drop. https://floridafruitgeek.com/cold-hardy-avocados/ Bing.com

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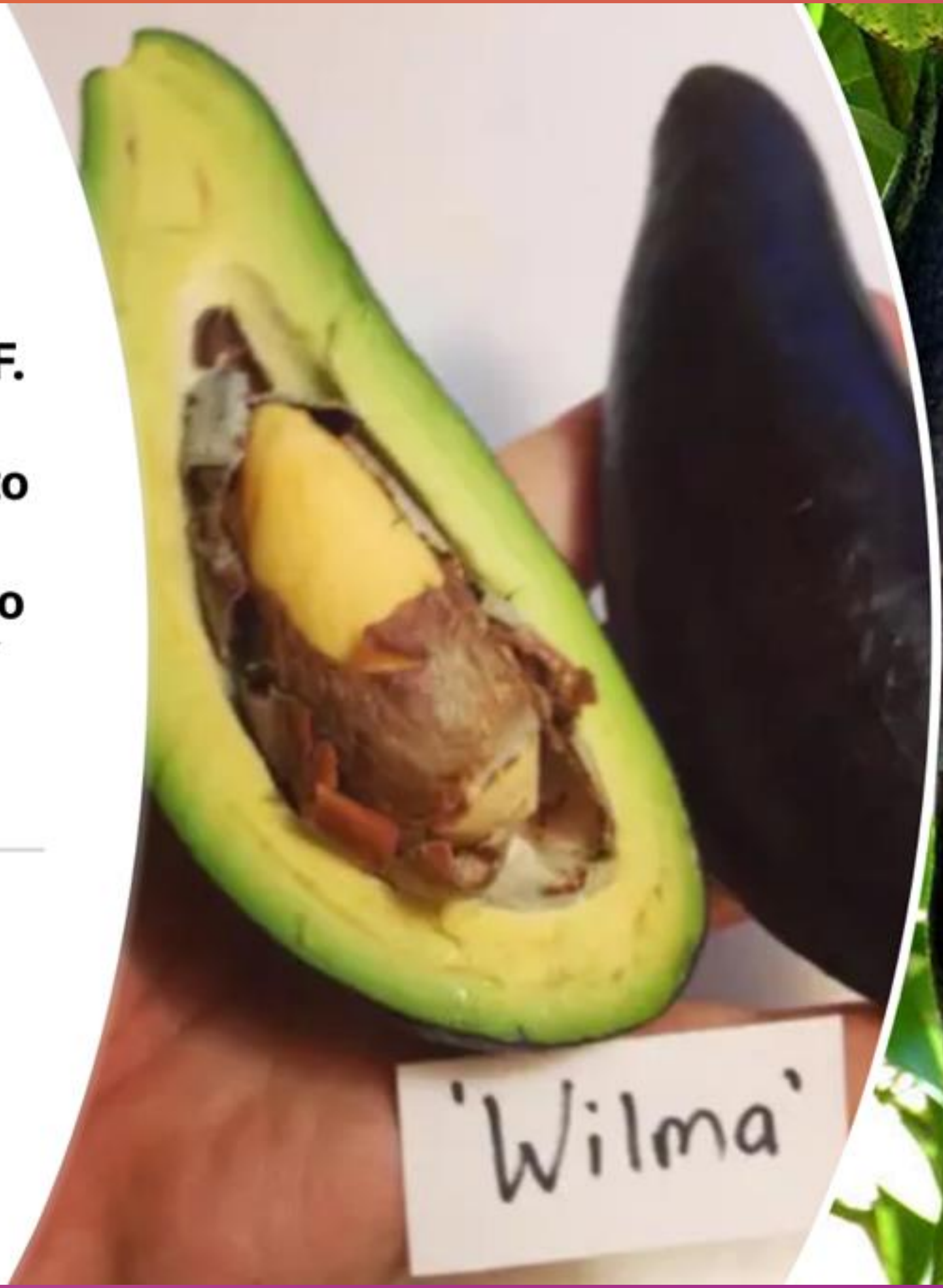


Gloria Avocado. 3 oz. Smooth skin. Cold hardy. Black. Early maturity (mid June).

https://floridafruitgeek.com/cold-hardy-avocados/

Gloria Avocado. Black. 3 oz. Smooth skin. Cold Hardy. Early maturity (Mid June).

https://floridafruitgeek.com/cold-hardy-avocados/

‘Gloria’ is a new avocado variety grown from a seedling of a ‘Gainesville’ tree growing in the vicinity of a ‘May’ tree. Since ‘Gainesville’ has green fruits, while ‘May’ has black-skinned fruits, and the seedling variety ‘Gloria’ has black-skinned fruits, this is apparently a cross between ‘Gainesville’ and ‘May’. Fruits are smallish, 3 ounces (84 grams), completely oval, and have good flavor. ‘Gloria’ is distinctive in being the earliest variety we know of here in North Florida, with fruits starting to ripen in mid-June.

Gainesville Avocado. Cold hardy. Green. Slightly rough. Small fruit.

https://floridafruitgeek.com/cold-hardy-avocados/

Gainesville Avocado. Green. Slightly rough. Cold hardy. Small fruit.

https://floridafruitgeek.com/cold-hardy-avocados/

‘Gainesville’ avocado has small, oval-shaped fruits that stay green at maturity. Flavor is good, but not spectacular. This variety is well-known because for many years a tree of this type grew outside McCarty Hall on the campus of the University of Florida in Gainesville. Many people got to see and taste “the avocado that fruits in Gainesville”, and the variety found its way into the nursery trade. But we now have lots of avocado varieties that can make fruit in the Gainesville area, and most of the ones on this page make larger, better fruit than ‘Gainesville’. (The original tree was broken off by the hurricanes of 2004. It started to re-sprout, but grounds keepers dug out the sprouting stump and replaced it with an oak tree. The campus tree person later apologized for the removal of this famous tree.)

Note: Since I wrote the above description of this variety, someone contacted me to say that he’d heard that avocado variety ‘Gainesville’ actually was propagated from a different tree, located near Hume Library on the campus of UF in Gainesville, that this tree may still be there, and it may possibly have different shaped fruits than the ones in the picture.

Brogden Avocado. 8-12 oz. Smooth skin. Hardy to 26-28 F. Purple/Black. Moderate production. B type flower.

https://floridafruitgeek.com/cold-hardy-avocados/

Brogden (Brogdon) Avocado. 8-12 oz. Smooth skin. Hardy to 26-28 F. Purple/Black. Moderate production. B type flower.

https://floridafruitgeek.com/cold-hardy-avocados/

‘Brogden’ avocados have a smooth-as-silk flesh unlike other avocados, and a high oil content that gives them the rich flavor characteristic of Mexican and Guatemalan varieties. ‘Brogden’ is an avocado-lover’s avocado. While the other avo varieties I’ve been profiling here are pure Mexican subspecies, ‘Brogden’ is a cross between Mexican and West Indies types. So the skin on this one is a little thicker than the skin on pure Mexican varieties, and the tree can take a hard freeze, but not quite as much cold as the pure Mexi-cados like ‘Del Rio’. But Brogden fruits get larger than the pure Mexican types, up to at least 10 (8-12) ounces (280g). This variety seems like an extremely promising market fruit both for existing avocado-growing territory, and also for areas slightly too cold to grow commercial avocados.

Winter Mexican Avocado. Purple-black. Medium sized. Smooth skin. Cold hardy. Low 20's F. (https://floridafruitgeek.com/cold-hardy-avocados/)

Winter Mexican Avocado. Purple/Black. Medium sized. Smooth skin. Hardy to low 20’s F.

(https://floridafruitgeek.com/cold-hardy-avocados/)

Not of pure Mexican subspecies parentage: it’s a hybrid between the Mexican and West Indies types. So it does not have the full cold hardiness of the Mexican cultivars. If your area is subject to winter lows that dip down to 20F (-7C) or colder, you really want the cold hardiness of the pure Mexican subspecies. ‘Winter Mexican’ has gotten distributed in the nursery trade and sold in the Gainesville (North Florida) area. I’ve spoken to more than one person around here who said, “I planted one of those supposedly cold-hardy Mexican avocado trees, and it froze!” In each case, it turned out that what they had planted was ‘Winter Mexican’. In North Florida and similar climate zones, nurseries should be selling avocado varieties that have pure Mexican parentage – a glance at this page will show there’s lots to choose from.

Mexicola Grande (Bing.com). Cold hardy. 20-22 F. Black. Smooth skin. 6-7 oz. Productive. A flower type.

Mexicola Grande Avocado. 6-7 oz. Smooth skin. Black. Hardy 20-22 F. A flower type.

(https://www.louiesnursery.com/plants/avocado-trees/mexicola-grande-avocado/) Cold hardy. Productive.

The Mexicola Grande avocado is one of the most frost-resistant of all avocado varieties (20-22 F). This high quality, black-skinned avocado is up to 25% larger than its parent, Mexicola. The trees have a tall, upright spreading habit. This variety is productive in both coastal and inland areas of California.

The fruit ripens from August through October in California. The fruit is easy to peel.

Mexicola (UCR)
(Photo: Etsy.com)

Parentage: Mexican
Peels: No
Seed Size: Large
Skin Texture: Smooth
Blossom Type: A
Fruit Shape: Obovate
Skin Color Unripe: Black
Skin Color Ripe: Black
Skin Thickness: Thin
Average Fruit Weight oz: 4 to 6.5
%Ratio Seed/Skin/Flesh: 27:12:61

Mexicola. (https://avocado.ucr.edu/variety-list#mexicola)

(https://avocado.ucr.edu/avocado-variety-database)

Mexican varieties have an anise smell to the leaves. This is a very typical Mexican variety. Season Aug-Oct.

Parentage: Mexican

Peels: No

Seed Size: Med-Large

Skin Texture: Smooth

Blossom Type: A

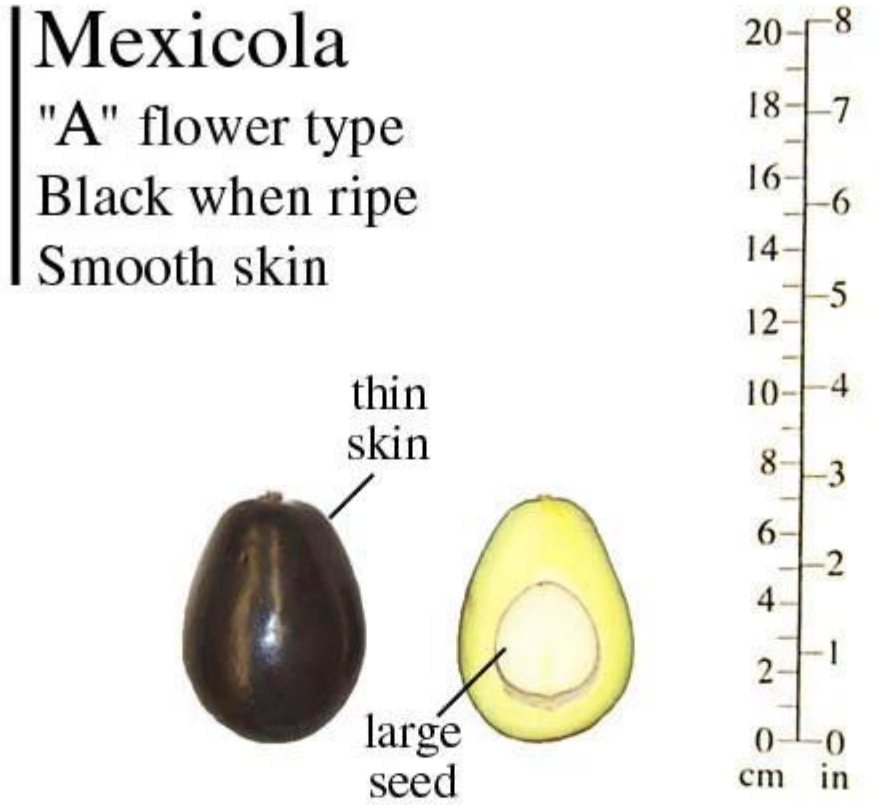
Fruit Shape: Obovate

Skin Color Unripe: Black

Skin Color Ripe: Black

Skin Thickness: Thin

Average Fruit Weight oz: 4 to 6.5



Mexicola. Mexican.

(https://avocado.ucr.edu/avocado-variety-database)

(https://avocado.ucr.edu/variety-list#mexicola)

Flower Type A   Fruit Color Black   Ecotype Mex

Orig. about 1910 as seedling at Coolidge Rare Plant Gardens, Pasadena, CA, propagated about 1912. One of the first varieties to be commercial, planted by Mr. Henry Huntington around 1915-17.

Tree resistant to heat & cold & consistent bearer, seed in demand for rootstocks.

Fruit season, Aug.-Oct.; weight, 3-6.5 ozs.; shape, spherical to pyriform; skin, thin, smooth; flavor, excellent. Seed med-lg. Often loose in the cavity. Keeping & shipping qualities, poor.

Difficult to peel. It has an anise flavor & is quite good tasting.

Appears to be resistant to Persea Mite.

Grown only in home gardens in CA.

Much used as a parent in CA breeding programs.

Mexicola Avocado. Black. Cold hardy. 20 F. A flower type. (UCR)

		4-6.5 oz					Seed				
Mexicola	Mexican	purple	Very smooth	Very thin	good	Anise-like	large	consistent	A	20 F	Aug-Oct

Joey.
Cold hardy.
15 F.
Productive.
Black. Looks
like Hass.
Slightly
larger.
(Bing.com)

Joey

Lula.
14-24 oz. Green.
Slightly rough.
Cold tolerant,
27 F.
A type flower.
High production.
(FloridaAvocadoVarieties.pdf)(USDA)

Variety: LULA

Size: medium; **Shape:** pear, short neck; **Stem Attachment:** centered, thin; **Skin:** dark green, slightly rough; **Pulp:** greenish yellow, thin; **Seed:** tight to slightly loose; **Season:** October - January

Lula Avocado. Green. Slightly rough. Cold tolerant. 27 F. A type flower. High production. 14-24 oz (Bing.com)

https://blogs.ifas.ufl.edu/stlucieco/2021/08/03/growing-avocado-in-florida/

Pest and disease: One of the major diseases of avocado in Florida is Laurel Wilt (LW). Early symptoms of LW are green wilted canopies which are particularly suspect if the symptomatic tree is located next to or near a completely desiccated, declining or dead tree. Other pests and diseases include avocado root rot, powdery mildew, anthracnose, avocado scab. Insects that may also impact trees include avocado looper, scale, red mites, and borer.

Laurel Wilt in Florida. (https://edis.ifas.ufl.edu/publication/HS1360)

There are no avocado varieties resistent to Laurel Wilt.

The LW susceptibility of 24 container-grown avocado cultivars of varied genetic backgrounds was tested, and those of Guatemalan × Mexican background (e.g., 'Hass', 'Winter Mexican') were less quickly affected by LW inoculation than avocado cultivars of Guatemalan × West Indian (e.g., 'Miguel') background, which were less quickly affected than West Indian (e.g., 'Simmonds' and 'Donnie') cultivars (Ploetz et al. 2011c). This suggests there may be some variability in how rapidly symptoms of LW progress dependent upon genetic background. In addition, symptom severity was positively correlated with plant size; larger plants declined more rapidly to infection by the LW pathogen than smaller plants.

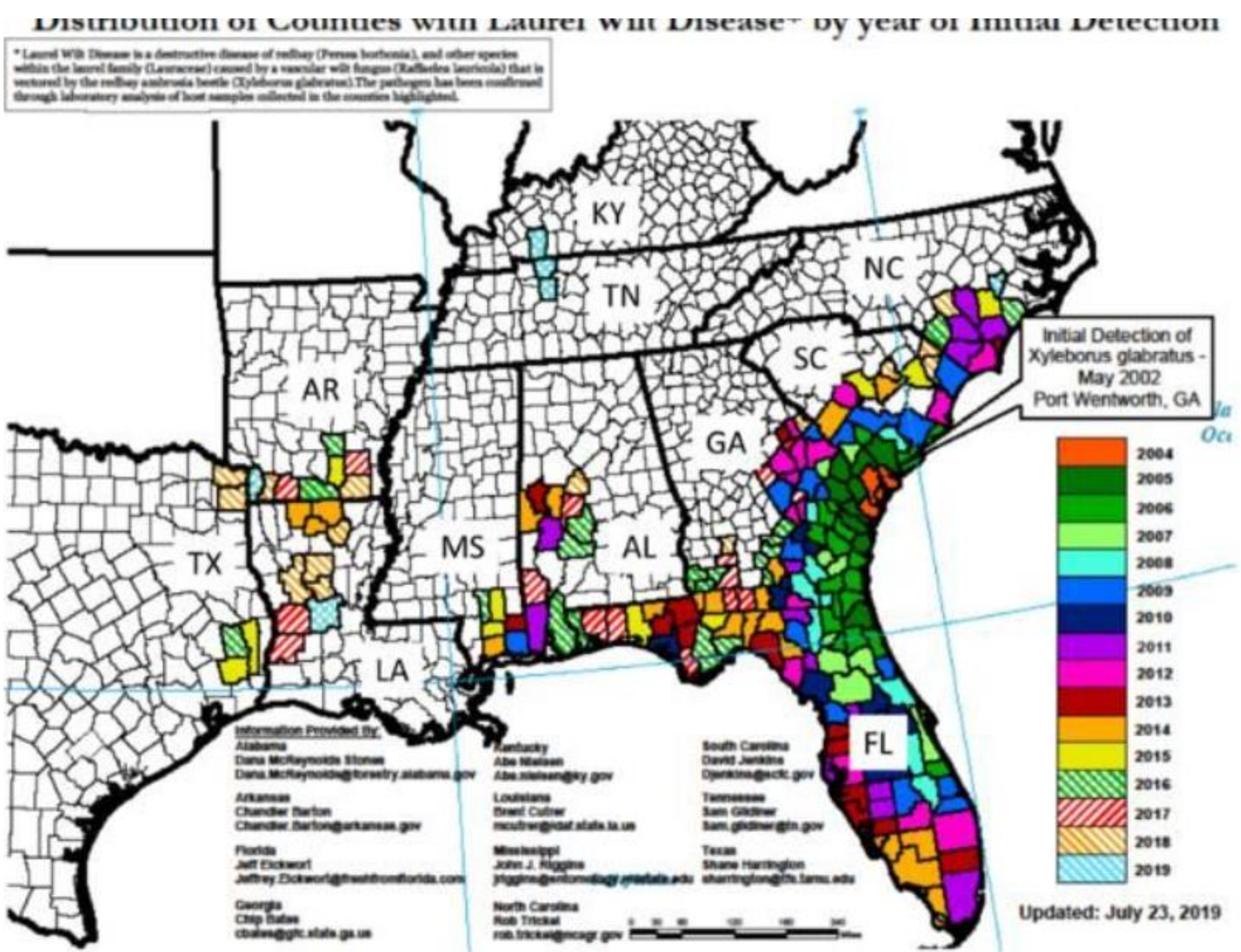


Figure 1. Map of current laurel wilt detection. Present in 11 southeastern US states, including Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Texas. Credit: US Forest Service.

Laurel Wilt Areas

At present LW has been detected in 11 southeastern US states, including Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Texas (Figure 1; US Forest Service 2019), and in all of Florida's 67 counties. Laurel wilt is now endemic in the avocado production area of Miami-Dade County. There is great risk for introduction of LW into California, Mexico, and Central and South America through natural spread of the redbay ambrosia beetle through natural areas and by movement of infested wood material (e.g., firewood) (Crane et al. 2015; Ploetz et al. 2011b).

Introduction of Laurel Wilt. The redbay ambrosia beetle, Xyleborus glabratus, and its fungal symbiont, Raffaelea lauricola (Rf), were introduced into Port Wentworth, Georgia, USA, in infested wood packing material from Asia during 2002 (Mayfield and Thomas 2006). This insect-disease complex, commonly called laurel wilt (LW), affects trees in the Lauraceae family and spreads through natural areas by redbay ambrosia beetle movement and anthropogenic movement of infested wood products (e.g., firewood, wood-turners wood, and BBQ smoke-wood). Plant hosts of the redbay ambrosia beetle-Rf complex include at least ten native lauraceous woody species (e.g., redbay [Persea borbonia] and swampbay [P. palustris]) in Florida, as well as non-native species such as camphor (Cinnamomum camphora), avocado (P. americana), and potentially California bay (Umbellularia californica) (Campbell et al. 2017; Dreaden et al. 2016; Fraedrich 2008; Fraedrich et al. 2008; Fraedrich et al. 2011; Fraedrich et al. 2015; Hughes et al. 2012; Hughes et al. 2013; Hughes et al. 2014; Mayfield et al. 2013; Ploetz and Konkol 2013). By February 2010, redbay ambrosia beetles were detected in a natural area 21 miles (33.7 km) north of the south Florida avocado production area (125 sq. miles; 324 sq. km) in Miami-Dade County (Thomas 2010; Ploetz et al. 2011a). In 2011, the first confirmed swampbay tree to succumb to LW was documented in this natural area, and by 2012 LW was detected in a commercial avocado grove in Homestead, Florida (J. Crane, personal observation). Contrary to predictions, populations of X. glabratus did not establish in commercial avocado groves. However, laurel wilt is still prevalent and continues to spread as a result of an unexpected, uncommon lateral transfer of R. lauricola to native and exotic ambrosia beetles, which now function as secondary vectors of R. lauricola (Carrillo et al. 2014; Ploetz et al. 2017). At least two ambrosia beetles, Xyleborus volvulus and X. bispinatus, have been shown to transmit the laurel wilt pathogen to avocado groves (Carrillo et al. 2014). These ambrosia beetles are most active during dusk (from about 4 PM–8 PM) and generally fly 10 ft (1.2 m) or less from the ground (Menocal et al. 2018).

Laurel Wilt in Florida (https://sfyl.ifas.ufl.edu/miami-dade/agriculture/laurel-wilt---a-disease-impacting-avocados/)

Laurel Wilt - a Disease Impacting Avocados

A battle is being waged in the avocado groves of South Florida where the region’s largest and most economically important fruit crop is under attack. Avocados account for approximately 4,200 acres in Miami-Dade County and have an economic impact of $54 million to the regional economy. The avocado industry has already lost over 300,000 trees due to laurel wilt since the introduction of the disease to Miami-Dade County in 2011.

The state of the battle against laurel wilt is in constant flux; current recommendations are evolving rapidly as we gain more knowledge and funding becomes available for further research.

In order to manage laurel wilt, suppression of the laurel wilt (LW) pathogen (the fungus Raffaelea lauricola) and the ambrosia beetle vectors (see photo below) is necessary.

Current Recommendations

General sanitation

Remove and destroy any trees in decline and dead wood (in trees and on the ground), these are breeding sites for ambrosia beetles that may transmit laurel wilt (LW).

Keep groves pruned. Ambrosia beetles prefer shady areas and are less likely to go to groves that are well pruned.

Scout groves often for signs of wilting, desiccated leaves on-trees, and stem and limb dieback.

In groves that have not had LW, consider taking a sapwood sample to the Diagnostic Clinic at TREC.

In groves that have had LW, sampling may not be necessary.

Early detection of laurel wilt

Sanitation for LW

Remove the entire tree (above and below ground) and destroy by chipping and/or burning.

Either burn or remove wood chips or spray wood chips twice with insecticide.

Apply foliar insecticide twice to general area of LW affected trees.

Prevent root-graft spread of LW

Spot treat (Opt. 1): Treat two to three healthy trees in all directions adjacent to a LW affected with Tilt®.

Trenching (Opt. 2): Sever the root systems and isolate LW affected trees by a perimeter trench surrounding two to three healthy trees in all directions adjacent to LW affected trees.

For more information, see the full version of current recommendations.

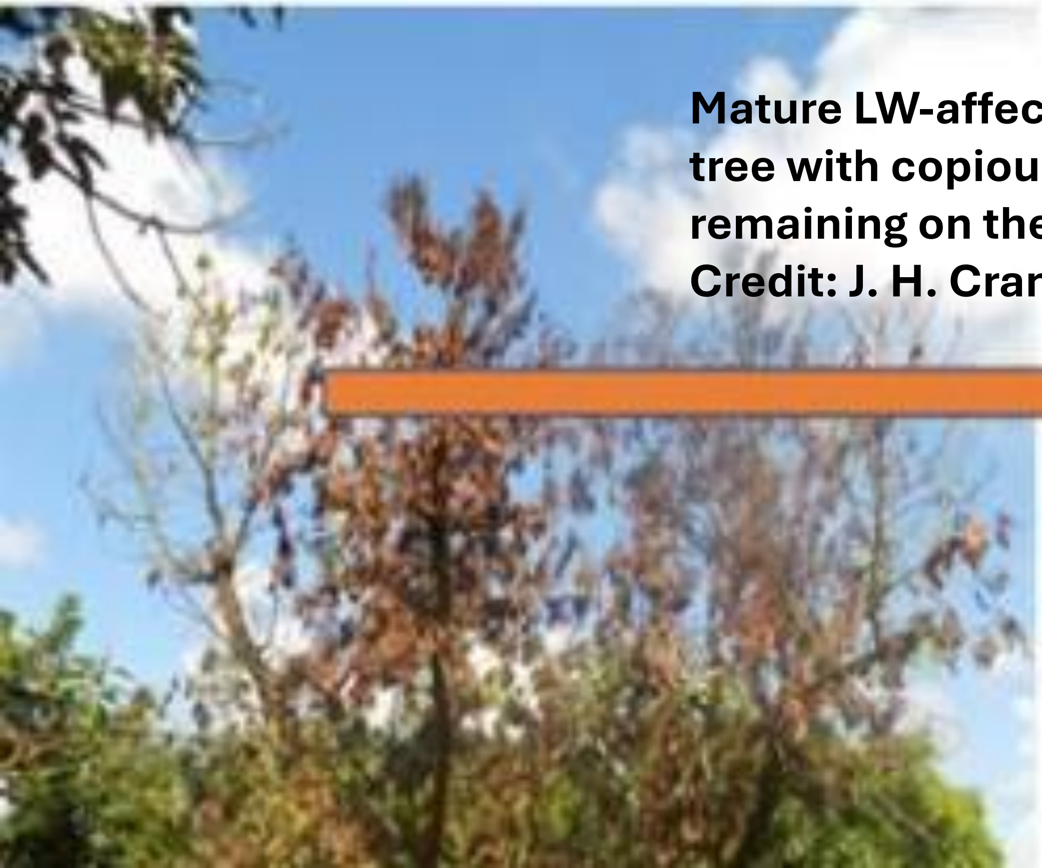
If you have trees symptomatic for laurel wilt please contact Jeff Wasielewski, Florida Commercial Tropical Fruit Crops Agent, (305-248-3311 ext. 227, jwasielewski@ufl.edu) for more information.

Laurel Wilt Control (https://edis.ifas.ufl.edu/publication/hs1360)

Recommendations for Control and Mitigation of Laurel Wilt and Ambrosia Beetle Vectors in Commercial Avocado Groves in Florida

Jonathan H. Crane, Daniel Carrillo, Edward A. Evans, Romina Gazis, Bruce Schaffer, Fredy Ballen, and Jeff Wasielewski

The visible external symptoms of laurel wilt disease begin as green-leaf wilting (A), typically in one section of the tree (B). Frass straws from AB boring may be evident (C), and the sapwood has blackish-brown-blue streaks (D). Credit: J. H. Crane, UF/IFAS



Mature LW-affected avocado trees with sections of the tree with copious leaf drop and other sections with leaves remaining on the stems prior to dieback and death.
Credit: J. H. Crane, UF/IFAS

(A) Regrowth and some branch dieback of tree cut to a stump (~1.2 m height), and (B) tree regrowth dies back repeatedly until the tree is dead.
Credit: J. H. Crane, UF/IFAS

Light exposure of highly shaded (A), top-worked (B), and newly planted (C) areas of an orchard. Credit: J. H. Crane, UF/IFAS

https://blogs.ifas.ufl.edu/stlucieco/2021/08/03/growing-avocado-in-florida/

Pest and disease management: The best practices to avoid disease are to grow scab-resistant varieties, planting trees in well-drained soils, and scouting the tree during the year.

For more information please read avocado growing in the Florida home landscape.

by **Amir Rezazadeh**
Posted: August 3, 2021

Variety Recommendations for Florida

The author recommends that Florida grow more black and purple varieties such as those from California: Hass, Lamb Hass, Gem, Sirprise, Stewart, Dickinson (old), Luna (new). Or even some from Hawaii: McDonald, Linda (too large?), Masami, Hayes, Healani, Malama. Black fruit from Texas: Brogdon, Wilma, Joey. Breeding new Florida Hass as they are doing is good. The only purple Florida cultivar is Brogdon. Or Joey from Texas. Black, productive, cold hardy 15 F. Looks like Hass. Or Gem or Lamb Hass from California. Look like Hass. Or Hayes from Hawaii. Looks like Hass. A Hass seedling. And the new Luna from UCR California. Better than Hass.

Florida Avocado Cultivars. Florida Avocado Varieties, Characteristics (growables.org)

Table 2. Some characteristics of Florida avocado varieties recommended for the home landscape

Variety	Race[1]	Season of maturity[2]	Flower type	Fruit wt. (oz)	Fruit color	Cold tol.[3]	Production	Scab susc.[4]	Rec.[5]
Donnie	W	May 21 -- June 31	A	12--20	Green	Low	Moderate	R	Y
Dupuis	W	June 15 -- July 31	A	12--24	Green	Low	Low	R	Y
Hardee	W	June 25 -- Sept. 1	B	12--24	Red	Low	High	R	N
Pollock	W	June 25 -- Sept. 15	B	18--40	Green	Low	Low	R	N
Simmonds	W	June 25 -- Sept. 15	A	16--34	Green	Low	Moderate	R	Y
Nadir	GW	July 1 -- Aug. 15	A	10--22	Green	Low	Moderate	R	Y
Russell	W	July 1 -- Aug. 31	A	16--24	Green	Low	Moderate	R	Y
Brogdon	CH	July 15 -- Sept. 15	B	8--12	Purple	High	Moderate	MS	Y
Miguel	GW	July 22 -- Sept. 15	B	18--26	Green	Low	High	R	Y
Nesbitt	GW	July 22 -- Aug. 30	A	14--26	Green	Low	Moderate	R	N
Tower-2	GW	Aug. 1 -- Sept. 15	B	12--20	Green	Low	Moderate	R	N
Beta	GW	Aug. 5 -- Sept. 15	B	16--24	Green	Moderate	High	R	N
Loretta	GW	Aug. 25 -- Sept. 30	B	20--36	Green	Moderate	High	M	Y

Slide 2: Florida Avocado Cultivars From the Horticultural Sciences Department, Florida Cooperative Extension Service Institute of Food and Agricultural Sciences, University of Florida

Waldin	W	Sept. 1 -- Nov. 1	A	14--28	Green	Low	Moderate	R	N
Tonnage	G	Sept. 15 -- Oct. 15	B	14--24	Green	High	Moderate	MS	N
Booth 8	GW	Oct. 1 -- Dec. 15	B	9--28	Green	Moderate	High	MS	Y
Lula[6]	GW	Oct. 1 -- Feb. 15	A	14--24	Green	High	High	S	M
Marcus	GW	Oct. 15 -- Nov. 30	B	18--48	Green	High	Moderate	R	N
Booth 7	GW	Oct. 15 -- Dec. 15	B	10--20	Green	Moderate	High	MS	Y
Choquette	GW	Oct. 30 -- Jan. 15	A	18--40	Green	Moderately High	Moderate	R	Y
Hall	GW	Nov. 15 -- Feb. 1	A	12--18	Green	High	Low	MS	N
Monroe	GW	Dec. 1 -- Feb. 15	B	24--40	Green	Moderate	High	MS	Y
Kampong	G	Dec. 1 -- March 31	B	14--24	Green	High	Low	R	N
Meya	G	Dec. 7 -- Feb. 28	A	10--16	Green	High	Low	R	N
Reed	G	Dec. 14 -- March 7	A	8--18	Green	Moderate	High	R	Y
Brookslate	GW	Jan. 14 -- March 7	A	10--22	Green	High	High	R	Y

[1] Race: W--West Indian; G--Guatemalan; M--Mexican; CH--Complex Hybrid.
[2] Season of maturity may not correspond with legal maturity.
[3] Cold tolerance rating.
[4] Scab susceptibility: R--resistant; MS--moderately susceptible; S--susceptible.
[5] Recommendation for home planting: Y, yes; N, no, and M, maybe.
[6] 'Lula' is susceptible to scab however in the home landscape this may not be a problem.

Florida Avocado Varieties. [Florida Avocado Varieties (usda.gov)]

Florida Department of Agriculture and Consumer Services Division of Fruit & Vegetables.
https://www.ams.usda.gov/sites/default/files/media/FloridaAvocadoVarieties.pdf

Only those with high production should be considered for growing: Hardee, Miguel, Beta, Loretta, Booth 8, Lula, Booth 7, Monroe, Reed, Brookslate.

Or from California: Hass, Lamb Hass, Gem, Stewart, Sirprise, Dickinson, Luna. Hawaii: McDonald, Linda (too large?), Masami, Hayes, Healani, Malama. Black fruit from Texas: Brogdon, Wilma, Joey. And the new Luna from UCR California. Better than Hass.

Cold hardy cultivars could also be considered for northern Florida: Holland, Del Rio, May, Wilma, Gloria, Gainesville, Brogdon, Winter Mexican, Tonnage, Joey, Lula, Mexicola, Mexicola Grande, Marcus, Hall, Kampong, Meya, Brookslate.

See the websites above.

Cold Hardy Florida Avocados for Northern Florida (https://floridafruitgeek.com/cold-hardy-avocados/)

Holland (Opal, Lila) Cold hardy.

Del Rio Hardy to 15 F.

May Cold hardy.

Wilma (Brazos Belle) Cold hardy. 15 F.

Gloria Cold hardy.

Gainesville Cold hardy.

Hybrids (Mex X West Indian):

Brogden - Cold Hardy. 26-28 F.

Winter Mexican - Cold hardy. Low 20’s F.

Other Cold Hardy Varieties: ‘Martin‘, ‘Joey‘, ‘Poncho‘/’Pancho’, ‘U-la-la‘, ‘Mexicola‘, and ‘Mexicola Grande‘. They will add to website later.

Joey. Cold Hardy. 15 F.

Mexicola Hardy to 20 F.

Mexicola Grande Hardy to 20-22 F.

Lula 27 F.

Black Fruit from California, Hawaii, Florida, Texas.

Black from California: Hass, Lamb Hass (new), Sir Prize (new), Gem (new), Stewart (new), Mexicola Grande (new), Dickinson (old). And the new Luna from UCR California. Better than Hass.

Black fruit from Hawaii: Recommended Hawaiian purple or black varieties are McDonald, Linda (too large?), Masami, Hayes, Healani, Malama.

Black fruit from Florida: Brogdon.

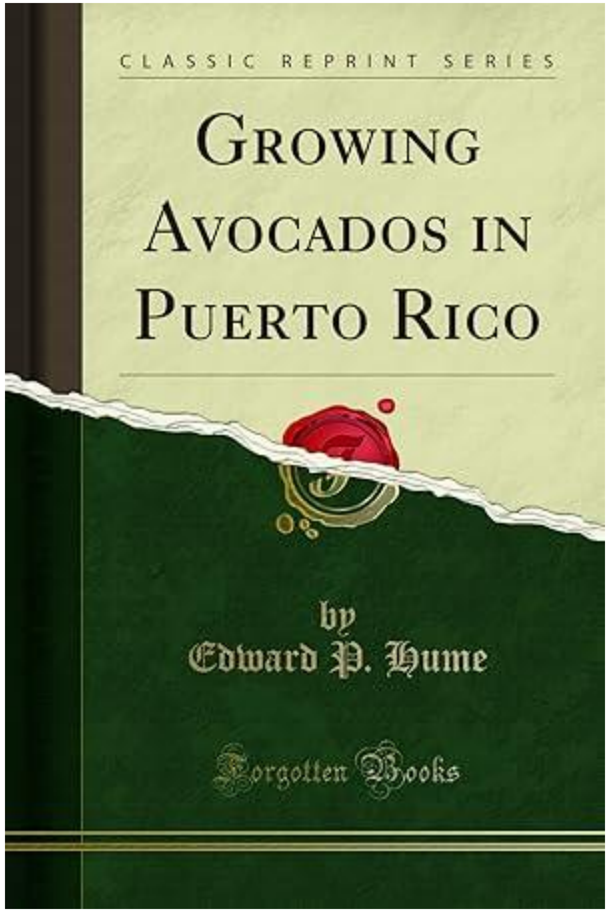
Black fruit from Texas: Brogdon, Wilma, Joey.

New black or purple varieties: Brogdon, Gloria, May, Wilma (Brazos Belle), Joey, Mexicola Grande. And the new Luna from UCR California. Better than Hass.

Avocados in Puerto Rico https://www.bing.com/search?q=avocados+in+puerto+Rico.

Puerto Rican avocados, also known as aguacates, are one of the most popular fruits grown in Puerto Rico. The unique tropical climate and soil composition of the island contribute to the high quality and delicious taste of Puerto Rican avocados. The varieties grown at present in Puerto Rico yield fruit between June of one year to early March of the following year. However, most of March, April and May there is very little harvesting of avocado in Puerto Rico, and avocado needs to be imported. Hawaii has cultivars that mature in March, April, and May.

Growing Avocados in Puerto Rico by Edward Hume. 1951. OUT OF DATE. Abebooks.com $17.65 Free shipping.



Avocado varieties in puerto rico - Google Search

Some avocado varieties grown in Puerto Rico include:

Butler: A tropical avocado with green skin grown by Martex Farms.

VENY: A fresh and high quality green avocado grown by Martex Farms that is available from June to October.

Semil 34: An avocado variety grown in Puerto Rico. Dark green.

Most avocados consumed in Puerto Rico are imported, and there is little harvesting in March, April, and May. The USDA is evaluating other varieties that may be harvested during these months to increase productivity and extend the fruit production year.

They also grow Hass, Reed, and Fuerte.

Description

(W.I.) P.I.26690 Tree originated 1904 at Miami, FL. Fruit season Aug., Sept.; color, light green; weight, 16-24 ozs.; shape, obovoid; skin, smooth. Seed, medium to large. (CAS Yearbook 1950) Origin, Florida; race, WI; Flowering group A (Lahav & Gazit)(A USDA selection in Florida; fruited in 1909, propagated from 1914 to 1918) pear-shaped; medium-large; skin smooth; seed of medium size, tight in the cavity. Season: Aug.-Sept. No longer grown in Florida. Cultivated in Puerto Rico.(J.Morton)

Butler. Light green.
16-24 oz. Smooth..
A flower type.

http://www.ucavo.ucr.edu/AvocadoVarieties/AvocadoVarieties.html

Butler Avocado. 16-24 oz. Light green. A type flower. WI. (https://www.oriundopr.com/blogs/ingredients/aguacate-butler-butler-avocado#:) (https://avocado.ucr.edu/avocado-variety-database)

Tree originated 1904 at Miami, FL. Fruit season Aug., Sept.; color, light green; weight, 16-24 ozs.; shape, obovoid; skin, smooth. Seed, medium to large. (CAS Yearbook 1950) Origin, Florida; race, WI; Flowering group A (Lahav & Gazit)(A USDA selection in Florida; fruited in 1909, propagated from 1914 to 1918) pear-shaped; medium-large; skin smooth; seed of medium size, tight in the cavity. Season: Aug.-Sept. No longer grown in Florida. Cultivated in Puerto Rico.

Culinary Use: The Aguacate Butler, or Butler Avocado, is a variety of avocado known for its smooth and creamy flesh. It is commonly used in salads, sandwiches, guacamole, and as a topping for various dishes.

Medicinal Use: Avocados, including the Butler Avocado, are considered nutritious and are a good source of healthy fats, vitamins, and minerals. They are known for their potential cardiovascular benefits and their contribution to a balanced diet.

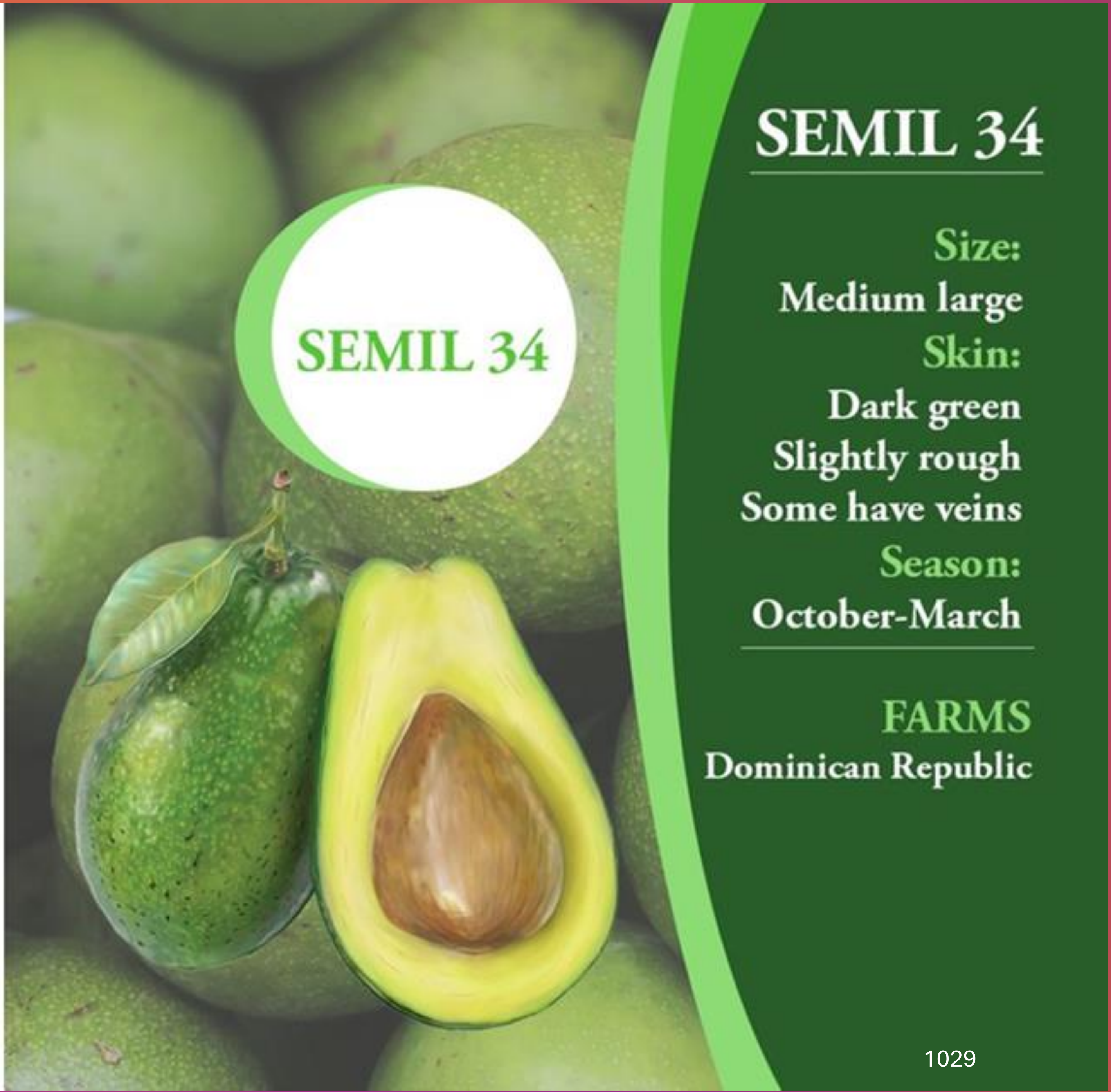
Fun Fact: The Butler Avocado is named after its developer, James A. Butler, who played a significant role in popularizing this particular avocado variety. It is known for its rich, buttery flavor and is favored by avocado enthusiasts for its taste and texture.

Veny Avocado. Green. (Martex Farms.com)

VENY avocados are available June to October. VENY avocados are guaranteed to be a fresher and a higher quality product.

Semil 34. Dark green.
Medium large.
Slightly rough.
(Bing.com)

Flower Type A
(Lahav and Gazit).
Origin Puerto Rico.
Guat x W. Indian.
Also a Semil B
(Lahav and Gazit).



Semil 34 Avocado (Bing.com) Dark green.

Semil 34.
Medium large.
Dark Green.
Slightly rough.
From Puerto Rico. A type flower.
(FloridaAvocadoVarieties.pdf)(USDA) .

Variety: SEMIL 34

Size: medium large to medium; **Shape:** pear;
Stem Attachment: centered, medium to thick;
Skin: dark green, slightly rough, some have veins;
Pulp: light yellow to greenish yellow, medium thick;
Seed: medium, tight;
Season: October - December

https://reeis.usda.gov/web/crisprojectpages/1009615-evaluation-of-avocado-persea-americana-varieties-and-management-to-extend-fruit-production-year round-and-increase-productivity.html

Study to Increase Avocados Year-round in Puerto Rico

Currently, avocado harvesting in Puerto Rico is limited to the months of summer, fall and winter [June-early March; Little fruit in March, April, and May]. This is due to to the fact that each avocado variety has a natural harvesting season that generally lasts 2 months of the year, with some varieties being harvested every year essentially the same months (for example, always in September and October), while other varieties may be naturally later (for example, November and December), and other varieties much earlier (for example, July-August). The varieties grown at present in Puerto Rico yield fruit between June of one year to early March of the following year. At any given year, most of March, April and May there is very little harvesting of avocado in Puerto Rico, and avocado needs to be imported. We propose to address the issue in three ways: First, to evaluate in Puerto Rico other varieties not currently grown, looking for varieties that may be harvested in the months we do not have local avocados (March-May). Second, for growers that prefer to stick to varieties already grown in Puerto Rico and with which they are familiar, we will investigate if tree management practices may result in those varieties producing fruit that can be harvested in the months of traditional scarcity (March-May). The third approach is to survey in the island to find existing avocado trees from seedlings that by genetic chance are able to produce fruit to be harvested in March-May and reproduce them to create new varieties that can fill the scarcity gap, as well as selection of new varieties from seedlings of late-season and early-season varieties currently grown in Puerto Rico.

Recommendations for Puerto Rico

The author recommends that Puerto Rico grow more black or purple avocados to meet the demand for Hass. They could try black or purple varieties from California, some new: Hass, Lamb Hass, Gem, Stewart, Surprise, Luna. Or grow some of the new Hass being breeded in Florida. Or try some of the black or purple varieties from Hawaii: McDonald, Linda (too large?), Masami, Hayes, Healani, Malama. Hayes looks like Hass. Or Joey from Texas. Black, productive, cold hardy 15 F. Looks like Hass. Or Brogdon or Wilma from Texas. And the new Luna from UCR California. Better than Hass. Hawaii has varieties that mature in March, April, and May. Best to try them. Sharwil matures from March-May in Hawaii, but green. Yamagata from March –July, green skin. Greengold from Feb-May, green. Linda from March-May, very large, dark purple. Lamb Hass spring and summer fruit, black. Hass April-November, black. Beshore late spring, dark green. Hayes March to May, black like Hass, looks like Hass-recommended for Puerto Rico. Masami April-June, black. McDonald April-August, black. Fujikawa spring season, green. Murashige late spring-early summer, dark green.

See Puerto Rico avocado varieties at:

https://www.bing.com/search?q=avocados+in+puerto+Rico.

https://reeis.usda.gov/web/crisprojectpages/1009615-evaluation-of-avocado-persea-americana-varieties-and-management-to-extend-fruit-production-year round-and-increase-productivity.html

Black Fruit from California, Hawaii, Florida, Texas.

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Black fruit from Hawaii: Recommended Hawaiian purple or black varieties are McDonald, Linda (too large?), Masami, Hayes, Healani, Malama. Hayes looks like Hass.

Black fruit from Florida: Brogdon.

Black fruit from Texas: Brogdon, Wilma, Joey.

New black or purple varieties: Brogdon, Gloria, May, Wilma (Brazos Belle), Joey, Mexicola Grande. Joey looks like Hass. And the new Luna from UCR California. Better than Hass.

Avocados in Texas (https://aggie-horticulture.tamu.edu/fruit-nut/wp-content/uploads/sites/6/2015/04/avocados_2015.pdf)

Avocados can grow well in Texas. However, production is so small that it is not reported in U.S. Department of Agriculture statistics. The only Texas counties that are suitable for commercial avocado production are in the Lower Rio Grande Valley, where avocados represent a very small percentage of commercial farm acreage. Avocados come in three main types: West Indian, Guatemalan and Mexican. The most cold-hardy varieties can withstand temperatures of about 25 degrees F. However, growing avocados in Texas is more challenging due to the hot weather and soil moisture.

Texas Avocado Cultivars. (https://aggie-horticulture.tamu.edu/fruit-nut/wp-content/uploads/sites/6/2015/04/avocados_2015.pdf)

‘Brogdon’ complex hybrid Average– below average cold tolerance. Oval to pear shaped Thin; purple. Summer Flowering type B. 26-28 F cold tolerance. Moderate producer.

‘Holland’ Little cold tolerance. Less than optimum quality, thick, rubbery Green. Summer. Found by the Holland family in Uvalde, TX; also sold as ‘Opal.’

‘Wilma’ Good cold tolerance. Large, good quality. Black. Summer. Newer variety planted in landscapes in Austin, San Antonio, and Houston areas. Cold hardy, 15 F.

‘Winter Mexican’ hybrid. Excellent cold and good heat tolerance. Large, average to fair quality Thick, green. December. Popular in the Valley for many years. Hardy to mid 20’s.

‘Lula’ Severe freeze damage below 27°F; usually regrows from below ground. Nears 1 pound; pear shaped Thick, green, slow to darken, making it good for restaurant use. October– February. Resists diseases well; grown commercially in the Lower Rio Grande Valley; the preferred rootstock for all avocados in South Texas. Guat x W. Indian hybrid.

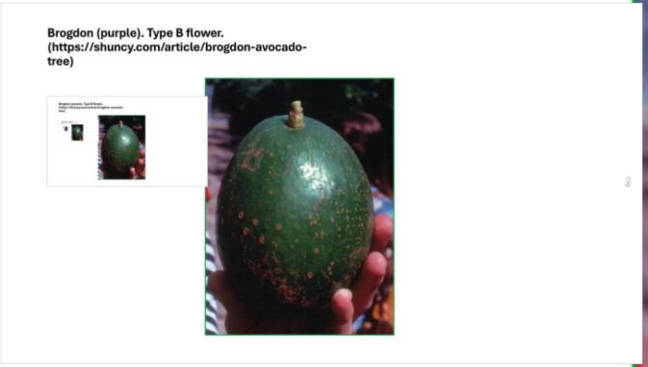
California. ‘Hass’ originated as a seedling and is thought to be a Guatamalan x Mexican hybrid. It has insufficient cold hardiness for Texas. 30 F.

Joey. Cold hardy, 15 F. Productive. Black. Looks like Hass.

Brogden Avocado. 7-20 oz. Smooth skin. Hardy to 26-28 F. Purple/Black. Moderate production. Susceptible to anthracnose. B type flower.

https://floridafruitgeek.com/cold-hardy-avocados/

Brogdon (purple). Type B flower. (https://shuncy.com/article/brogdon-avocado-tree)



Brogdon. (https://shuncy.com/article/brogdon-avocado-tree)

Brogdon avocado trees are a unique variety of avocado that is known to be both cold (26-28 F) and drought tolerant. These trees are grown in the southern parts of the United States, and they produce medium to large-sized fruit (7-20 oz.) with a purple, smooth skin and a rich, buttery taste. Moderate productivity? Susceptible to anthracnose.

(https://avocado.ucr.edu/avocado-variety-database)

Brogdon. Mexican. A Texas Cultivar. Moderate productivity. Smooth skin. 7-20 oz. Very hardy. 26-28 F. Purple or black. Susceptible to anthracnose. Type B flower.

Orig. in Winter Haven, FL, by Tom W. Brogdon. Introd. in 1951. Parentage unknown; discovered in late 1930s; tested by Univ. of Florida, Sub-Tropical Expt. Stal, as PI 4761; Mexican race. Fruit: 7 to 20 oz; somewhat pear shaped; skin purple, very thin; susceptible to handling injury; flesh yellow, buttery; ripens late July to Aug. Tree: small to medium; vigor moderate; productivity low; very hardy; susceptible to anthracnose; recommended for central Florida. (B&O Register) Flowering group B (Lahav & Gazit)

Scientific Name Persea americana 'Brogdon’
https://shuncy.com/article/brogdon-avocado-tree

Type Hybrid

Height 30-40 feet

Width 20-25 feet

Growth rate Medium

Fruit size 7-20 oz.

Fruit shape Pear-shaped

Skin texture Smooth

Skin color Purple

Flesh color Pale yellow-green

Flavor Nutty, buttery, rich

Seed size Large, easy to remove

Ripening season December - March

Cold hardiness 26-28 degrees F

Drought tolerance Moderate to high

Pollination type Type B

Yield Moderate productivity?

https://aggie-horticulture.tamu.edu/fruit-nut/wp-content/uploads/sites/6/2015/04/avocados_2015.pdf

Texas A&M: Commercial production. Mexico leads the world in avocado production, with over 1 million metric tons produced annually. In the United States, avocados are produced commercially in California (65,000 acres), Florida (6,500 acres), and Hawaii (600 acres).

In Texas, production is so small that it is not reported in U.S. Department of Agriculture statistics. The only Texas counties that are suitable for commercial avocado production are in the Lower Rio Grande Valley, where avocados represent a very small percentage of commercial farm acreage.

Growers south and southwest of San Antonio have experi mented with avocado varieties purported to survive the winters there with little damage. But because no formal, long-term research has been conducted on those varieties, commercial plantings should be considered very risky unless they are well protected from freezes.

https://aggie-horticulture.tamu.edu/fruit-nut/wp-content/uploads/sites/6/2015/04/avocados_2015.pdf

Mexican varieties grown in Texas include ‘Brogdon’, ‘Holland’, ‘Wilma’, and ‘Winter Mexican’. ‘Lula’ is a popular Gua temalan x West Indian hybrid variety grown commercially in the Lower Rio Grande Valley. The pebbly skinned ‘Hass’ is the most widely consumed avocado in the United States and the main commercial variety in California. ‘Hass’ originated as a seedling and is thought to be a Guatamalan x Mexican hybrid. It has insufficient cold hardiness for Texas.

Monte Nesbitt , Larry Stein, and Jim Kamas
Extension Fruit Specialists, The Texas A&M University System

Avocados from Texas

Texas%20Avocados.pdf
https://aggie-horticulture.tamu.edu/fruit-nut/

Brogdon, Holland, Hass, Lula, Wilma, Winter Mexican.
(https://galveston.agrilife.org/files/2012/03/Fruit-Nut-Production-Avocados.pdf)

Brogdon, Holland, Wilma, Winter Mexican, Lula.

(https://aggie-horticulture.tamu.edu/fruit-nut/wp-content/uploads/sites/6/2015/04/avocados_2015.pdf)

TABLE 1: Characteristics of avocado varieties grown in Texas

Species	Variety	Climate	Fruit	Skin	Harvest	Other characteristics
Guatemalan x Mexican hybrid	'Hass' seedling or hybrid variety	Little cold tolerance; plant only if it can be protected from freeze often; best in dry areas	Good quality, well liked	Thick, black, pebbly, rough textured	September–October	Most widely grown and consumed variety; ships well; main commercial variety in California
Mexican	'Brogdon' complex hybrid	Average– below average cold tolerance	Oval to pear shaped	Thin; purple	Summer	Flowering type B
	'Holland'	Little cold tolerance	Less than optimum quality, thick, rubbery	Green	Summer	Found by the Holland family in Uvalde, TX; also sold as 'Opal'
	'Wilma'	Good cold tolerance	Large, good quality	Black	Summer	Newer variety planted in landscapes in Austin, San Antonio, and Houston areas
	'Winter Mexican' hybrid	Excellent cold and good heat tolerance	Large, average to fair quality	Thick, green	December	Popular in the Valley for many years
West Indian		Almost none ≤32°F	Very large	Light green to reddish purple	September – October	Mild flavor; low in oil
Guatemalan x West Indian hybrid	'Lula'	Severe freeze damage below 27°F; usually regrows from below ground	Nears 1 pound; pear shaped	Thick, green, slow to darken, making it good for restaurant use	October–February	Resists diseases well; grown commercially in the Lower Rio Grande Valley; the preferred rootstock for all avocados in South Texas

Recommendations for Texas

The author recommends that Texas grow and sell more black or purple varieties that they have to meet the demand for Hass. Or grow some of the new Hass that Florida is breeding. Or try some of the black varieties from California: Hass, Lamb Hass, Gem, Sirprise, Stewart, Mexicola Grande, Dickinson (old), Luna (new). Or try some of the black or purple varieties from Hawaii: McDonald, Linda (too large?), Masami, Hayes, Healani, Malama. Hayes looks like Hass. Or Joey from Texas. Cold hardy, 15 F. Productive. Black. Looks like Hass. Or Brogdon or Wilma from Texas. And the new Luna from UCR California. Better than Hass.

Black Fruit from California, Hawaii, Florida, Texas.

Black from California: Hass, Lamb Hass (new), Sir Prize (new), Gem (new), Stewart (new), Mexicola Grande (new), Dickinson (old). And the new Luna from UCR California. Better than Hass.

Black fruit from Hawaii: Recommended Hawaiian purple or black varieties are McDonald, Linda (too large?), Masami, Hayes, Healani, Malama.

Black fruit from Florida: Brogdon.

Black fruit from Texas: Brogdon, Wilma, Joey.

New black or purple varieties: Brogdon, Gloria, May, Wilma (Brazos Belle), Joey, Mexicola Grande, And the new Luna from UCR California. Better than Hass. Gem (CA), Lamb Hass (CA), Joey (Texas), and Hayes (Hawaii) all four look like Hass. All are productive. And the new Luna from UCR California. Better than Hass.

https://toptropicals.com/html/toptropicals/articles/fruit/varieties_avocado.htm

More Cold Hardy Avocado Varieties for Florida and Texas

The most cold hardy varieties:

Wilma(Brazos Belle): Produces medium-large, purple-black long fruit. Season: October-November. 15 F.

Fantastic: Produces green, paper thin skin, supposedly the most cold hardy of all. The fruit has a creamy texture. 15 F.

Joey: Selected by Joey Ricers in Uvalde, Texas (just outside of San-Antonio). Produces medium size, egg shaped purple-black fruit. It has excellent flavor. Heavy bearer. Season: September-October. 15 F.

Lila: Produces medium size, green fruit. 15 F. Season: September-October. Don't confuse this variety with Lula, which is a popular Florida variety and commonly used for rootstock. (Lula is cold hardy to 25 F)

Poncho: Produces medium to large green fruit. Cold hardy to 15 F.

Cold Hardy Varieties recommended for Northern Florida or Texas by the author.

Wilma

Joey

Brogdon

Wurtz

Lula

Winter Mexican

Mexicola Grande

Mexicola

Poncho

Lila

Hall

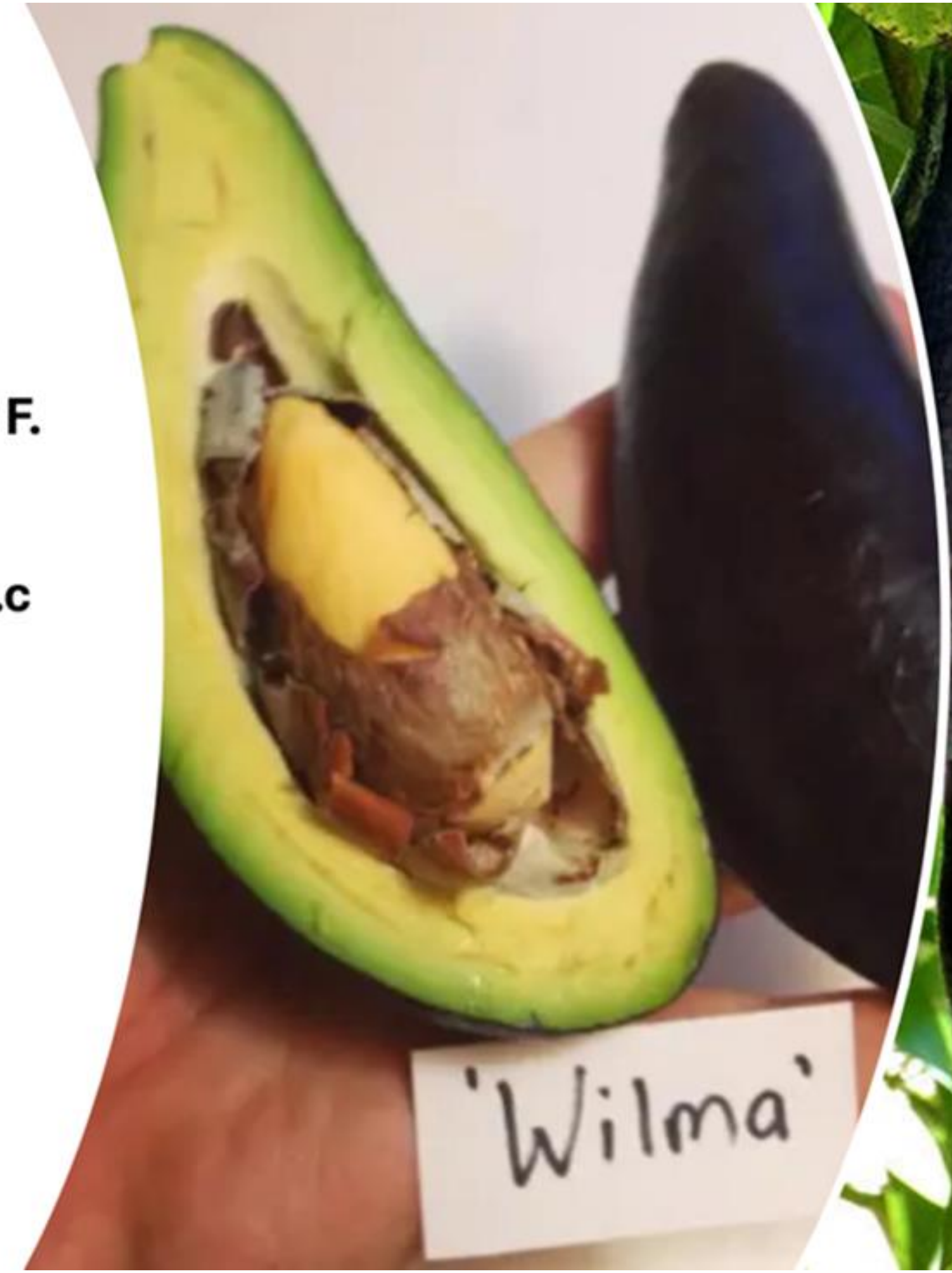
Fantastic

Day

Fuerte

Wilma Avocado from Texas. Type B flower. Cold hardy. 15 F. (Bing.com)

Wilma (Brazos Belle) Avocado. Cold hardy. 15 F. Black. Long neck. Smooth. Type B flower. (https://floridafruitgeek.com/cold-hardy-avocados/) (Bing.com)



Wilma. (https://galveston.agrilife.org/files/2012/03/Fruit-Nut Production-Avocados.pdf)

‘Wilma’™ -A Mexican avocado that origi nated as a seedling near Pearsall, Texas. Tree has demonstrated good cold hardiness (15 F) and is be ing planted in landscapes from Austin to San An tonio to Houston. The fruit is large in shape and has good flavor. The skin is black in color. Nurs eries propagating this variety must acknowledge that the name is trademarked, limiting its use for marketing and promotional purposes.

Wilma (Brazos Belle). Black. Cold Hardy. 15 F. Long neck. Susceptible to anthracnose. Fruit drop. Productive.

https://floridafruitgeek.com/cold-hardy-avocados/

‘Wilma’ has long, skinny fruits that turn black at maturity. Trees of this variety grow well in North Florida and sets lots of fruit, but the fruits seem particularly susceptible to anthracnose, which makes most of the fruits drop off prior to maturity. ‘Wilma’ might be better suited to climates with drier, less humid summers than we experience here in North Florida. We do get some fruits of this type to ripen here, and they are rich and tasty.

Like other Mexican types, the tree’s leaves smell like licorice. People have grown this variety locally in Texas for many years under the name ‘Wilma’, but in the last decade a big nursery started propagating this type and selling the trees to big-box stores under their own trademarked name, ‘Brazos Belle,’ so you can sometimes find it under that name – but it is ‘Wilma’.

Unlike most other Mexican varieties, in ‘Wilma’ fruits the seed tends to be loose inside the fruit, so if you shake the fruits you can hear the seed rattling inside. Fruiting season for ‘Wilma’ is September-November.

Wilma(https://toptropicals.com/html/toptropicals/articles/fruit/varieties_avocado.htm)

Variety: Wilma (Brazos Belle).   Purple-Black. Hardy to 15 F. Medium-large.

Type: M

Origin: Texas

Flower Type: B

Tree size: 20-25 feet

Season: September-November

Productive.

Fruit shape/size/color: medium-large, long, purple-black.

Cold tolerance: Very cold hardy.

Comments: Produces medium-large, purple-black long fruit. Can take temperatures down to 15 F for short period of time without significant damage.

Wilma aka Brazos Belle (Homesteadandchill.com)

Flower/Pollination: Type B

Zones: 8-11

Growing Habits: Tree reaches 20 to 25 feet when mature. Can begin to produce fruit at 1 to 2 years of age (grown from a grafted nursery tree).

Cold-Hardy to: 15 to 18°F. One of the most cold-tolerant avocado varieties!

Fruit Characteristics: The medium-size fruit are long and narrow, with a rich nutty flavor reminiscent of Hass. The thin skin turns purplish black when ripe.

Blooming Time: Winter to spring

Ripens: September to November

Other Unique Facts: Like the Pryor/Fantastic name game – Brazos Bell is a genetic clone of Wilma. Wilma is the parent variety, and nursery trees sold as Wilma will come on the most trusted rootstock that consistently exhibit the characteristics described above. However, "Brazos Belle" could potentially be grafted onto a different rootstock and therefore be less cold-hardy.

Joey. Medium sized. 7-20 oz. Pebbly. Purple-black. Very cold hardy (15 F). Heavy production. Flower type B. Looks like Hass.

Joey. (https://buchanansplants.com/plant-library/trees/joey-avocado/)

This selection produces high yields of oval, purplish fruits with a rich flavor; more cold hardy (15 F) than other Mexican avocados; great for eating fresh, added to salads, or blended into sauces or dips; an excellent tropical look for home landscapes.

Hardiness zone 8b

Foliage type evergreen

Plant form upright spreading

Mature height 25 feet

Spread 25 feet

Light requirements full sun to partial shade

Moisture requirements average to moist

Plant origin Mexican

Joey avocado (Homesteadandchill.com)

Flower/Pollination: Type B Black.

Zones: 8b – 11

Growing Habits: Grow to 25 feet or taller

Cold-Hardy to: 15 to 18°F (for a short period of time)

Fruit Characteristics: 7-20 oz. Considered a “heavy producer” of small egg-shaped fruit. The thin skin is dark purple to black, and the flesh is described as flavorful and nutty.

Bloom Time: Spring

Ripens: August to October

Other Unique Facts: Everything I see about Joey describes it as “self-fruitful” (though all avocados technically are, to a degree). This variety may perform particularly well without a pollinator partner tree.

Joey. Medium sized. 7-20 oz. Pebbly. Purple-black. Very cold hardy (15 F). Flower type B. Heavy production. (https://avocado.ucr.edu/avocado-variety-database)

Variety: Joey

Type: Mex

Origin: Texas

Flower Type: B

Tree size: Large, vigorous

Season: August-October

Production: Heavy

Fruit shape/size/color: Egg shaped, medium, 7-20 oz. purple/black

Cold tolerance: Very cold hardy

Comments: Selected by Joey Ricers in Uvalde, Texas. It has excellent flavor. Can take temperatures down to 15 F for short period of time without significant damage.

Brogden Avocado. 7-20 oz. Smooth skin. Hardy to 26-28 F. Purple/Black. Moderate production. Susceptible to anthracnose. Flower type B. (https://floridafruitgeek.com/cold-hardy-avocados/)

Brogdon. (https://galveston.agrilife.org/files/2012/03/Fruit-Nut-Production-Avocados.pdf)

‘Brogdon’-complex
Mexican hybrid variety;
oval to pear-shaped
fruit, with thin skin that
becomes purple in color
upon maturity. A nice
quality variety with aver
age to below-average cold
Hardiness (26-28 F) compared to other Mexican types.
Flowering Type B.

Brogdon. 7-20 oz. Red-purple. Cold hardy. 26-28 F. Moderate production. Susceptible to anthracnose. Flower type B.

(https://floridafruitgeek.com/cold-hardy-avocados/)?

Variety: Brogdon

Type: M

Origin: Florida

Flower Type: B

Tree size: Small to medium, medium vigor

Season: Late summer-fall. Late July to November.

Production: moderate

Fruit shape/size/color: Pear shaped, 7-20 oz., red-purple

Cold tolerance: Cold hardy

Comments: Skin is very thin. Yellow buttery flesh. It is an excellent choice for guacamole lovers. Good for Central Florida. Originated in Winter Haven, Florida, by Tom Brogdon.

BROGDON (https://avocado.ucr.edu/avocado-variety-database)
Flower Type
B
Fruit Color
Purple
Ecotype
Mex
Description
Orig. in Winter Haven, FL, by Tom W. Brogdon. Introd. in 1951. Parentage unknown; discovered in late 1930s; tested by Univ. of Florida, Sub-Tropical Expt. Stal, as PI 4761; Mexican race. Fruit: 7 to 20 oz; somewhat pear shaped; skin purple, very thin; susceptible to handling injury; flesh yellow, buttery; ripens late July to November. Tree: small to medium; vigor moderate; productivity low to moderate; very hardy; susceptible to anthracnose; recommended for central Florida. (B&O Register) Flowering group B (Lahav & Gazit)

Brogdon avocado (Homesteadandchill.com)

Flower/Pollination: Type B

Zones: 8b-11

Growing Habits: Mature trees reach over 30 feet tall, with a very upright and dense canopy.

Cold-Hardy to: 26-28°F

Fruit Characteristics: The flesh from this variety is very buttery and yellow, said to be “perfect for guacamole”. It produces quite large fruit, with smooth skin that turns dark purple as it ripens.

Bloom Time: Mid spring to early summer

Ripens: Late July to November

Wurtz (Little Cado). Green. 8-12 oz. Pebbly. Very cold hardy (25 F). Bears moderately but regularly. Alternating production. Small to medium sized fruit. Dwarf tree 8-15 ft. Flower type A and B.

Wurtz (Little Cado). Bears moderately but regularly. Green. Pebbly. 8-12 oz. Very cold hardy (25 F). Dwarf tree. 8-15 ft. Flower type A and B. (https://avocado.ucr.edu/variety-list#wertz)

Variety: Wurtz (Little Cado)

Type: Guat.

Origin: California

Flower Type: A & B

Tree size: Dwarf, compact and slow growing to 8-12 feet.

Season: May-September.

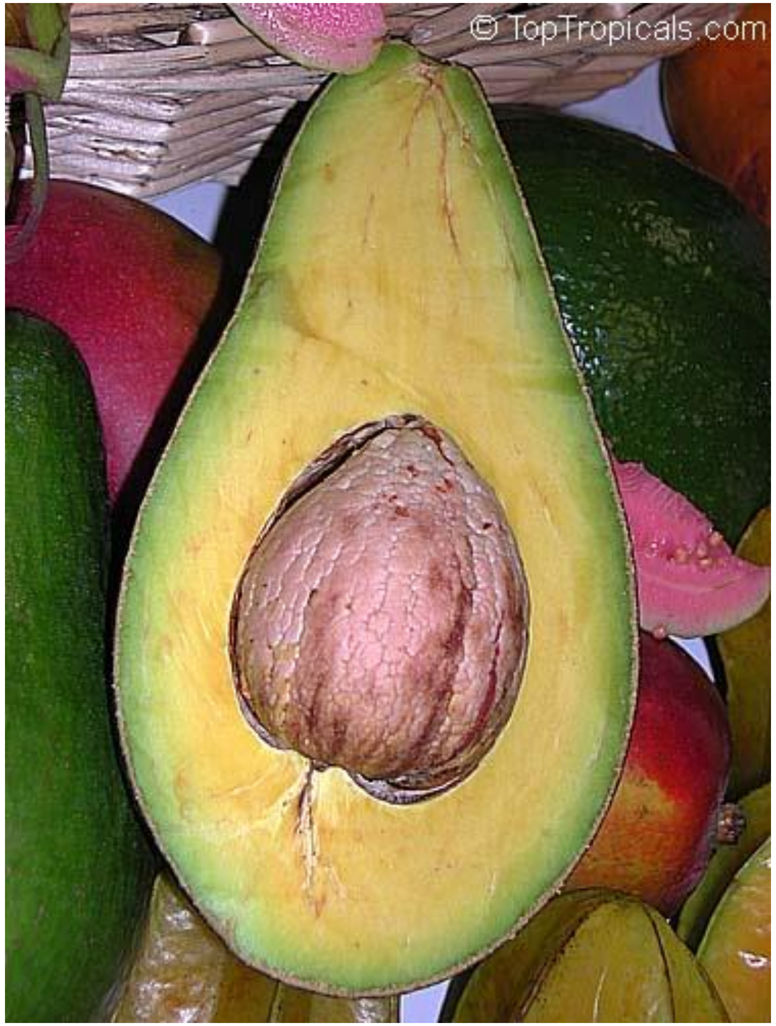
Production: Production is good and it is a consistent bearer. Bears moderately but regularly.

Fruit shape/size/color: Pear shaped, or ovate. Small to medium, green.

Cold tolerance: Cold hardy (25 F).

Comments: Dwarf hybrid. Fruit 8-12 oz. Skin medium-thick. Quality good, oil content 18%. Distinctive weeping growth habit. Suited for planters, containers, patios or greenhouse use. Great for dooryard or container growing. The tree can handle temperatures to 25(F) degrees. The seed is small and fruit skin is smooth. Fruits ripen green from May to September. The flavor is very good. Originated in Encinitas (California) by Roy Wurtz.

Lula. Med-large. Green. Cold hardy. 25 F. Bears early and heavily. Flower type A. 16-24 oz. (TopTropicals.com)



Lula. Type A flower.
Winter Mexican Avocados (Bing.com) from Texas.

Lula. (https://galveston.agrilife.org/files/2012/03/Fruit-Nut-Production-Avocados.pdf)

'Lula'- a popular Guatemalan x West Indian hybrid variety grown commercially in the lower Rio Grande Valley. Originated in Flor ida. Bears individual pear-shaped fruits near ing a pound in size and having a green, thick peel which resists disease quite well. Flesh is slow to oxidize (darken) making it popular for restaurant use. It matures in October and stores well on-tree into January or February. 'Lula' sustains severe freeze damage below 27 degrees, although it commonly regrows from below ground. Seeds from 'Lula' are the pre ferred rootstock for all avocados in South Texas. Flowering Type A.

Lula. Medium-large. Green. Bears early and heavily. Flower type A. Cold hardy. 25-27 F. (https://avocado.ucr.edu/variety-list#lula).

Variety: Lula

Type: GxM

Origin: Florida

Flower Type: A

Tree size: Tall, vigorous, upright

Season: October-February.

Production: Bears early and heavily

Fruit shape/size/color: Pear shaped sometimes with a neck, medium/large (16-24 oz), green

Cold tolerance: Very cold hardy

Comments: Skin almost smooth. Flesh pale to greenish-yellow. Oil content 12-16%. Seed large, tight. Successful in Central and South Florida where it is a formerly the leading commercial cultivar. More frost resistant than most. It is renowned for its ability to endure harsh winters, and for its exceptionally long harvesting period. This makes Lula an exceptional choice for homeowners in and around Orlando. Originated from seed from parent tree planted 1915 by Mrs. Lula Cellon at Miami, Florida

Lula (https://avocado.ucr.edu/avocado-variety-database)

Flower Type A

Fruit Color Green

Ecotype Guat x Mex

(Guat.x Mex.) FL Origin.from seed from parent Taft tree planted 1915 by Mrs. Lulu (Geo.B.) Cellon at Miami, FL,fruited 1919, propagated 1921. A rapid, thrifty grower in FL, precocious & productive; more frost resistant than most, very satisfactory in the Ridge section lower east coast sections, & recommended for southern FL. Fruit season, Oct-Feb. Color, green. Weight,16-24 ozs. Shape, pyriform. Skin, nearly smooth. Flavor, good. Oil,12-16%. Seed, lg. Illus.& desc. FL Agri. Exper. Sta. Bul.272. (CAS Yearbook 1950) Orig. in Miami, FL, by George B. Cellon, nurseryman. Introd. in 1921. Open-pollinated seedling of Taft; selected in 1919. Fruit:pyriform; skin almost smooth, dark, glossy green; quality good; lg. seed, tight in cavity; fair market appeal; very susceptible to avocado scab. Tree: vigorous & upright, prolific & regular bearer; class "A" blossom type. (B&O Register) (Lulu) Origin, FL; Race, GxM; Flower group, A (Lahav & Gazit) (seed of Taft planted in Miami in 1915);pear-shaped, sometimes with neck; med.-lg; skin almost smooth;flesh pale-to greenish-yellow,12-16% oil; seed lg.,tight. Season: med.-late (mid-Nov.& Dec.).Tree tall, bears early & heavily; cold-resistant (25-27 F), successful in central & southern FL where it was formerly the leading commercial cultivar. It is the principal cultivar in Martinique for exporting to France; represents 95% of the crop. (J.Morton 1987)

Winter Mexican. Dark green. Pebbly. Bears heavily and regularly. 12-18 oz. Flower type B. Very cold hardy (mid-20’s).

Winter Mexican (Homesteadandchill.com)

Flower/Pollination: Type B

Zones: 8b -11

Growing Habits: Up to 40 feet or taller after 25 years of growth

Cold-Hardy to: Mid 20°F degrees for short periods, otherwise 25°F once established

Fruit Characteristics: The flesh from Winter Mexican avocados is similar to the Hass, but with smaller fruit on average. Produces quite early.

Bloom Time: Mid spring to early summer

Ripens: November to January

Other Unique Facts: While this tree is fairly cold-hardy, don't let the name "winter" lead you to think it is the most cold-hardy of Mexican avocado varieties! Those would be Joey, Pryor, Wilma and Mexicola Grande. It is a Mexican-Guatemalen hybrid, less cold-hardy than pure Mexican types. Rather, this avocado gets its name from the time of year it bears fruit.

Winter Mexican (https://avocado.ucr.edu/avocado-variety-database)

WINTER MEXICAN Flower Type B Fruit Color Green Ecotype Guat x Mex FL Originated at Palm Beach & first propagated there in 1922. Now propagated on west coast of FL since 1936. A vigorous growing tree, bearing well & regularly in Pinellas Co. Hardy to cold & said to be resistant to scab. Promising for west coast. Fruit: season, Nov.-Jan.; color, green; weight, 12-18 ozs.; shape, oblong, skin, thick, leathery. Seed, med. (CAS Yearbook 1950) Orig. in Palm Beach, FL. Introd. in 1936. Hybrid of Guat.xMex. types; discovered in 1922. Fruit: 12-18 oz; oblong to pyriform; skin thick, leathery, dark green; seed size med., tight in cavity; Tree: very vigorous, bearing heavily & regularly; hardy; resistant to scab; susceptible to anthracnose; flowering group B. Obsolete. (B&O Register) Origin, FL; Race, GxM; Flowering group, B (Lahav & Gazit)

(https://galveston.agrilife.org/files/2012/03/Fruit-Nut-Production-Avocados.pdf)

'Winter Mexican'-A Mexican hybrid avocado that has been popular in the Rio Grande Valley for many years. Excellent cold hardiness (Mid 20's F) and good heat tolerance, with average to fair fruit quality. Thick, green skin with fruit maturing in November to January.

Winter Mexican. Dark green. Pebbly. 12-18 oz. Very cold hardy (mid-20’s). Bears heavily and regularly. Flower type B.

(https://floridafruitgeek.com/cold-hardy-avocados/)

Variety: Winter Mexican

Type: GxM

Origin: Florida

Flower Type: B

Tree size: Vigorous tree

Season: November-January

Production: Bears heavily and regularly

Fruit shape/size/color: Oblong to byriform, medium to large (12-18 oz), dark green

Cold tolerance: Very cold hardy (Mid 20’s F).

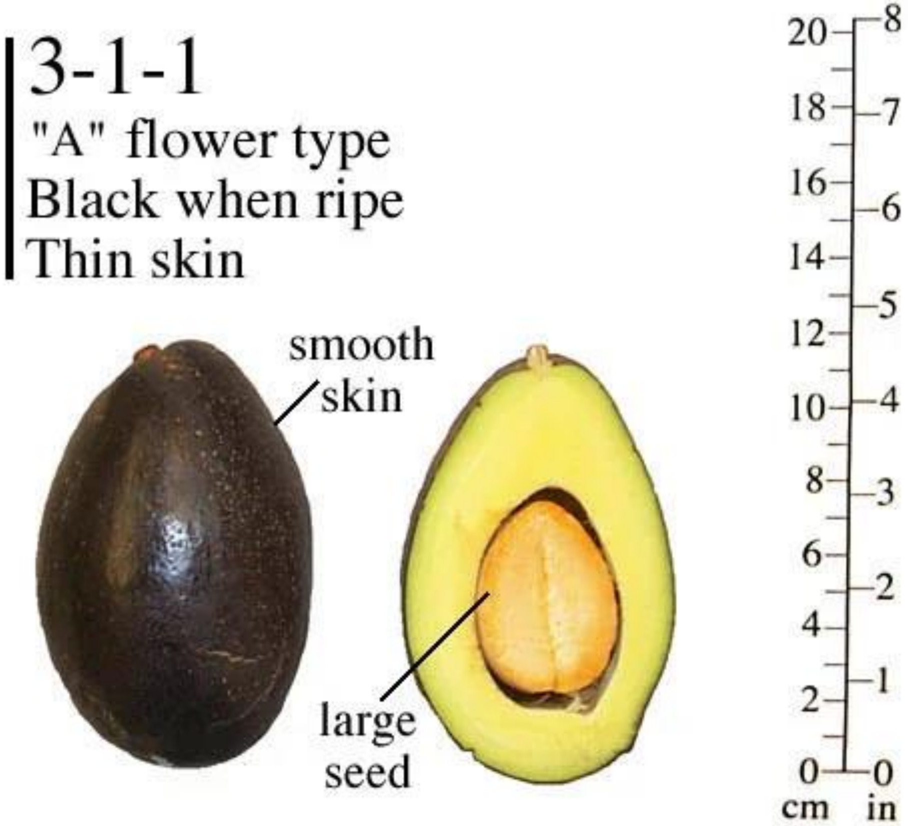
Comments: Fruit 12-18 oz., skin thick, leathery, dark green. Seed medium, tight in cavity. Winter Mexican is one of the most cold hardy varieties. Mature trees may withstand temperatures in the mid 20s. Originated in Palm Beach, Florida

Mexicola Grande.

Very cold hardy. As low as 15 F for short periods. Usually 20-22 F. 6-10 oz. Black. Smooth. Bears early and regularly. Aug to October. Type A flower. Heat hardy. (Homesteadandchill.com)

Mexicola Grande (https://avocado.ucr.edu/variety-list#mexicola-grande) Ripens Aug to October. Heat hardy.

Shape of fruit is round bottomed obovate to ellipsoid.
Sold by one nursery as "Mexicola Grande."
Mexican. Cold hardy. 15 F.
Peels: No. Nutty flavor.
Seed Size: Large
Skin Texture: Smooth. Edible skin.
Blossom Type: A
Fruit Shape: Obovate
Skin Color Unripe: Black
Skin Color Ripe: Black
Skin Thickness: Thin
Average Fruit Weight oz: 6 to 10



Mexicola Grande avocado (Homesteadandchill.com)

Flower/Pollination: Type A. Mexican.

Zones: 8b-11

Growing Habits: Considered a vigorous grower and producer, bearing fruit regularly and heavily. A large avocado tree, reaching heights of 40 feet or greater.

Cold-Hardy to: 20-22°F (down to 15°F for short periods or once quite mature). Heat hardy.

Fruit Characteristics: Fruits 6-10 oz. Large pit. The leathery skin is black when ripe, and the fruit has a nice nutty flavor.

Bloom Time: Mid spring to early summer.

Ripens: August to October.

Other Unique Facts: Mexicola Grande is the most cold-hardy of these Type A's. It is also more heat-hardy than Hass.

Mexicola Grande. Very cold hardy, as low as 15 F. for short periods. Usually 20-22 F. 6-10 oz. Black. Smooth. Bears early and regularly. Type A flower. (https://avocado.ucr.edu/variety-list#mexicola-grande)

Variety: Mexicola Grande Type: M Origin: Texas

Flower Type: A Tree size: Tall 25 feet, vigorous.

Season: August-October Production: Bears early and regularly.

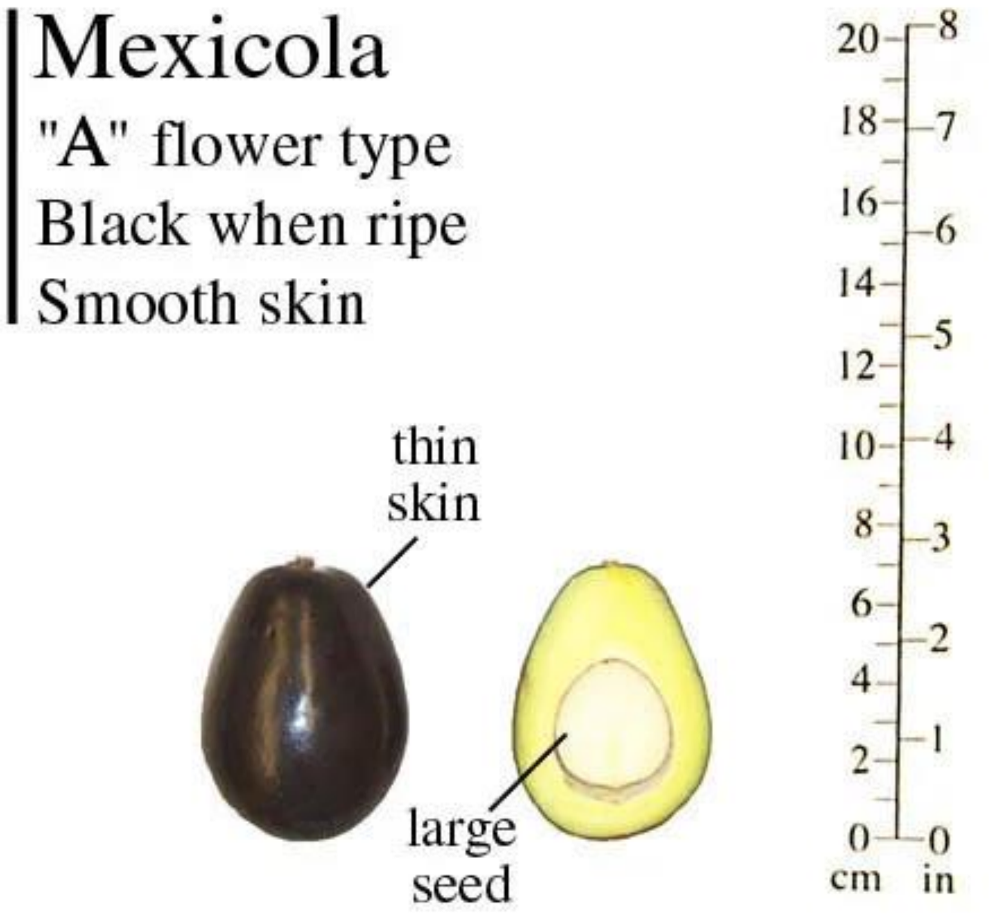
Fruit shape/size/color: Ovate to pyriform, medium 6-10 oz. black. Large seed. Cold tolerance: Very cold hardy. Heat hardy.

Comments: This variety is similar to Mexicola but much larger fruit. It survived temperatures around 10 F near San Antonio, Texas (Zone 8b). Can take temperatures down to 15 F for short periods of time without significant damage.

Mexicola. (Etsy.com) 4-6.5 oz. Black. Anise leaf smell. Smooth skin. Bears early and regularly. Cold hardy to low 20’s F.
A type flower.

Mexicola (https://avocado.ucr.edu/variety-list#mexicola)

Mexican varieties have an anise smell to the leaves. This is a very typical Mexican variety.
Peels: No.
Seed Size: Large.
Skin Texture: Smooth.
Blossom Type: A.
Fruit Shape: Obovate.
Skin Color Unripe: Black.
Skin Color Ripe: Black.
Skin Thickness: Thin. Edible.
Average Fruit Weight oz: 4 to 6.5.



Mexicola. Black. Smooth. Very cold hardy. Low 20’s F. Heat resistant. 4-6.5 oz. Bears early and regularly. A type flower. (https://avocado.ucr.edu/variety-list#mexicola)

Variety: Mexicola.

Type: Mex.

Origin: California.

Flower Type: A.

Tree size: Medium 15-20 feet.

Season: August-October.

Production:Bears early and regularly.

Fruit shape/size/color: Ovate to pyriform. Small 4-6.5 oz, black.

Cold tolerance: Very cold hardy. Low 20’s F.

Comments: Skin black, thin, smooth. Excellent flavor. Seed large. Very heat and cold-resistant. It is a very cold hardy variety, may withstand temperatures in the low 20s. Much used as a parent in California breeding programs. Originated at Pasadena, California.

Mexicola (https://avocado.ucr.edu/avocado-variety-database)

Flower Type A Fruit Color Black Ecotype Mex

Orig. about1910 as seedling at Coolidge Rare Plant Gardens, Pasadena, CA, propagated about 1912. (CAS Yearbook 1950) 2 trees at the South Coast Research Station, Irvine, CA., Field 44, Row 2, trees 16 & 17. One of the first varieties to be commercial, planted by Mr. Henry Huntington around 1915-17.

Tree resistant to heat & cold & consistent bearer, seed in demand for rootstocks. Seed large. Fruit season, Aug.-Oct.; color, black; weight, 4-6.5 ozs.; shape, ovate to pyriform; skin, thin, smooth; flavor excellent.

This is a 100% Mex. avocado with thin black skin, ovate or pear shaped with well centered stem, med.-large seed that is often loose in the cavity, difficult to peel. It has an anise flavor & is quite good tasting.

Appears to be resistant to Persea Mite. Keeping & shipping qualities, poor. A very sm.; skin black; flesh of excellent flavor; seed lg.

Season: Aug.-Oct. Grown only in home gardens in CA. Bears early & regularly; very heat & cold resistant; much used as a parent in CA breeding programs.

Poncho. Very cold hardy. 15 F. Medium-large size. Green. Ovate. Pebbly. Flower type B. Average production. (TopTropicals.com)

Poncho. Very cold hardy. 15 F. Medium-large size. Ovate. Green. Pebbly. Flower type B. Average production. (TopTropicals.com)

Variety: Poncho.

Type: Mex.

Origin: Texas.

Flower Type: B.

Tree size: 30 feet, vigorous.

Season: July-September.

Production: Average.

Fruit shape/size/color: Medium, ovoid, green.

Cold tolerance: Very cold hardy.

Comments: Produces medium to large green fruit. It survived temperatures around 10F near San Antonio, Texas (Zone 8b). Can take temperatures down to 15F for a short period of time without significant damage.

Lila (Holland, Opal). Dark green. Ovate. Pebbly. Very cold hardy, 15°F for short periods of time, otherwise 20 to 22°F Medium size. Flower type A. Strong production. (TopTropicals.com)

Lila (Holland, Opal) avocado (Homesteadandchill.com)

Mexican.

Flower/Pollination: Type A.

Zones: 8b/9-11.

Growing Habits: A smaller avocado tree, reaching 15 to 20 feet on average.

Cold-Hardy to: 15°F for short periods of time, otherwise 20 to 22°F.

Fruit Characteristics: Considered very rich and nutty. Medium-size, ovate or pear-shaped fruit that stay green when ripe.

Bloom Time: Later winter through spring.

Ripens: July to November.

Other Unique Facts: Lila is a genetic clone of Opal, and is considered to be the second most cold hardy of all Mexican avocado varieties.

Lila (Holland, Opal). Medium sized. Dark Green. Pebbly.

Very cold hardy. 15°F for short periods of time, otherwise 20 to 22°F Strong production. Flower type A. (TopTropicals.com)

Type: M   Origin: Texas

Tree size: Semi-dwarf 15 feet tall, can be maintained to 5 feet in container.

Season: July-November.

Production: Strong.

Fruit shape/size/color: Ovoid, medium, dark green.

Cold tolerance: Very cold hardy. 15°F for short periods of time, otherwise 20 to 22°F.

Comments: Produces medium size, green fruit. Don't confuse this variety with Lula, which is popular in Florida and used for rootstock (that one is cold hardy to only 25F). Can take temperatures down to 15 F for a short period of time without significant damage.

Lila (Holland, Opal)

(https://galveston.agrilife.org/files/2012/03/Fruit-Nut-Production-Avocados.pdf) Medium sized. Cold hardy, 15°F for short periods of time, otherwise 20 to 22°F

'Holland'- a Mexican race seedling tree found by the Holland family in Uvalde, Tx. The vari ety grew well and survived several hard win ters in Uvalde, but was killed to the ground in the severe 1989 freeze event with temperatures in the 'teens'. Fruit skin is green in color, and quality is less than optimum having thick, rub bery flesh texture. This variety is also sold un der a registered trademark name: 'Opal'®.

Lila (Holland, Opal)
Green. Cold tolerance 15°F for short periods, otherwise 20 to 22°F
Less than optimum quality, thick, rubbery. Green. Summer. Found by the Holland family in Uvalde, TX; also sold as ‘Opal.’ (Bing.com)

Hall Avocado. Green. Smooth. Large. Very cold hardy. Alternate but heavy bearer. Flower type B. GuatxMex. (TopTropicals.com)

Hall Avocado. Large. 20-30 oz. Green. Smooth. Very cold hardy. Flower type B. Alternate but heavy bearer. (https://avocado.ucr.edu/avocado-variety-database)

GuatxWI. Florida Originated on place of Willis Hall, Miami as seedling of unknown origin. (CAS Yearbook 1950) Origin, FL; Race, WIxG; Flowering group, B. (originated in Miami; of unknown parentage; fruited in 1937, propagated in 1938).

Pear-shaped; large.; skin smooth, fairly thick; flesh deep-yellow, 12-16% oil; seed med. large., tight. Season: Nov. & Dec. Heavy bearer & cold-hardy but subject to scab.

Tree heavy bearing & hardy; color, dark green; weight 20-30 oz.; shape, pyriform; skin, smooth, thick; quality, fine.

Variety: Hall   Type: GxW   Origin: Florida   Flower Type: B   Tree size: Medium.

Season: November-December   Production: Alternate, but heavy bearer.

Fruit shape/size/color: Pear shaped, elongated, large, green   Cold tolerance: Very cold hardy.

Comments: Large, tasty pear shaped fruit. Skin bright green, attractive, smooth and fairly thick. Flesh deep yellow, oil content 12-16%, seed medium-large, tight. Excellent for the limited fancy-fruit market. Originated in Miami, Florida, by Willis Hall.

Fantastic (Pryor, Del Rio) Avocado. Medium size. Green. Tolerates 15 F. Vigorous production. Flower type A. (TopTropicals.com)

Fantastic (Pryor, Del Rio) Avocado. Medium size. Green. Tolerates 15 F. Flower type A. (Top Tropicals.com)

Variety: Fantastic.

Type: Mexican.

Origin: Texas.

Flower Type: A.

Tree size: Large 25-30 feet.

Season: August-November.

Production: Vigorous in full sun.

Fruit shape/size/color: Ovate or pear shaped , medium, green.

Cold tolerance: Very cold hardy 15 F.

Comments: Supposedly the most cold hardy of all avocados. Green, paper thin skin. The fruit has a creamy texture. Can take temperatures down to 15 F for short period of time without significant damage.

Fantastic (Pryor, Del Rio) (Homesteadandchill.com)

Flower/Pollination: Type A.

Zones: 8-11.

Growing Habits: A medium-large tree that can reach 25 to 30 feet high.

Cold-Hardy to: 15 to 18°F (once established).

Fruit Characteristics: Fairly small-medium fruit with medium to olive green thin skin. The texture is creamy and has good oil content, with mild flavor.

Bloom Time: Winter through late spring.

Ripens: August to November.

Other Unique Facts: Note that Pryor/Del Rio is the true variety and rootstock that consistently exhibits the characteristics described above. “Fantastic” avocado trees are often grafted onto Pryor rootstock and essentially become one in the same, and are often marketed as such. However, there has been noted variation between Fantastic trees (e.g. they may sometimes be grafted onto other less cold-hardy rootstock).

Day Avocado. Large fruit. Pyriform. Very cold hardy. Dark green. Flower type B. (TopTropicals.com)

Day Avocado. Large fruit. Large seed. Very cold hardy. Dark green. Flower type B.

(https://avocado.ucr.edu/avocado-variety-database)

Origin, FL. Race, WIxM. Flowering group B.

Tree size: Tall slender.

Season: July-September.

Production: Alternating.

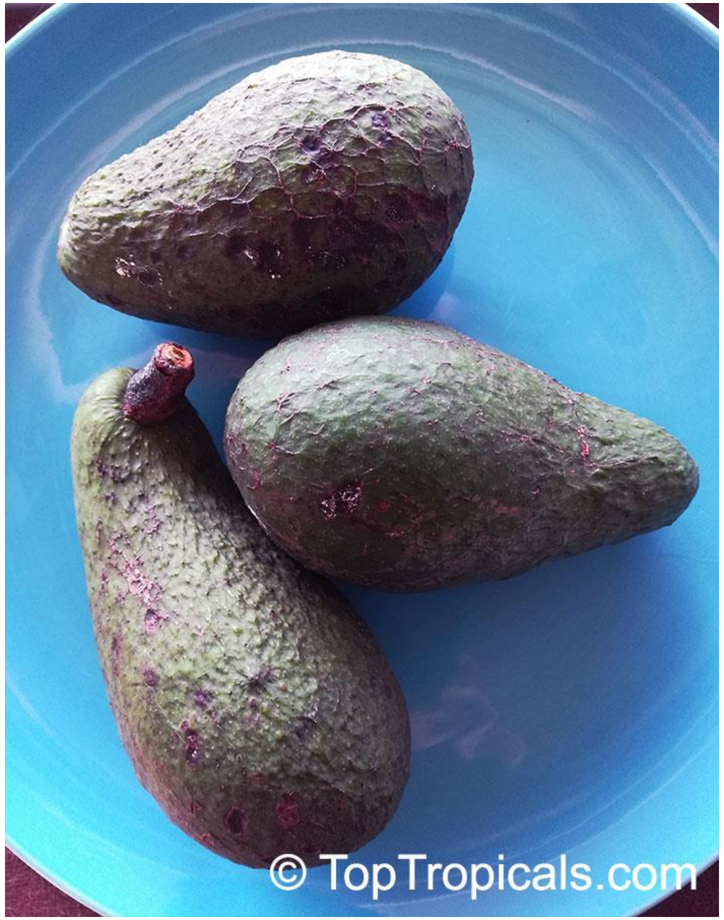
Fruit shape/size/color: Long club shape, large, dark green.

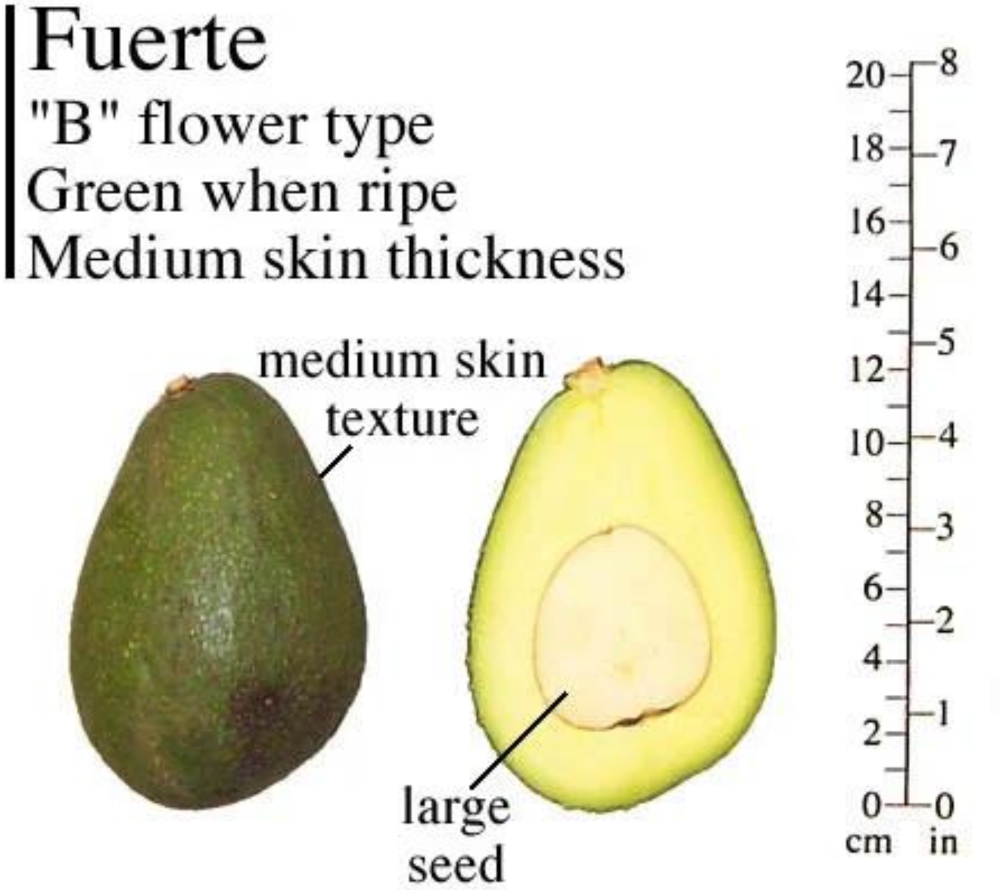
Cold tolerance: Very cold hardy.

Comments: Smooth skin and is shaped like a club. The fruit is of very good quality and has a nice buttery consistency. The slender tree is very cold tolerant and produces July through September.

Fuerte. 8-16 oz. Dark green. Cold hardy 27 F. Alternate year bearing habit. Flower type B.

(TopTropicals.com) (https://avocado.ucr.edu/variety-list#fuerte)





Fuerte (https://avocado.ucr.edu/variety-list#fuerte)

Introduced as budwood in 1911 from Atlixco, Puebla, Mexico. A hybrid Mexican variety that is ready to pick in November and is good through March. Hangs on the tree well. A long time California commercial variety valued for its winter season and its B blossom type. Skin thickness is medium thin. Seed size is medium large.

Parentage: Hybrid. Peels: Yes.

Seed Size: Large. Skin Texture: Medium.

Blossom Type: B.

Fruit Shape: Pyriform.

Skin Color Unripe: Green.

Skin Color Ripe: Green.

Skin Thickness: Medium.

Average Fruit Weight oz: 8 to 16.

Fuerte. (https://avocado.ucr.edu/avocado-variety-database)

Flower Type B Fruit Color Green Ecotype Guat x Mex Intro.1911 as No.15 by Carl Schmidt for West India Gardens, Altadena, CA., from Atlixco, Mex.,elev. 6150 feet. For accounts of parent tree, see An. Rept. Cal. Avo. Soc.1919-1920 &1936. An. Rept. 1916 & Cal. Agr. Ext. Service Circ. 43, Revised. Analyses in Yearbook 1920-21 Also in Jour Ag. Research Vol. 54, No.9 & in USDA Bul.1073.(CAS Yearbook 1950). (A natural hybrid orig. at Atlixco,Mex.; introd. into CA in 1911).

It is a spreading vigorous tree with decidedly alternate year bearing habit. Was the leading variety in CA. for shipping & general market. Formerly furnished 60-70% of state production. Fruit season, Nov.- June. Color, green. Wt. 8-16 ozs. Shape, pyriform. Skin, thin, leathery. Flavor, excellent. Oil 18%. Although the Fuerte tree is cold resistant, spring- time temperatures appear to strongly affect blossom set & production. Production & fruit size on individual trees vary considerably leading to the assumption that there are different strains of Fuerte, however when studying the productive trees they are found to be in areas with warmer temps at flower production time.

Production of Hass improves with proximity to Fuerte. B flower type. pear-shaped; sm. to med. or a little larger; skin slightly rough to rough, with many small yellow dots, thin, not adherent to flesh; flesh green near skin, 12-18% oil; seed sm.-med, tight. Season: Jan.-Aug. in southern CA.; Apr.& May in Queensland, & New South Wales; mid-Aug. to Oct.in New Zealand. It is the leading cultivar in Chile where it bears moe dependably than in CA. Represents 42% of all AUS plantings. Has long been the leading avocado on the European market.

Tree is broad, very productive, but tends to bear biennially. Subject to scab & anthracnose in FL. Formerly very popular in CA; now second to Hass because of a trend to summer instead of winter production & marketing that began in 1972. It is a very erratic bearer in CA.

Fuerte. 8-16 oz. Dark green. Slightly rough. Cold hardy 27 F. Flower type B. Alternate year bearing habit. (TopTropicals.com)

Variety: Fuerte

Type: GxM

Origin: Mexico

Flower Type: B

Tree size: Vigorous spreading. 20x20 spacing.

Production: Decidedly alternate year bearing habit

Fruit shape/size/color: Pear shaped, elongated, medium 8-16 oz. dark green

Cold tolerance: Cold hardy 27 F.

Comments: Green fruit elongated 8-16 oz. Skin slightly rough, thin, and not adherent to flesh. Flesh green near skin, oil content 12-17%. Flavor excellent, buttery. Seed medium to large. Often cukes used for cocktail avocadoes. Natural hybrid originated at Atlixco, Mexico.ng

Hass Avocado

(Etsy.com) **6-14 oz. Black. Pebbly skin. Not Hardy. 30 F. Productive. A flower type.**

Hass. (https://galveston.agrilife.org/files/2012/03/Fruit-Nut-Production-Avocados.pdf) Not cold hardy, 30 F. The leading variety in CA.

'Hass'- a Guatemalan seedling or hybrid vari ety, which is the main commercial variety in California. Skin is black in color, thick, and rough textured, allowing it to ship well. Pro duces a good quality, well-liked fruit, but the tree has little freeze tolerance and should only be planted in frost free areas or where frequent protection from cold can be given. Also is best suited to arid, dry climates.

Hass avocado (Homesteadandchill.com, https://avocado.ucr.edu/variety-list#hass, https://avocado.ucr.edu/avocado-variety-database)

Regist.1932 Plant Patent139 Aug. 27,1935 Origin.1926 from seed planted by R.G.Hass at 430 West Road, La Habra Hts.,CA. Originated in LaHabra, Heights, California, by Rudolph Hass. Introduced in 1936. Oval/pear shaped fruit. The leading commercial variety in California. One of the longest harvest seasons. 94.8% of the California acreage in 2012.

Guat x Mex. Flower/Pollination: Type A. Zones: 9-11. 6-14 oz. Medium seed. Tight in cavity. Medium skin thickness. Peels easily. Pebbly. Good shipper. Oil 18-23.7%. Up to 35% in Queensland. No fiber.

Growing Habits: Up to 35 feet, though can be kept pruned to be shorter (as with all avocado trees). Very productive. Some alternate bearing.

Cold-Hardy to: Frost-sensitive at 30 F. Also less heat tolerant than some avocado varieties, such as the more heat-hardy Mexicola, Lamb Hass, and Reed.

Fruit Characteristics: Creamy, nutty, high-fat flesh and medium-large fruit. Thick textured skin that turns black when ripe. Keeping quality excellent. Good shipper.

Bloom Time: February to May.

Ripens: April through November – from the previous years flowers.

Other Unique Facts: The Hass variety was first bred in a Southern California backyard in the 1930s. However, the Hass wasn’t grown and marketed on a large scale until the late 1970s. Both Hass and Reed avocado varieties provide a decent crop when grown solo (without a pollinating partner).

https://www.ctahr.hawaii.edu/oc/freepubs/pdf/C1-382.pdf

PRODUCING AVOCADOS in HAWAII

The avocado (Persea americana) is among the earliest of the fruit trees brought to the Hawaiian Islands. Records indicate introduction early in the nineteenth century by Don Francisco de Paulo Marin. By 1855 trees which are believed to be of Guatemalan origin had become quite common on Oahu and were transported to the other islands. Avocado ranks fourth among fruits commercially produced for fresh consumption. In addition, many farm and city homes have trees in the yard to supply family and nearby market needs. The largest commercial planting ever established in the Hawaiian Islands was that of the Hawai ian Avocado Company near Waimea, Oahu. The acreage in avocados reached its peak, in 1941 with approximately 500 acres planted, but

Hawaii-continued.

since, then has declined. Total acreage in the State is now [1979], estimated at less than 200 acres [actually 600 in 2024].

Most of the fruits produced are consumed in Hawaii.

Statistics of Hawaiian Agriculture show that heaviest production of fruits generally occurs during the months from January-April and lowest production from June -September. At present the principal growing area is in the Kona district of Hawaii. Many of the avocados marketed from this district are of seedling origin.

As early as 1904-1907, the Hawaii Agricultural Experiment Station made test shipments of avocados to West Coast cities as far north as Vancouver and to other cities including Chicago, New York, and Wash ington. In 1910 however, the Mediterranean fruit fly became estab lished in Hawaii, and to prevent its introduction to the mainland federal· and state quarantines were imposed against fresh fruit shipments from the Islands.However, shipments can be made now after a disinfestation treatment which destroys any fruit fly infestations.

Hawaii-continued

Varieties. Avocados have been classified into 3 races: Guatemalan, Mexican and West Indian. The principal races in Hawaii are the West Indian and Guatemalan and hybrids or crosses of these two. Avocados in the Mexican group are not commonly cultivated in Hawaii. However, a Hybrid of this race, the Fuerte variety is grown to a limited extent in home gardens. The Hawaiian Agricultural Experiment Station had as many as 65 Hawaiian varieties under observation in1911. The most popular was the McDonald. The McDonald is thought to be a parent of some of our out-standing seedling avocados. The most important of these is the Beards lee. Other varieties include Nutmeg, Holt, Wilder, Case, the Lehua and Ilialu. Many avocados imported into the State have adapted themselves well. Among them are the Linda, Nabal, Panchoy, Itzamna and Kaguah. All of these except Kaguah are being marketed in Honolulu.

https://hawaiiavocado.weebly.com/uploads/2/6/7/7/26772370/avocado_in_kona.pdf

Marketability - Around thirty years ago, leaders in the Kona-based avocado industry developed a two-pronged marketing plan focused on the use of only three of the many local varieties. It was determined that such a plan would hopefully not only stem the tide of increasing imports of avocado into the state (through nearly year-round production of local "branded" cultivars), but also develop the Sharwil avocado into an export crop.

In addition to Sharwil (winter) the three cultivars included Yamagata and Ota. Although little known outside the Big Island and not as exceptional as the best "winter pears," Yamagata and Ota are among the best spring and summer avocados, respectively. Promotion of Ota eventually was discontinued because it failed to produce flowers in many areas of Kona. For better or worse the industry put itself behind the Sharwil, arguably the best avocado in the world, as the premier cultivar, not only for the future export trade but as the leader in the tri cultivar strategy to reclaim the local market Sharwil, originally from Australia and highly regarded there, compares favorably with the Hass variety (the main cultivar worldwide) in the following industry-accepted parameter Sharwil, originally from Australia and highly regarded there, compares favorably with the Hass variety (the main cultivar worldwide) in the following industry-accepted parameters that constitute a good commercial avocado fruit.

https://www.bing.com/search?q=hawaiian+avocados

Some of the most popular Hawaiian avocado varieties include:

Hass: A rich and buttery variety with a small seed and dark green skin that turns black when ripe.

Sharwil: A thin-skinned green variety with a nutty flavor and creamy texture.

Kahaluu: A medium-sized green variety with a high oil content and smooth texture.

Malama: A large, round variety with purple skin and with a firm flesh and sweet, nutty flavor.

Healani. Fruit characteristics: form, oblong-oval; color, dark purple when mature; surface, very smooth; skin, very thin; welght, 3/4-1pound.

Masami. Masami Avocado. ½-1 lb. Shiny black. Annual bearer.

Avocados were introduced to Hawaii in the early 1800s and the climate suited the plant well. Trees are usually medium to large size and grow rapidly in sunny locations and thrive in well-aerated soil with lots of drainage. The fruit varies in size, color, shape, and taste.

Hawaiian Cultivars

(https://www.hawaiiavocadoassociation.com/hawaiian-avocado-varieties.html)

Sharwil is an excellent tasting green skin winter variety originally from Australia. It is the main commercial variety grown in Hawaii and is perfectly suited to our tropical climate. The Sharwil has a rich, smooth, creamy texture, and nutty flavor. It has a very high average oil content of 28%, and a small seed. It is easy to peel and resists browning when cut. The size varies from around 7 oz to 18 oz. The Sharwil avocado is the only variety permitted to be exported to the U.S. mainland. Discover the features and history of the Sharwil avocado. Read more about identifying the Sharwil variety. B type flower. Productive. Pebbly.

Mainland exports are permitted from 1 November to 31 March to 43 northern states. To learn more about the Sharwil export requirements, contact your local USDA/APHIS/PPQ office, or contact the HAA.

Sharwil. Type B flower. (https://www.plantithawaii.com/avocado)

Sharwil is popular with commercial growers, and has a long and heavy bearing season throughout the winter months of November to February. The fruit is medium sized and pear-shaped with a small seed, high oil content, and a green rough skin. Sharwil is an amazingly consistent bearer, and is the only variety allowed by the USDA to be shipped to other states.

Sharwil avocado. (Bing.com) ½-1.4 lb. Green. Rough surface. Ripe fruits store well in cold storage. Productive. Type B flower.

Sharwil. 7-18 oz. Green. Pebbly. Productive. Resists browning. Productive. Exported. B type flower. (Hawaii.edu)

Sharwil is an excellent tasting green skin winter variety originally from Australia. It is the main commercial variety grown in Hawaii and is perfectly suited to our tropical climate. The Sharwil has a rich, smooth, creamy texture, and nutty flavor. It has a very high average oil content of 28%, and a small seed. It is easy to peel and resists browning when cut. The size varies from around 7 oz to 18 oz. The Sharwil avocado is the only variety permitted to be exported to the U.S. mainland. Discover the features and history of the Sharwil avocado. Read more about identifying the Sharwil variety.

Mainland exports are permitted from 1 November to 31 March to 43 northern states. To learn more about the Sharwil export requirements, contact your local USDA/APHIS/PPQ office, or contact the HAA.

Hawaii avocados. Sharwil. Green. Type B flower.
(Hawaii.edu)

Sharwil is a relatively new introduction into Hawaii from Australia that has been well accepted by home gardeners. Fruit characteristics: form, oval; weight, 7-18 oz.; color, green; surface, rough; skin, medium; seed, small; flesh, greenish yellow; flavor, rich and nutty; season, March to May. Ripe fruits keep well in cold storage. Productive.

Kona Sharwil (https://avocado.ucr.edu/variety-list#kona-sharwil)

A Guatamalan x Mexican cross from Australia. Commercially grown in Hawaii. Has a well centered stem. Fruit shape is oval/pear shape. Very easy to tell when it is soft and ready to use. At South Coast Field Station, Orange County, Ca. the old fruit can remain on the tree till the new crop is ready to begin picking. Fruit stores well.

Parentage: Hybrid

Peels: Yes

Seed Size: Small

Skin Texture: Medium

Blossom Type: B

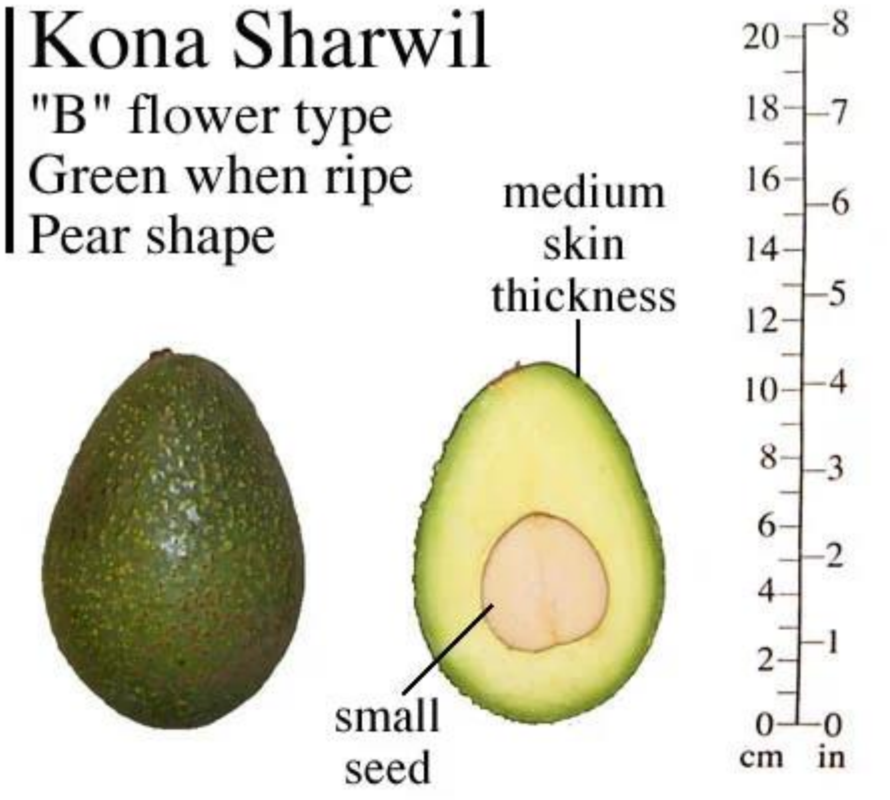
Fruit Shape: Narrowly obovate

Skin Color Unripe: Green

Skin Color Ripe: Green

Skin Thickness: Medium

Average Fruit Weight oz: 8 to 16



Kona Sharwil (https://avocado.ucr.edu/avocado-variety-database)

Variety

KONA SHARWIL

Flower Type

B

Fruit Color

Green

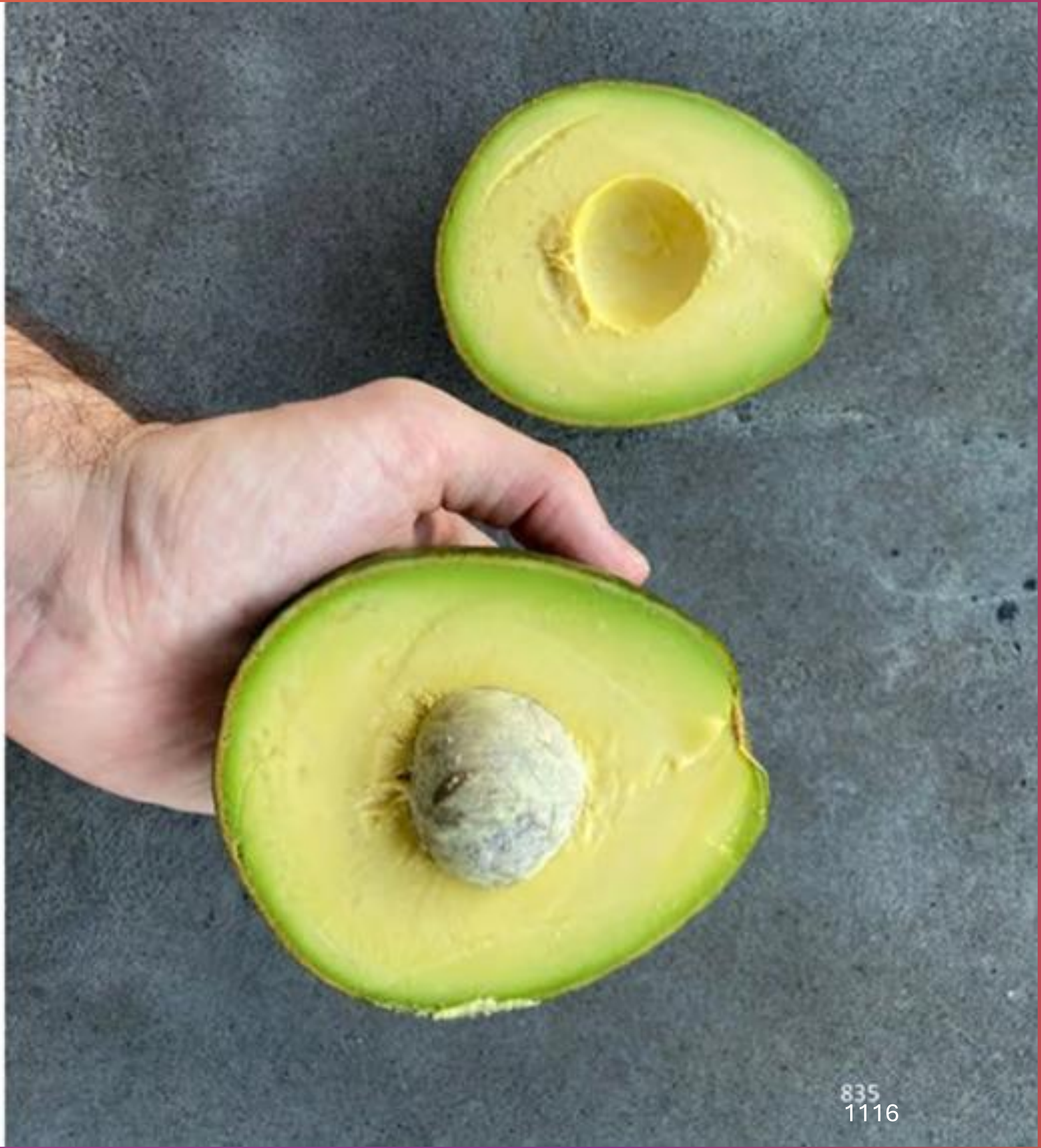
Ecotype

Guat x Mex

Description

See Sharwill. This hybrid was originally from Australia but became commercial in Hawaii hence the added "Kona". A high quality fruit. Sometimes spelled Sharwil (J.R.Frink 1998)

Kahalu’u. Flower type B. 10-28 oz. Green. Smooth. (https://treevitalize.com/avocado-trees-hawaii/)



Kahalu’u 10-28 oz. Green. Smooth. Flower type B. (Hawaii.edu)

The Kahalu'u is a large green skin Hawaiian variety that matures in the fall. It has a high oil content which gives it a delicious flavor and soft creamy texture. It has a thin skin and the size ranges from approximately 10 oz to 28 oz. It is usually available in Hawaii from late October to December.

Kahaluu (https://avocado.ucr.edu/avocado-variety-database)

Variety

KAHALUU

Flower Type

B

Fruit Color

Green

Ecotype

Guat x WI

Description

Orig. in Kahaluu, N. Kona, Hawaii. Introd. in 1955. Guatemalan type x West Indian type; selected in 1940. Fruit: obovate to pyriform; 12-18 oz; skin smooth, green; seed small, tight in cavity; oil content high; quality excellent; ripens Nov. - Jan.; resembles Fuerte. Tree: large; upright; vigorous; annual bearer, but only moderately productive. (B&O Register) Origin, HI; Race, WIxG; Flowering group, B (Lahav & Gazit)

Yamagata. Large. Light green. Rough skin. (https://www.plantithawaii.com/avocado)

Yamagata is a Hawaii selection with a long and heavy bearing season from March to July. The fruit is large and pear-shaped with a small seed and green skin. The fruit is delicious and received the 2011 award for best tasting and all around best Avocado in Kona's Buyers Preference challenge.

Yamagata. Large. Light Green. Rough skin. (https://www.ctahr.hawaii.edu/oc/freepubs/pdf/CFS-AVO-3D.pdf)

Yamagata is a late spring, early summer variety that is generally [from March to July]. available from May to June. It has a light green rough skin and excellent flavor.

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Yamagata (https://avocado.ucr.edu/avocado-variety-database)

Variety
YAMAGATA
Flower Type
B
Fruit Color
Light green. Rough skin.
Ecotype
Not available
Description
Origin, HI; Flowering group, B (Lahav & Gazit)

Greengold. Flower type A. (Plantithawaii.com)

Greengold is a cultivar developed by the University of Hawaii, considered by many to be superior to the Sharwil. Trees have a long and heavy bearing season generally between January and April. The fruits are medium size, pear-shaped with a small seed, high oil content, and a rough green-gold skin. Type A flowers.

Greengold. 10.6 – 17.6 oz. Green. Pebbly. Heavy yielding. Tolerates methyl bromide fumigation. (Hawaii.edu) Flower type A.

Greengold. 10.6 – 17.6 oz. Green. Pebbly. Heavy yielding. Tolerates methyl bromide fumigation. Flower type A.

(https://www.ctahr.hawaii.edu/oc/freepubs/pdf/CFS-AVO-3D.pdf)

Named for the color of the skin, this variety was developed by the University of Hawaii. It has a high oil content and excellent taste and is considered by some to be even better than the Sharwil. It is usually available from February to May. It is heavy bearing. Fruit size is 10.6 to 17.6 oz.

Greengold is a high quality, late season cultivar developed by the Department of Horticulture, University of Hawaii at Manoa. The cultivar is suitable for local and export markets.

Origin 'Greengold' is an open-pollinated seedling of 'Sharwil' grown at Haleakala Experimental Farm. It was first designated as HAL R27T8 in 1976. It was also tested suitable for local and export markets.

A type flower. Tolerates methyl bromide fumigation without damage to quality or appearance. Damage from fruit rot and anthracnose is less than that of 'Sharwil'. Yield is higher than Sharwil.

It meets the need for a quality, high yielding cultivar for local and export markets. Greengold is very heavy yielding. Average annual yield of 528 lbs per tree for 18-22 year old trees.

Hass. 6-14 oz. Black. Ovate. Pebbly. High yielding. A type flower. (Hawaii.edu)

The most common of all avocados, the Hass turns black when ripe. It is a small fruit (6-14 oz.) with good flavor but a larger seed and less oil content than other Hawaiian varieties. High yielding.

Hass (https://avocado.ucr.edu/variety-list#hass)

Originated in LaHabra, Heights, California, by Rudolph Hass. Introduced in 1936. Oval/pear shaped fruit.The leading commercial variety in California. One of the longest harvest seasons usually in February through November in Ca. Excellent flavor and shipping qualities. Hass is often used as a control in field testing of other varieties.

Parentage: Hybrid

Peels: Yes

Seed Size: Medium

Skin Texture: Pebbly

Blossom Type: A

Fruit Shape: Narrowly obovate to obovate

Skin Color Unripe: Green

Skin Color Ripe: Black

Skin Thickness: Medium

Average Fruit Weight oz: 6 to 14

Hass avocado (Homesteadandchill.com, https://avocado.ucr.edu/variety-list#hass, https://avocado.ucr.edu/avocado-variety-database)

Regist.1932 Plant Patent139 Aug. 27,1935 Origin.1926 from seed planted by R.G.Hass at 430 West Road, La Habra Hts.,CA. Originated in LaHabra, Heights, California, by Rudolph Hass. Introduced in 1936. Oval/pear shaped fruit. The leading commercial variety in California. One of the longest harvest seasons. 94.8% of the California acreage in 2012.

Guat x Mex. Flower/Pollination: Type A. Zones: 9-11. 6-14 oz. Medium seed. Tight in cavity. Medium skin thickness. Peels easily. Pebbly. Good shipper. Oil 18-23.7%. Up to 35% in Queensland. No fiber.

Growing Habits: Up to 35 feet, though can be kept pruned to be shorter (as with all avocado trees). Very productive. Some alternate bearing.

Cold-Hardy to: Frost-sensitive at 30 F. Also less heat tolerant than some avocado varieties, such as the more heat-hardy Mexicola, Lamb Hass, and Reed.

Fruit Characteristics: Creamy, nutty, high-fat flesh and medium-large fruit. Thick textured skin that turns black when ripe. Keeping quality excellent. Good shipper.

Bloom Time: February to May.

Ripens: April through November – from the previous years flowers.

Other Unique Facts: The Hass variety was first bred in a Southern California backyard in the 1930s. However, the Hass wasn’t grown and marketed on a large scale until the late 1970s. Both Hass and Reed avocado varieties provide a decent crop when grown solo (without a pollinating partner).

Lamb Hass. Type A flower. (https://www.plantithawaii.com/avocado)

Lamb Hass

Lamb Hass is a California selection bearing spring and summer fruit. It is a heavy regular bearer, with fruit averaging 10 to 18 ounces with skin black when ripe. Fruit may have a larger seed when grown in rainy areas. Type A flowers.

Lamb Hass avocado (Homesteadandchill.com. https://avocado.ucr.edu/avocado-variety-database. https://avocado.ucr.edu/variety-list#lamb-hass)

Guat x Mex Hybrid from the University of California avocado breeding program. Originally named BL122. Flowering group A. Fruit black when ripe. Usually is a shouldered pear shape with pebbly skin texture weighing from 10 to 18 oz. Tree grows upright. Is being grown commercially in California. Matures later than Hass.

Flower/Pollination: Type A. Zones: 9-11. Growing Habits: Medium size upright and compact tree. Lamb-Hass is a cross between the traditional Hass Avocado and a Gwen (semi dwarf) avocado varieties.

Cold-Hardy to: Sensitive below 30° F. More cold and heat-tolerant than Hass.

Fruit Characteristics: Similar but larger than Hass. Excellent flavor and high oil content. The thick pebbly skin turns black as the fruit ripens, isn't as pliable as Hass and therefore less easy to peel. Medium skin thickness. Medium sized seed. Obovate fruit shape. Black unripe and ripe.

Bloom Time: Late winter to spring. Ripens: The following April to November. The Lamb Hass has a longer and later season than Hass (extends the typical Hass season), but also takes slightly longer to mature on the tree. Give Lamb Hass at least one year (up to 18 months) on the tree after the fruit first develops until harvest.

Beshore. Larger than Sharwil. Dark green. Pebbly. (Hawaii.edu)

The Beshore is a seedling of the Sharwil and has a similar excellent taste and high oil content. It is generally larger and more elongated than the Sharwil. The skin is dark green and thick and it is usually available in the late Spring.

Malama

1-1.5 lb.
Purple. (Hawaii.edu)
Tolerates methyl bromide.
Resist stem rot and anthracnose. Type B flower.

Malama is a purple skin early fall variety. It is a medium size fruit (1-1.5 lb) with excellent taste and a small seed. It is usually available in Hawaii from September to November. 'Malama' is a new, high quality, fall-ripening avocado (Persea americana L.) cultivar developed by the Department of Horticulture, University of Hawaii. Fruits are tolerant of methyl bromide fumigation and appear resistant to stem end rot and anthracnose. The flesh is bright yellow, shading to green next to the skin. The flavor of the flesh Is rich and nutty, and the oil content is more than 20 percent. The texture of the flesh is smooth and without fiber. Type B variety.

Malama. Type B flower.
1-1.5 lb.
(https://www.plantithawaii.com/avocado)

Malama

Malama is a Hawaii selection that is a regular, heavy bearer with fruit ripe early in the fall. Skin is purple when ready to eat, easy to peel, with a rich and nutty flavor. The fruit has high oil content and is deliciously creamy.

Malama. 1-1.5 lb.
Purple. Tolerates methyl bromide.
Resist stem rot and
anthracnose. Type B flower. (Hawaii.edu)

USDA Projects (Fall 2023 Newsletter from the Hawaii Avocado Association (mailchi.mp))

Malama Export Suitability Study - The USDA Agricultural Research Service (ARS) in Hilo (PBARC) completed the oriental fruit fly susceptibility study of Malama avocado and has submitted a recommendation to USDA/APHIS for the Malama variety to be added to the existing Sharwil systems approach protocol for mainland export. While it may take considerable time for approval, it is encouraging news for Malama growers. Mahalo to Dr Peter Follett for all his research efforts on our behalf.

Healani, Hawaii. Dark purple. Smooth skin. ¾-1 lb. (Yahoo.com)

Black fruit from Hawaii. Healani. Dark purple. ¾-1 lb. Smooth skin.

(Producingavocadoinhawaii.com,1979)

The Healani is a seedling planted by Howard Cooper in Hana, Maui. The tree and fruit characteristics indicates it to be of West Indian origin. Fruit characteristics: form, oblong oval; color, dark purple when mature; surface, very smooth; skin, very thin; welght, 3/4-1 pound; flesh, yellow; flavor, mild and pleasant; seed, small-medium; season, August to September. Oil content, about 14.8 percent.

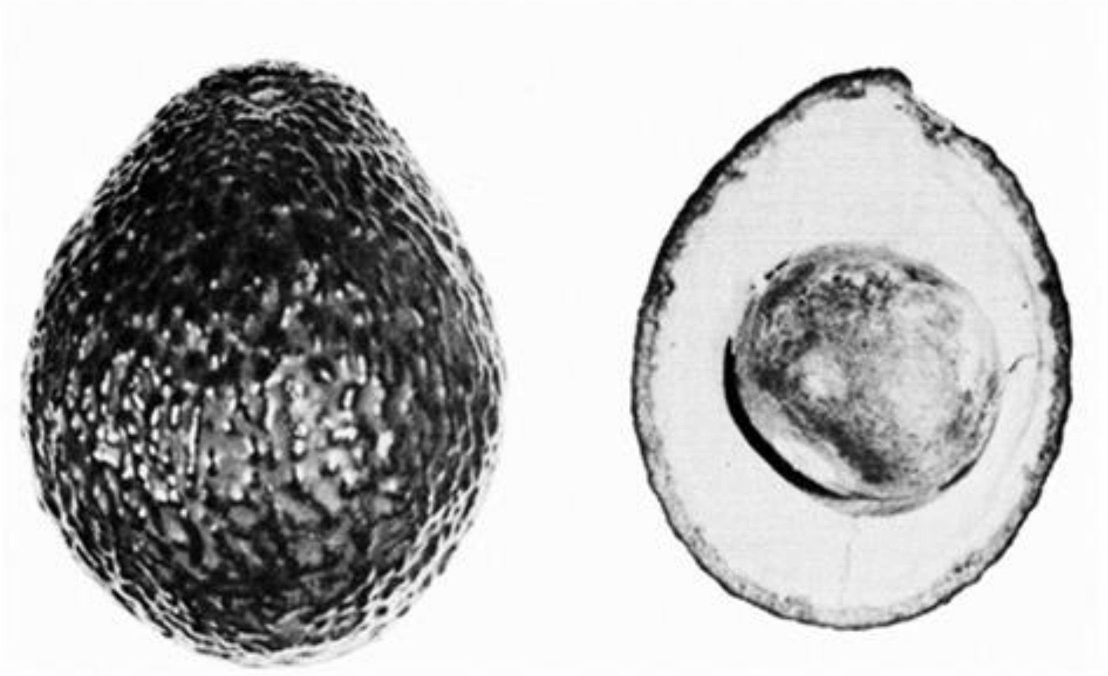
Masami Avocado. Hawaii. (Bing.com)
½-1 lb. Shiny black. Annual bearer.
Keeps well in cold storage.

Masami Avocado. Hawaii. (Bing.com) ½-1 lb. Shiny black. Annual bearer. Keeps well in cold storge.

Masami is a seedling from Masami Ohata's farm at Keala kekua, Kona. It has borne crops in Kona annually. Fruit characteristics: form, pyriform; color, attractive shiny black when fully mature; skin, thin and smooth; weight,1/2-1 pound; flesh, light yellow; flavor, mild and pleasant; seed, medium to large; season, April to June. Oil content, about 19.4 percent or lower. It is an annual bearer in Kona. Ripe fruits have good cold storage keeping quality. In some locations bearing is so heavy that fruiting occurs in alternate years.

Hayes (Producingavocadoinhawaii.com,1979)

Black or dark purple. Hayes is an open pollinated seedling selection of Hass from the College of Tropical Agriculture Branch Station at Poamoho, Oahu. Like the Hass, the shape is oval to pyriform; color, reddish-pur ple to dark purple; skin, pebbled and leathery; weight, 1/2-3/4 pound; flesh, pale yellow; flavor, rich and nutty; seed, small to medium; season, March to May. Oil content, about 20.5-21.6 percent. Type A flower. Black. Very productive. Cold hardy. Similar to Hass.



Hayes. Hawaii.
Black. Similar to Hass but larger. 11-19 oz. Glossier, pebbled. Very productive.
Hardy.
A flower type.
(https://flyingdragonnursery.co.nz/products/avocado-hayes)

Hayes (https://avocado.ucr.edu/variety-list#hayes)

Oval/sphere or oval/pear have been used to describe this fruit's shape. Looks like Hass.

Parentage: Guat X WI hybrid.

Peels: No

Seed Size: Small to medium.

Skin Texture: Medium

Blossom Type: A

Fruit Shape: Obovate

Skin Color Unripe: Green

Skin Color Ripe: Black

Skin Thickness: Thick

Average Fruit Weight oz: 11 to 19

Hayes (https://avocado.ucr.edu/avocado-variety-database)

Flower Type A   Fruit Color Black   Ecotype Guat X Wi

One tree is growing at the South Coast Research Station, Irvine, CA., in field 44, row 5, tree 14. Pear shaped, green firm, black when soft,11-19 ozs, doesn't peel easily, attractive flesh; flavor, average minus; season March to May. A flower. Originally 2 trees but one Hayes was grafted over. Tree is large & hardy & very productive. (J.R. Frink 1998) (=Haes) 7315 Origin, HI; Race, GxWI; Flower group, A (Lahav & Gazit)(a new hybrid in HI, one parent being Hass). Fruit resembles Hass but is larger; skin is glossier, is pebbled, rough, thick & becomes brown- purple. Season:late (mid-Oct. to Dec. in New Zealand). Tree is erect with drooping branches & the fruit is largely sheltered by the foliage.

Hayes (7315) is an open pollinated seedling selection of Hass from the College of Tropical Agriculture Branch Station at Poamoho, Oahu. Like the Hass, the shape is oval to pyriform; color, reddish-purple to dark purple; skin, pebbled and leathery; weight, 11-19 oz; flesh, pale yellow; flavor, rich and nutty; seed, small to medium; season, March to May. Oil content, about 20.5-21.6 percent. (Yahoo.com)

Linda Avocado. (Yahoo.com)

Purple. 1.5-2 lbs. Too large. A regular bearer.

B type flower.

Rough skin.

Hawaiian.

Linda. B type flower. (Plantithawaii.com)

Linda. 1.5-2 lbs.

Linda is a regular, heavy bearing tree with fruit that ripens in the spring. The avocados are large and roundish with a medium seed, dark purple skin when ripe. It is often referred to as the "dieter's avocado" due to its lower oil content and good flavor.

Linda. 1.5-2 lbs. Too large. Purple. Regular bearer, moderate to heavy crops. Rough skin. B type flower.
(HawaiiAvocadoGrowing.pdf)

The Linda is a Guatemalan variety introduced by E. E. Night to California in 1914. There is no record of its first introduction to Hawaii. The variety is well distributed throughout the Islands, however. The tree is a regular bearer with moderate to heavy crops. Fruit characteristics: form, round to oblong; color, purple when mature; surface, rough; rind, medium-thick; weight, 1.5-2 pounds; flesh, light yellow tinged with green next to rind; flavor, very mild; seed, small, season May to Oct in CA. Oil content, about 10-14 percent.

Linda Avocado, Hawaiian. 1.5-2 lbs (Too large). Dull purple. Rough skin. Bears regularly. Moderate to heavy crops. B type flower.

(https://avocado.ucr.edu/avocado-variety-database)

Flower Type B   Fruit Color Purple   Ecotype Guat

Introduced 1914 by E.E. Knight at Yorba Linda, CA, from Antigua, Guat., elevation 550 ft. Being propagated in HI & satisfactory in West Coast area of FL. Illus. An. Rept. 25-26. Also FL.Exp. Sta. bul.272. Shipping quality good. Too large for market. (CAS Yearbook 1950) 2 Linda trees at South Coast Research Station, Irvine, CA. Budwood introduced into CA from GUAT. in 1914; propagated in FL in 1917); Some older Linda seedling cultivars are also at this location. (L137, L141 & L28 and more) (J.R. Frink 1998) Origin, Guat.

Fruit season, May-Oct.; color, purple; weight,16-48 ozs.; shape, round to oblong; skin, smooth, med. thick;flavor, excellent; oil,12%.

Seed, small. Race, Guat.; Flowering group, B. (elliptical; very large; skin rough, dull-purple when ripe; flesh yellow, 10-14% oil; seed small, tight.

Season: May-Oct. in CA; late (Dec.-Feb.) in FL. A good shipper but not popular in FL because of size & color. Tree low, spreading, vigorous & bears regularly.

McDonald. Dark purple to black.

8-16 oz.

B type flower.

Pebbled skin.

Productive.

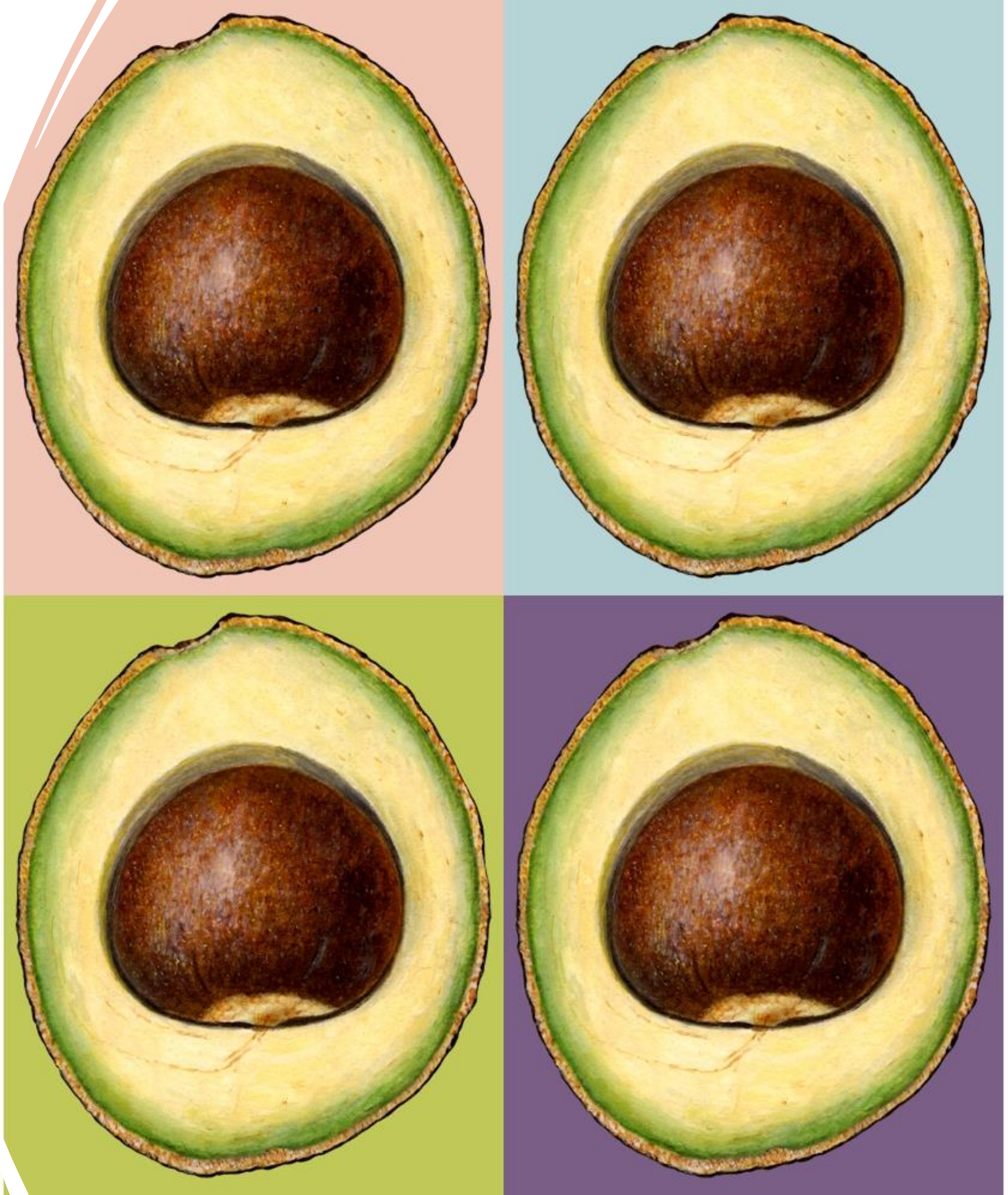
(Hawaii.edu)

Medium-large seed.

McDonald
(https://avocado.ucr.edu/variety-list#mcdonald)
Medium-large seed..

879

McDonald was grown from a seed imported from Guatemala by Admiral Beardslee in 1891. The tree was planted at 1402 Punahou Street by Judge Wiedman. Fruit characteristics: form, spherical; color, dark purple to black; skin, highly pebbled, thick and granular; weight, 8-16 ounces; flesh, yellow; flavor, rich and nutty; seed, large; season, May to August in Hawaii. B type flower. Productive. Pebbled. 8-16 oz. (Hawaii.edu)



McDonald (https://avocado.ucr.edu/avocado-variety-database)

Flower Type B   Fruit Color Purple   Ecotype Guat

Hawaii-Florida Originated from seed planted 1895. Brought to Honolulu by Admiral Beardslee. This & a few seedlings of it are among the leading commercial varieties in Hawaii. Illus. & desc. HA Agri. Exp. Sta. Bul. 51.

Fruit season, Nov.-Apr. in CA; color, purple; weight, 8-16 ozs.; shape, spherical; skin, thick, rough, warty; flavor, rich. Seed, medium-large.

This variety is commercial in HA. (CAS Yearbook 1950). One tree at South Coast Research Station, Irvine, CA. field 46, row 57, tree #2. Origin, HI; Race, Guat.; Flowering group, B.

Black fruit from Hawaii: McDonald. Dark purple to black. 8-16 oz. Pebbled. Productive. A type flower. (HawaiiAvocadoGrowing.pdf)

The McDonald was grown from a seed imported from Guatemala by Admiral Beardslee in 1891. The tree was planted at 1402 Punahou Street by Judge Wiedman.

Fruit characteristics: form, spherical; color, dark purple to black; skin, highly pebbled, thick and granular; weight, 8-16 ounces; flesh, yellow; flavor, rich and nutty; seed, med-large; season, May to August in Hawaii.

MacDonald (https://avocado.ucr.edu/variety-list#mcdonald)

Originated from seed planted in 1895. Brought to Honolulu by Admiral Beardslee. This and a few seedlings of it were among the leading commercial varieties in Hawaii. Fruit season Nov. – April in CA.

Parentage: Guatemalan

Seed Size: Medium-large.

Skin Texture: Rough, warty

Blossom Type: B

Fruit Shape: Spheroid

Skin Color Unripe: Green/Black

Skin Color Ripe: Black

Skin Thickness: Thick

Average Fruit Weight oz: 8 to 16

Beardslee. Type A flower. (https://www.plantithawaii.com/avocado)

Beardslee were introduced to Honolulu in 1911, Beardslee is a fall to early winter variety bearing fruit weighing between 24 and 40 ounces. The fruit are oval to pyriform in shape, with a purple skin, and a rich and creamy flavor.

Beardslee (https://avocado.ucr.edu/avocado-variety-database)

Flower Type A.   Fruit Color Purple   Ecotype Guat

Ables Tree originated from seed of Macdonald planted 1911 by L.C. Ables in Honolulu, HI. First known as Ables but renamed for man who brought the seed of parent tree into HI. Illus. & described HI Agr. Exper. Sta. Bul. 51. One of important commercial varieties in HI. (CAS Yearbook 1950).

Fruit season, fall to early winter; color, purple; weight, 24-40 ozs.; shape, oval to pyriform; skin, rough; flavor, rich. Seed size, small.

A flowering type.

Fujikawa. B type flower. (https://www.plantithawaii.com/avocado)

Fujikawa

Fujikawa is a Hawaii selection that has a consistent heavy bearing spring season. The pear-shaped fruit has a medium-sized seed and green skin with excellent flavor.

Fujikawa (https://avocado.ucr.edu/avocado-variety-database)

Flower Type B

Fruit Color Green

Ecotype Guat

Origin, HI; Race, Guat.; Flowering group, B.

Murashige. B type flower. (https://www.plantithawaii.com/avocado)

Murashige is a Hawaii selection that is a heavy bearer with fruit ripe in late spring and early summer. The fruit is large and pear shape, with a small seed and a dark green skin. It has excellent flavor but ripe fruit does not store well.

Murashige (https://avocado.ucr.edu/avocado-variety-database)

Flower Type B

Fruit Color Dark Green

Ecotype Guat

Origin, HI; Race, Guat.; Flowering group, B

Ota. (https://www.plantithawaii.com/avocado)

Ota. Green.

Ota is a Hawaii selection with a long and heavy bearing season from late in the fall and all through the winter months. The fruit holds well on the tree, and is round with great flavor and a small seed.

San Miguel. A type flower. (https://www.plantithawaii.com/avocado)

San Miguel

San Miguel bears pear-shaped fruit in fall and winter. The green skinned roundish fruit is about 8 to 20 ounces, with creamy texture that melts in the mouth. It is a productive spreading tree. Type A flower.

San Miguel (https://avocado.ucr.edu/avocado-variety-database)

Flower Type A

Fruit Color Purple

Description

San Miguel is a high quality fall bearing avocado. The fruits are pyriform shaped and purple when mature. Type A flower. (Frankie's Nursery, Waimanalo, Hawaii,1999)

Nabal. 16-35 oz. Guatemalan. Type B. Spheroid. Green. Large seed. Excellent flavor. Oil 10-22%. Hardy to 30 F. Peels easily. Heavy bearer in alternate years. June to Oct in CA. Subject to wind scars and shedding. (Bing.com)

Nabal. 16-35 oz. Type B. Productive but alternate bearing. Green. High quality. (https://avocado.ucr.edu/variety-list#nabal)(Specialtyproduce.com)(https://avocado.ucr.edu/avocado-variety-database)

Guatemalan. Imported into the U.S. by F. W. Popenoe in 1927, in Florida in 1937. Introd.1917 by F. W. Popenoe, USDA from Antigua, Guat., elevation 5100 ft. Parentage unknown. Being propagated in HI and FL. Marketability, good. Season June-Oct in CA. Jan. & Feb. in FL; Oct. & Nov. in Queensland. Tree is strongly alternate bearing. Tree a good grower & heavy bearer in alternate years. Tree bears well in central FL; In Queensland, bears in alternate yrs. very heavily, but is rated as of med. quality & disease-prone during prolonged ripening. **Frost-sensitive (30 F)**, and when planted in windy areas, this variety can also be subject to wind scars and shedding of fruit.

Skin and Flesh: Peels: Easily. Skin Texture: Smooth. Skin Thickness: Medium-thick. Hard and shell like. Flavor, excellent. Flesh of high quality. Creamy and greenish yellow. **Fruit** Shape: Spheroid. Average Fruit Weight oz: 16 to 35. Oil 10-22%. Seed large, tight in cavity.

Nabal.

(https://specialtyproduce.com/produce/Nabal_Avocados_11226.php)

The Nabal avocado is a rare Guatemalan variety with smooth, dark green, medium-thick skin that peels easily and is covered with yellow freckles. Nabal avocados are very large, weighing up to seventeen ounces, and they have a rounded, softball shape. They are known for having exceptionally high-quality flesh that is deliciously creamy and greenish-yellow in color, and surrounds a large central pit.

The Nabal avocado tree has a greater tendency to alternate bearing than other commercial varieties, but it is known to be a vigorous producer of the hefty, flavorful fruit. It is one of the more frost-sensitive cultivars, and when planted in windy areas, this variety can also be subject to wind scars and shedding, when nearly mature.

Avocados on the tree are inhibited from ripening because of a hormone supplied from the leaves, and hence farmers can store the fruit on the tree for up to eight months after maturity. Once the fruit is harvested it starts to ripen, and unlike most fruit, the sugar content of avocados decreases rapidly during ripening.

Nabal avocados are available in the summer and early fall.

Panchoy.

(https://www.avocadosource.com/CAS_Yearbooks/CAS_13_1928/CAS_1928_PG_87-90.pdf)

Panchoy: A splendid, two pound, green colored fruit. Heavy oval, even sized, no small fruits, very thick skin, small seed, yellow, clean, rich, dry flesh, heavy fruiter, holds in the wind. BUT, for past two years fruit has developed black end and dropped prematurely. Its ordinary season is late summer and fall of the next year. Will hang some fruits until Christmas. Am holding Panchoy under observation. Grown in South Africa.

Itzamna.

(http://avocadosource.com/CAS_Yearbooks/CAS_16_1931/CAS_1931_PG_217-226.pd) Grown in South Africa.

The Itzamna is an exceptionally fine variety, and has done very well at Alkmaar. The tree is very vigorous and has borne good crops of fine fruit every year. The tree is much more vigorous than the Mayapan, and owing to its spreading habit, combined with height, it is a much larger tree than the Mayapan and will naturally carry more fruit. The Itzamna fruit is much superior to the Mayapan, hence in the opinion of the writer the Itzamna is a much better variety than the Mayapan, at Alkmaar at any rate, yet the Mayapan is ranked higher than the Itzamna in California. It would seem that the Itzamna would merit promotion to list No. 2. Photo 8 shows a six-year-old Itzamna tree at Alkmaar. This tree bore fruit at three years of age and a good crop at four years of age, and the fruit is exceptionally fine, resembling the Fuerte somewhat. This is a particularly fine growth for six years, and it is doubtful whether one could find anything much better anywhere. The writer is full of praise for this variety, and regards it as our second best variety of those fruiting so far at Alkmaar. It would be interesting to know whether the Itzamna has also gained in favor in California. In the Hawaiian Islands it seems to be making a name for itself. The Itzamna so far has beaten the Fuerte, as far as yield is concerned, at Alkmaar and its future performance will be watched with interest. It is also a good late variety and, therefore, valuable.

Itzamna.
(https://www.avocadosource.com/CAS_Yearbooks/CAS_13_1928/CAS_1928_PG_87-90.pdf)

Itzamna:

**Another splendid variety, average pound, green color, looks much like a large Lyon fruit, smooth, clean, yellow flesh, flavor fine, seed under medium, late summer,
fruit last year held into October. First fruiting last year was from a top-work then only three and half years old. 80 fruits. This is another of Wilson Popenoe's varieties to be proud of. Two trees were top-worked, but one turned out to be a heavy fruiter of some other good variety which is under observation. Likewise this tree has been closely clipped for budwood, so that I haven't yet gotten any for myself. But hope to have a number of top-works of Itzamna. Probably nine people out of ten carelessly call this "Examiner". Wilson Popenoe said he retained the name, "Itzamna", which the natives had given it, in Guatemala, in honor of the chief god of their Mayan religion. So they must have esteemed it highly.**

Kaguah avocado. (bing.com) Another Hawaiian variety.

Recommendations for Hawaii

The author recommends dark purple or black varieties for Hawaii to meet the demand for Hass. As long as they have consistent production. Recommended Hawaiian purple or black varieties are McDonald, Linda (too large?), Masami, Hayes, Healani, Malama. Or try some of the new Hass that Florida is breeding. Or try some of the black varieties from California: Hass, Lamb Hass, Gem, Sirprise, Stewart, Mexicola Grande, Dickinson (old), Luna (new). Or Joey, cold hardy (15 F), very productive, purple-black, from Texas, looks like Hass. Or Brogdon or Wilma from Texas, both purple or black. And the new Luna from UCR California. Better than Hass. Looks like Hass.

Hawaiian avocado varieties are at https://www.hawaiiavocadoassociation.com/hawaiian-avocado-varieties.html

Black Avocados from Hawaii: Linda, McDonald, Hayes, Masami, Healani, Malama. (McNeil, 2024)

Linda Avocado. (Yahoo.com)

Purple. 2 lbs.
regular beare
Rough skin.

McDonald was grown from a seed imported from Guatemala by Admiral Beardslee in 1891. The tree was planted at 1402 Punahou Street by Judge Wiedman. Fruit characteristics: form, spherical; color, dark purple to black; skin, highly pebbled, thick and granular; weight, 8-16 ounces; flesh, yellow; flavor, rich and nutty; seed, large; season, May to August. B type flower. Productive. Pebbled. 8-16 oz. (Hawaii.edu)

857

Hayes. Hawaii.
Black. Similar to Hass but larger. 11-19 oz.
Glossier, pebbled.
Very productive.
Hardy.
A flower type.
(https://flyingdragonnursery.co.nz/products/avocado-hayes)

835

Masami Avocado. Hawaii. (Bing.com)
½-1 lb. Shiny black. Annual bearer.

Healani. Hawaii. Dark purple.
Smooth skin. ¾-1 lb. (Yahoo.com)

850

Malama, Hawaii. 16-24 oz.
Purple. (Hawaii.edu)

Black Fruit from California, Hawaii, Florida, Texas.

Black from California: Hass, Lamb Hass (new), Sir Prize (new), Gem (new), Stewart (new), Mexicola Grande (new), Dickinson (old). And the new Luna from UCR California. Better than Hass.

Black fruit from Hawaii: Recommended Hawaiian purple or black varieties are McDonald, Linda (too large?), Masami, Hayes, Healani, Malama.

Black fruit from Florida: Brogdon.

Black fruit from Texas: Brogdon, Wilma, Joey.

New black or purple varieties: Brogdon, Gloria, May, Wilma (Brazos Belle), Joey, Mexicola Grande. And the new Luna from UCR California. Better than Hass.

Hawaii-continued.

The Division of Marketing of the State Department of Agriculture has setup grade standards for commercial export shipments. Avocado must be graded Hawaii No.1 or better, to be shipped. In addition, the minimum oil content of the avocados in any lot must be 12 percent or higher. Further information on characteristics of each grade can be obtained from the above agency. Small individual gift packages, however, are not affected by these grade restrictions.

https://www.hawaiiavocadoassociation.com/hawaiian-avocado-varieties.html

Hawaii Avocado Association
PO Box 925, Kealakekua, Hawaii, 96750
(808) 329-9729

September 28, 2018

Aloha Hawaii Avocado Growers.

This letter is in follow up to our letter sent on 8/28/18 informing you of our opportunity to ship Sharwil avocados to the mainland.

As previously announced, Pacific Coast Fruit company will be marketing our Sharwils on the US mainland and are able to pay $1.40/pound for number 1 avocados. Pacific Coast Fruit Company has made it clear that they want Sharwil avocados and are interested in establishing a yearly market for Sharwils.

The avocado association encourages all avocado growers to check into this opportunity as soon as possible. So far only a few farmers have expressed interest in this program.

If you wait until November or December, the opportunity may be lost.

The process for shipping avocados to the mainland is not difficult. Jeff Knowles will come to your farm at no charge and give you a summary of the program and other technical advice. Jeff can be reached at jknowl12@yahoo.com and 808-896-0504.

Please check with Jeff to see if this program is right for you.

John

John App, President
Hawaii Avocado Association

Avocado Production in Other States - References

See the following websites about avocado production in Florida, Texas, Puerto Rico, and Hawaii.

https://www.bing.com/search?q=florida+avocado+growing

https://www.flgardening.com/growing-avocados-in-florida/

https://blogs.ifas.ufl.edu/stlucieco/2021/08/03/growing-avocado-in-florida/

https://blogs.ifas.ufl.edu/stlucieco/tag/avocado/

university of hawaii growing avocados - Search (bing.com)

https://gms.ctahr.hawaii.edu/gs/handler/getmedia.ashx?moid=4689&dt=3&g=12

Best: https://www.ctahr.hawaii.edu/oc/freepubs/pdf/C1-382.pdf

https://shuncy.com/article/puerto-rican-avocados

https://reeis.usda.gov/web/crisprojectpages/1009615-evaluation-of-avocado-persea-americana-varieties-and-management-to-extend-fruit-production-year-round-and-increase-productivity.html **In Puerto Rico**

https://caribbeantrading.com/puerto-rican-avocado-most-versatile-ingredient/

https://aggie-horticulture.tamu.edu/fruit-nut/wp-content/uploads/sites/6/2015/04/avocados_2015.pdf

https://www.hawaiiavocadoassociation.com/hawaiian-avocado-varieties.html

https://hawaiiavocado.weebly.com/uploads/2/6/7/7/26772370/avocado_in_kona.pdf

https://shuncy.com/article/brogdon-avocado-tree

https://news.ucr.edu/articles/ **Luna UCR**

Avocado Forecast for Other States

All other states that grow avocados want to increase their avocado plantings and production. The reason is to produce more profits, especially because of the high demand and prices for avocados, especially for California, and Mexico, Peru, Chile –all those exporting into the United States. Florida has lost half of its citrus acreage (400 acres out of 800 acres) from citrus greening disease for which there is no prevention or cure. It would like to replace some of those losses with increased avocado production and income in the Indian river area.

My recommendation would be to increase production of their black and dark purple cultivars to sell in the Hass market, the number one cultivar with the best prices. In fact Florida is trying to breed a new Hass that they can grow and market. It has gotten Hass seed from California crossed with Bacon a cold hardy cultivar. They also should plant cold hardy varieties in northern Florida. As should Texas. Or plant the new Luna from California. Black. Better than Hass. Looks the same. Not cold hardy.

Other states should also increase their plantings of purple or black varieties like the Hass or other black varieties from California, Hawaii, Texas, Florida, and Puerto Rico.

Read the articles below:

https://explore.research.ufl.edu/uf-research-may-give-new-hope-expanding-avocado-production.html

https://www.freshfromflorida.com/Divisions-Offices/Plant-Industry/Save-the-Guac.

Cold Hardy Varieties recommended for Northern Florida or Texas by the author.

Joey
Wurtz
Winter Mexican
Poncho
Mexicola Grande
Mexicola
Lula
Lila
Hall
Fantastic
Day

Slide 1: Cold Hardy Varieties recommended for Northern Florida or Texas by the author. Joey, Wurtz, Winter Mexican, Poncho, Mexicola Grande, Mexicola. Black are recommended, espec. Joey. (McNeil, 2024)

Joey. Medium sized. Purple-black. Very cold hardy (15 F). Heavy production.

Wurtz (Little Cado). Green. 8-12 oz. Very cold hardy (25 F). . Bears moderately but regularly

Winter Mexican. Dark green. Bears heavily and regularly. 12-18 oz. Very cold hardy (mid-20's).

Poncho. Very cold hardy. 15 F. Medium large size. Green. Average production.

Mexicola Grande. Very cold hardy. 15 F. 6-10 oz. Black. Bears early and regularly

Mexicola. (Etsy.com)
3-5 oz. Black. Anise leaf smell. Smooth skin. Bears early and regularly. Cold hardy to 20 F.
A type flower.

Slide 2: Cold Hardy Varieties recommended for Northern Florida or Texas by the author: Lula, Lila, Hall, Fantastic, Day. Black are recommended. Joey slide 1. (McNeil, 2024)

Lula. Med-large. Green. Very cold hardy. Bears early and heavily.

805

Lila. Dark green. Very cold hardy, 15 F. Medium size. Strong production.

Hall Avocado. Green. Large. Very cold hardy. Alternate but heavy bearer.

799

Fantastic Avocado. Medium size. Green. Tolerates 15 F. Vigorous production.

795

Day Avocado. Large fruit. Very cold hardy. Dark green.

793

Black Fruit from California, Hawaii, Florida, Texas.

Black from California: Hass, Lamb Hass (new), Sir Prize (new), Gem (new), Stewart (new), Mexicola Grande (new), Dickinson (old). And the new Luna from UCR. Better than Hass.

Black fruit from Hawaii: Recommended Hawaiian purple or black varieties are McDonald, Linda (too large?), Masami, Hayes, Healani, Malama.

Black fruit from Florida: Brogdon.

Black fruit from Texas: Brogdon, Wilma (Brazos Belle), Joey.

New black or purple varieties: Brogdon, Gloria, May, Wilma (Brazos Belle), Joey, Mexicola Grande, Winter Mexican (dark green), Mexicola. Available in Florida?, some in Texas. Luna from California. Better than Hass.

Other cold hardy black varieties – probably available from Florida, some from Texas, some from California.

May Avocado. 4-5 oz. Cold hardy. Black.

Wilma (Brazos Belle) Avocado. Cold Hardy, 25 F. Med-large. Black.

Gloria Avocado. 3 oz. Cold hardy. Black.

Brogdon avocado. 10 oz+. Black. Hardy to 26-28 F.

Mexicola Grande. Black. Cold hardy 20-22 F.

Mexicola. Black. Large. Cold hardy 20 F.

Joey. Purple-black. Medium sized. Very cold Hardy, 15 F. Heavy production. Looks like Hass.

Hayes. Black. Cold Hardy. From Hawaii. Looks like Hass.

Six New Black Fruit from California: Mexicola Grande, Gem, Sir Prize, Lamb Hass, Stewart, Luna. (McNeil, 2024)

Mexicola Grande (Bing.com). Cold hardy. 20-22 F. Black. Large.

Gem avocado. (etsy.com)
Less alternate bearing. Black. Slightly pebbly. 7-11 oz. Not Hardy. 30 F. A flower type.

77

Sir Prize avocado Light yield.
(etsy.com) 10-20 oz. Black. Rough Fuerte skin. Not Hardy. 30 F. B flower type.

74

Lamb Hass
Productive.
(etsy.com) 10-18 oz. Pebbly. Not Hardy. 30 F. Black. A flower type.

68

Stewart. (Walmart.com). Hardy to 20-22, or 25 F. Black. Smooth skin. Medium sized. Variable production. A flower type.

9

The new Luna UCR avocado.
B type flower. Could cross-pollinate Hass.
Tree half the size of Hass.
More trees per acre.
Therefore more production per acre.
Easier to harvest.
Same production as Hass.
Consistent.
Similar size fruit as Hass.
Fruit store better when ripe.
A very good eating fruit.
Earliest field plantings in fall 2024. 1000 trees from Brokaw Nursery. Full production in five years.

Other Black Varieties: Joey, Mexicola Grande, Brogdon, Wilma (Brazos Belle), Gloria, May. (McNeil, 2024)

Joey. Medium sized. Purple-black. Very cold hardy (15 F). Heavy production.

829

Mexicola Grande. Very cold hardy. 15 F. 6-10 oz. Black. Bears early and regularly.

8

Brogden Avocado. 7-20 oz. Smooth skin. Hardy to 26-28 F. Purple/Black. Moderate production. Susceptible to anthracnose.
https://floridafruitgeek.com/cold-hardy-avocados/

613

Wilma (Brazos Belle) Med-large. Purple-black. Hardy to 15 F.

Gloria Avocado. 3 oz. Cold hardy. Black.
https://floridafruitgeek.com/cold-hardy-avocados/

May Avocado. 4-5 oz. Cold hardy. Black.
https://floridafruitgeek.com/cold-hardy-avocados/

741

Recommendations for California

Plant more of the black varieties, some new. Black from California: Hass, Lamb Hass (new), Sir Prize (new), Gem (new), Stewart (new), Mexicola Grande (new), Dickinson (old), Luna (new).

From Hawaii: McDonald, Linda (too large?), Masami, Hayes, Healani, Malama.

Or Joey, cold hardy (15 F), very productive, purple-black, from Texas, looks like Hass. Also Brogdon and Wilma from Texas both black.

And the new Luna from UCR California. Black. Better than Hass.

California avocado varieties are described at https://avocado.ucr.edu/variety-list.

Recommendations for Florida

The author recommends that Florida grow more black and purple varieties such as those from California, some new. Hass, Lamb Hass (new), Sir Prize (new), Gem (new), Stewart (new), Mexicola Grande (new), Dickinson (old), Luna (new).

Or even some from Hawaii or Texas. Hawaii: McDonald, Linda (too large?), Masami, Hayes, Healani, Malama.

Breeding new Florida Hass as they are doing is good.

Or Joey, cold hardy (15 F), very productive, purple-black, from Texas, looks like Hass. Or Brogdon and Wilma from Texas, both black.

And the new Luna from UCR California. Better than Hass.

Florida avocado varieties are described at: https://www.ams.usda.gov/sites/default/files/media/FloridaAvocadoVarieties.pdf

Recommendations for Texas

The author recommends that Texas grow and sell more black or purple varieties that they have to meet the demand for Hass.

Or grow some of the new Hass that Florida is breeding.

Or try some of the new black varieties from California: Hass, Lamb Hass (new), Sir Prize (new), Gem (new), Stewart (new), Mexicola Grande (new), Dickinson (old), Luna (new).

Or try some of the black or purple varieties from Hawaii: McDonald, Linda (too large?), Masami, Hayes, Healani, Malama.

Or Joey, cold hardy (15 F), very productive, purple-black, from Texas, looks like Hass. Or Brogdon and Wilma from Texas, both black.

And the new Luna from UCR California. Better than Hass.

Texas avocado varieties are described at:

https://aggie-horticulture.tamu.edu/fruit-nut/wp-content/uploads/sites/6/2015/04/avocados_2015.pdf

Recommendations for Hawaii

The author recommends dark purple or black varieties for Hawaii to meet the demand for Hass. As long as they have consistent production. Recommended Hawaiian purple or black varieties are McDonald, Linda (too large?), Masami, Hayes, Healani, Malama.

Or try some of the new Hass that Florida is breeding.

Or try some of the new black varieties from California: Hass, Lamb Hass (new), Sir Prize (new), Gem (new), Stewart (new), Mexicola Grande (new), Dickinson (old), Luna (new),

or from Texas, Joey, cold hardy (15 F), very productive, purple-black, from Texas, looks like Hass. Or Brogdon and Wilma from Texas, both black.

And the new Luna from UCR California. Better than Hass.

Hawaiian avocado varieties are described at: https://www.hawaiiavocadoassociation.com/hawaiian-avocado-varieties.html

Recommendations for Puerto Rico

The author recommends that Puerto Rico grow more black or purple avocados to meet the demand for Hass.

They could try black or purple varieties from California: Hass, Lamb Hass (new), Sir Prize (new), Gem (new), Stewart (new), Mexicola Grande (new), Dickinson (old), Luna (new).

Or grow some of the new Hass being breeded in Florida.

Or try some of the black or purple varieties from Hawaii: McDonald, Linda (too large?), Masami, Hayes, Healani, Malama,

or Texas, Joey, cold hardy (15 F), very productive, purple-black, from Texas, looks like Hass. Or Brogdon and Wilma from Texas, both black.

And the new Luna from UCR California. Better than Hass.

Puerto Rico avocado varieties are described at: https://reeis.usda.gov/web/crisprojectpages/1009615-evaluation-of-avocado-persea-americana-varieties-and-management-to-extend-fruit-production-year-round-and-increase-productivity.html.

Chapter 18 Avocado Breeding

Avocado trees have thousands of flowers. They have only .1 % fruit set. 999 out of 1000 flowers fall on the ground. Breeding therefore is not practiced by hand pollination, a waste of time. Breeding is done by simply planting seeds of known varieties to see what you get. To get all Hass genes in a seed, Hass trees are isolated away from other varieties. To cross different varieties two varieties are grown near each other.

Florida has obtained Hass seeds from California pollinated by the Bacon variety to breed a new more cold hardy Hass. It takes several years for seedlings to produce fruit. They must go through a juvenile period first before they will produce flowers.

Most of the older avocado varieties (Hass, Fuerte, Bacon, Zutano) were discovered as chance seedlings in someone's yard or orchard. I discovered many seedings in the CalPolySLO orchards for 29 years. Most were not of any value such as small green Hass, Zutano seedlings, etc. New avocado varieties (Lamb Hass, Gwen, Gem, Sirprise) have been produced by planting thousands of seeds on cooperating farms and observing their characteristics.

Avocado Breeding.

Proceedings of the First International Tropical Fruit Short Course: The Avocado. J.W. Sauls, R.L. Phillips and L.K. Jackson (eds.). Gainesville: Fruit Crops Dept., Florida Cooperative Extension Service. Institute of Food and Agricultural Sciences, University of Florida, 1976. Pages 24-33.

So far, successful avocado breeding has been primitive. The leading cultivars around the world originated as chance seedlings-not even the male parent is known. This seems likely to change in the years ahead since procedures involving the known parentage of both sex cells are now available and are considerably more efficient. The use of such procedures is likely to markedly increase the chances for obtaining superior new cultivars by breeding.
B. O. Bergh, UCRiverside.

https://www.californiaavocadogrowers.com/sites/default/files/Avocado-Plant-Breeding-Review.pdf

Preface to a review of plant breeding sponsored by the California Avocado Commission: Since 2010 there has been an on-going process of critical review and change to production research funded by the California Avocado Commission (CAC). A number of changes to the system and process of production research have occurred that has set strategic goals and addressed weaknesses in the system. The most notable changes have been to improve the accountability of the research contracts and to place the research efforts in a multi-year context with well-defined objectives and milestones to be met as the research projects are conducted. As a continuation of the review of production research the areas of significant activity that are of strategic interest for the long term progress of the California Avocado industry are being critically examined. Plant breeding is a sensible very long term strategic activity for CAC to advance the industry and is accordingly an important activity that CAC has sponsored for several decades in partnership with the

Breeding Review-continued.

University of California, Riverside. To this author's knowledge there is no record of a comprehensive review of the plant breeding program that has looked at the goals and objectives of the program, benchmarks of success, a cost benefit analysis and an identification of the barriers to the development of new varieties for commercial use. The fact is, major changes in the industry due to a change in the varietal mix have been rare as a new variety needs to overcome a number of significant challenges to become part of the mainstream varietal mix. To understand these challenges the plant breeding strategic component parts can be defined as: deciding why a new variety is needed, what that variety should have as traits, making the new variety, testing the new variety, outreach on the new variety, and commercial development of the new variety.

Breeding Review-continued.

The discussion on current and future plant breeding activity has focused on making new varieties. The real impediments to the plant breeding program are not the making of new varieties. The limitations are first to identify why a new variety is needed and then a plan with milestones and benchmarks developed so that the industry understands progress on the new variety and the costs and benefits likely to accrue to the California avocado industry. The second, the long testing period of new varieties which is needed no matter how fast or selective the generation of new varieties. The long testing period is not overcome by new genetic technology which allows more selective techniques to be applied so that wastage in evaluating unsuitable selections can be reduced. Third, in the commercialization of a new variety where there appears to be little effort by CAC to develop the necessary retail pull in demand for a new fruit variety that will lead to enhanced profitability for the grower. CAC's active involvement in the commercialization of a new variety is needed so that handlers will aggressively support the planting of a new variety giving the critical mass necessary to establish and maintain its commercial success. At present there is no call from the major retailers for avocado varieties with different characteristics. This means that to bring a new variety to the retail shelf requires CAC to commit considerable resources for outreach and marketing. To date without CAC support the commercialization of new varieties has largely been unsuccessful in bringing new varieties to the California avocado market.

Breeding Review-summary.

The current California plant breeding program appears to have four parts:

Conventional scion breeding: selection and evaluation of improved fruit varieties (this includes new varieties from foreign breeding programs) and rootstocks.

Conventional root rot resistant rootstock breeding: selection and evaluation of improved rootstocks (this includes new rootstocks from foreign breeding programs) with resistance to Phytophthora cinnamomi and other traits like salt tolerance, dwarfing etc.

Application of molecular markers to avocado improvement.

Germplasm preservation.

Dr. Mary Lu Arpaia, UC Riverside.

The new Luna UCR avocado. The results of avocado breeding for 86 years. Better than Hass. 6-9 oz..
(https://news.ucr.edu/articles/)

The new Luna UCR avocado.
B type flower. Could cross-pollinate Hass.
Tree half the size of Hass.
More trees per acre.
Therefore more production per acre.
Easier to harvest.
Same production as Hass.
Consistent.
Similar size fruit as Hass.
Fruit store better when ripe.
A very good eating fruit.
Earliest field plantings in fall 2024. 1000 trees from Brokaw Nursery. Full production in five years.

The new Luna UCR avocado. (https://news.ucr.edu/articles/)

The variety is the result of a University of California avocado tree breeding program that started at UCLA just over 80 years ago, was transferred to UCR in the 1950s, and continues today. It offers consumers a nutty flavor and a smooth texture that's ideal for guacamole. The Luna UCR™ also has a rind that turns a tell-tale black when ripe and is bred to maintain its quality well after it is harvested.

Growers, meanwhile, benefit from a smaller tree size, allowing denser plantings for more efficient and safer harvesting, and minimal pruning. It also has a type of blossom that makes it an efficient pollinizer for various avocado varieties, including the Hass, the world's leading variety.

The new Luna UCR avocado. (https://news.ucr.edu/articles/)

A United States plant patent for Luna UCR™ under its official variety denomination, 'BL516' will be issued on Oct. 31, according to a notice from the United States Patent and Trademark Office. The patent (No. PP35444) will credit as inventors Mary Lu Arpaia, a UC Cooperative Extension horticulturist based at UCR, and her colleague Eric Focht, a UCR staff research associate in the Botany and Plant Sciences Department in the College of Natural and Agricultural Sciences. Other credited co-inventors are former UCR scientists Gray Martin, the late David Stottlemyer, and the late B.O. "Bob" Bergh.

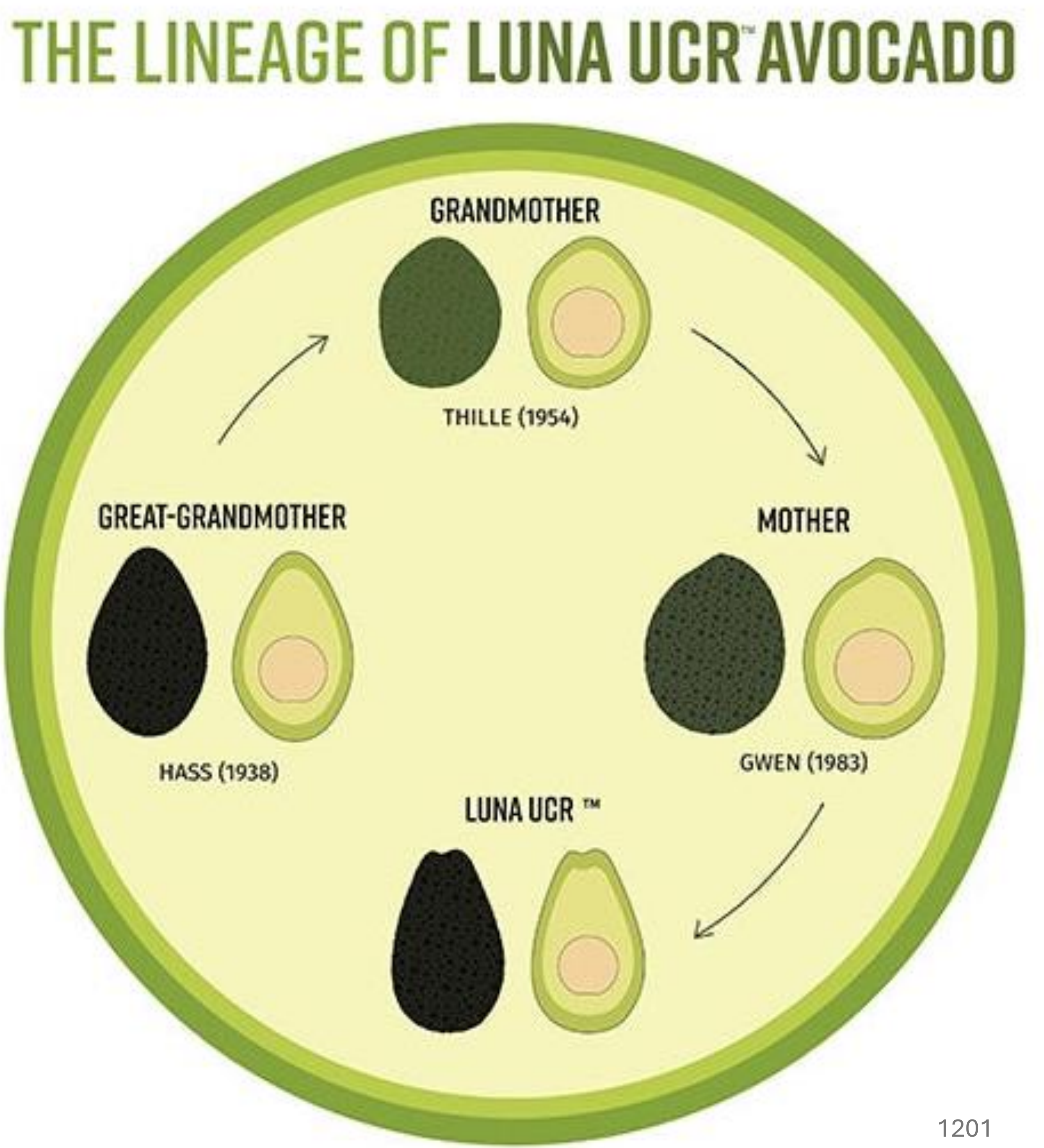
The new Luna UCR avocado. (https://news.ucr.edu/articles/)

The variety is being marketed to commercial growers worldwide through a partnership with Eurosemillas, SA, a company based in Spain that specializes in international sales of proprietary crop varieties. Under an agreement executed by UCR's Office of Technology Partnerships, Eurosemillas is the master licensee of the variety. Eurosemillas has established partnerships with growers in 14 countries outside of the USA to grow the Luna UCR™. Commercial growers interested in planting the variety may make inqueries through Green Motion Avocados. The Luna UCR is not yet available to backyard growers but discussions are underway to make it available in the near future.

The new Luna UCR avocado. (https://news.ucr.edu/articles/)

So, Bergh and Martin went back to work and planted as many as 70,000 genetically distinct seedlings from Gwen mother trees at three sites with different microclimates in San Bernardino, Ventura, and San Luis Obispo counties. One of the Ventura County trees that grew in Camarillo became the first of what is now the Luna UCR™ avocado, with the preferred black skin when ripe. Unfortunately, Bergh died in 2021 at age 96 – two years before the release of Luna UCR™.

The new Luna UCR avocado. (https://news.ucr.edu/articles/)



Luna UCR unripe left, ripe right. (Photo by Mary Lu Arpaia) (https://ucanr.edu/News/)

6-9 oz..

Row of Hass on top, Luna on bottom.

(https://ucanr.edu/News/?routeName=newsstory&postnum=57734)

Luna Characteristics

(https://ucanr.edu/News/?routeName=newsstory&postnum=57734)

B type flower. Could cross-pollinate Hass.

Tree half the size of Hass. More trees per acre. Therefore more production per acre. Easier to harvest.

Same production as Hass. Consistent.

Similar size fruit as Hass. Luna 6-9 oz.

Fruit store better when ripe.

A very good eating fruit.

Earliest field plantings in fall 2024. 1000 trees from Brokaw Nursery. Full production in five years.

A Luna UCR Tree, upright and tall, but half the size of Hass. (https://ucanr.edu/News/?routeName=newsstory&postnum=57734)

Luna Fruit 6-9 oz.

A Luna Tree.
Upright and tall.
But half the size of
Hass. But with the
same fruit production.
(https://ucanr.edu/News/?routeName=newsstory&postnum=57734)

Luna fruit 6-9 oz.

Chapter 19 Avocado Botany

Avocado Botany (Britannica.com)

Avocado, (Persea americana), tree of the family Lauraceae and its edible fruit. Avocados are native to the Western Hemisphere from Mexico south to the Andean regions and are widely grown in warm climates. Avocado fruits have greenish or yellowish flesh with a buttery consistency and a rich nutty flavour. They are often eaten in salads, and in many parts of the world they are eaten as a dessert. Mashed avocado is the principal ingredient of guacamole, a characteristic saucelike condiment in Mexican cuisine. Avocados provide thiamin, riboflavin, and vitamin A, and in some varieties the flesh contains as much as 25 percent unsaturated oil.

Britannica.com

Physical description

Avocado trees can be tall or spreading, and they have elliptic to egg-shaped leaves that are 10–30 cm (4–12 inches) in length. The small greenish flowers are borne in dense inflorescences and lack true petals. The flowers have nine stamens, arranged in three series, and a one-celled ovary. Interestingly, there are two types of avocado flowers, A and B, depending on the cultivar. These flowers are dichogamous (male and female parts mature separately), and each flower opens only twice. Type A flowers are functionally female in the morning, close at midday, and then reopen as functionally male in the afternoon of the following day. Type B flowers are functionally female in the afternoon, close in the evening, and then reopen the following morning as functionally male. When the two flower types are grown together, this temporal overlap of mature male and female parts encourages cross-pollination and, thus, greater fruit production.

Britannica.com

The fruit is exceedingly variable in size, no larger than a hen's egg in certain Mexican races and sometimes weighing 1–2 kg (2–4 pounds) in other races. The form varies from round to pear-shaped with a long slender neck, and the colour ranges from green to dark purple. **Botanically, the fruit is a berry** and features a single large round seed with two cotyledons. The fruit's outer skin is sometimes no thicker than that of an apple and sometimes is coarse and woody in texture.

Britannica.com

Berry, in botany, a simple fleshy fruit that usually has many seeds, such as the banana, grape, melon, orange, and tomato. As a simple fruit, a berry is derived from a single ovary of an individual flower. The middle and inner layers of the fruit wall often are not distinct from each other. Together with drupes (e.g., cherry, mango, and olive) and pomes (e.g., apple, pear, and loquat), berries are one of the main types of fleshy fruits.

An avocado is a single seeded berry.

History and Production (Britannica.com)

Avocados were first domesticated in tropical America, where they were cultivated as individual seedling trees before the Spanish conquest. The plants did not receive serious horticultural attention until about 1900, when horticulturists found that production of grafted trees was simple and allowed perpetuation of superior seedlings and the establishment of orchards. Flourishing avocado industries have since developed around the world in suitable climates. Mexico, the Dominican Republic, Peru, Indonesia, and Colombia were the top producers worldwide in 2020. The fruits are also grown commercially in Florida, California, Texas, Hawaii, Puerto Rico, Kenya, Haiti, Chile, South Africa, Brazil, and Australia, as well as on some Pacific islands and in several Mediterranean countries, including Israel.

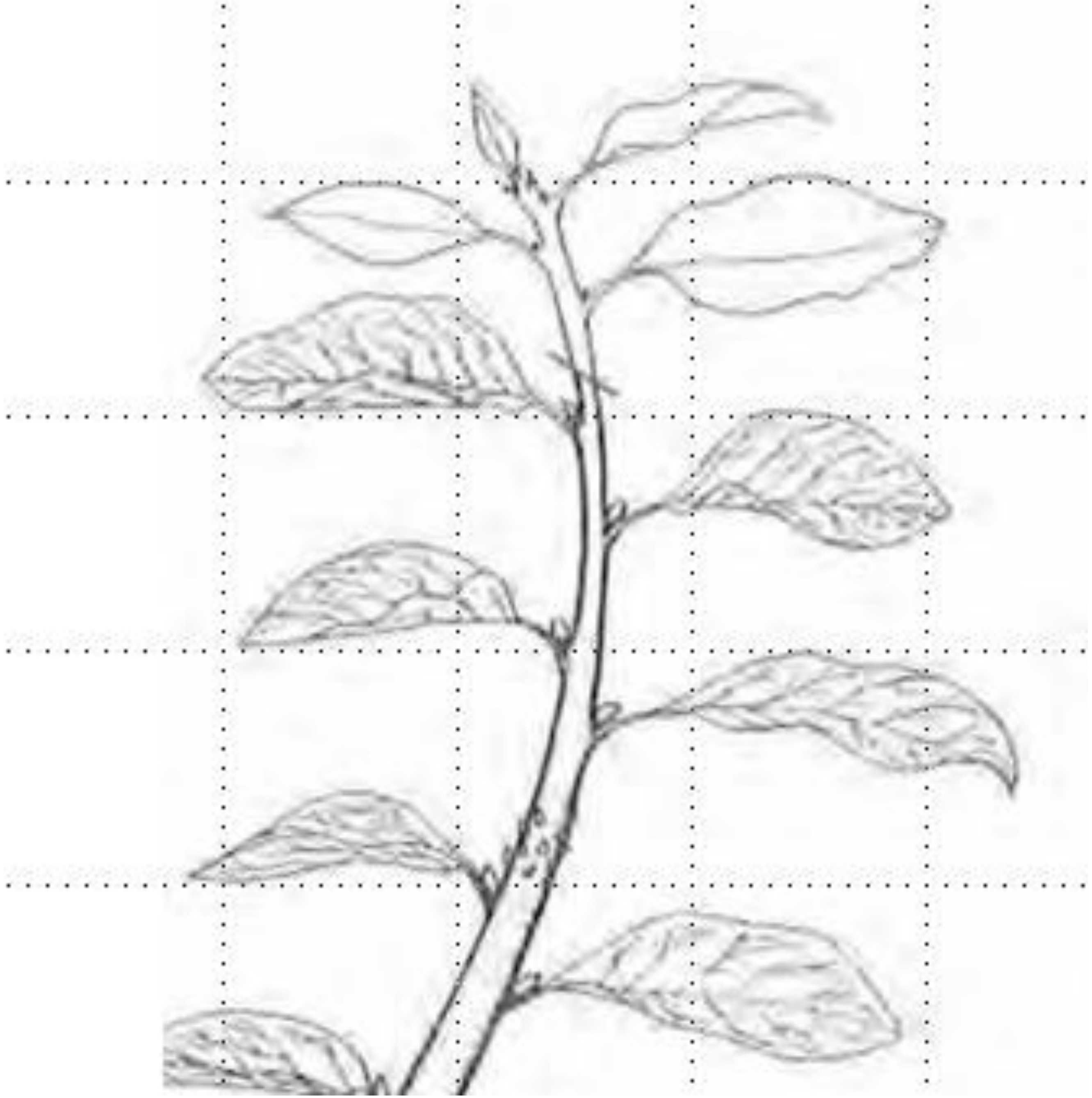
Description https://en.wikipedia.org/wiki/Avocado

Persea americana is a tree that grows to 9–20 m (30–66 ft) with a trunk diameter between 0.3–0.6 m (1–2 ft). The leaves are 8–25 cm (3–10 in) long and alternately arranged.

Panicles of flowers with deciduous bracts arise from new growth or the axils of leaves. The tree flowers thousands of blossoms every year. Avocado blossoms sprout from racemes near the leaf axils; they are small and inconspicuous 5–10 mm (3⁄16–3⁄8 in) wide. They have no petals but instead two whorls of three pale-green or greenish-yellow downy perianth [calyx and corolla] lobes, each blossom has 9 stamens with 2 basal orange nectar glands.

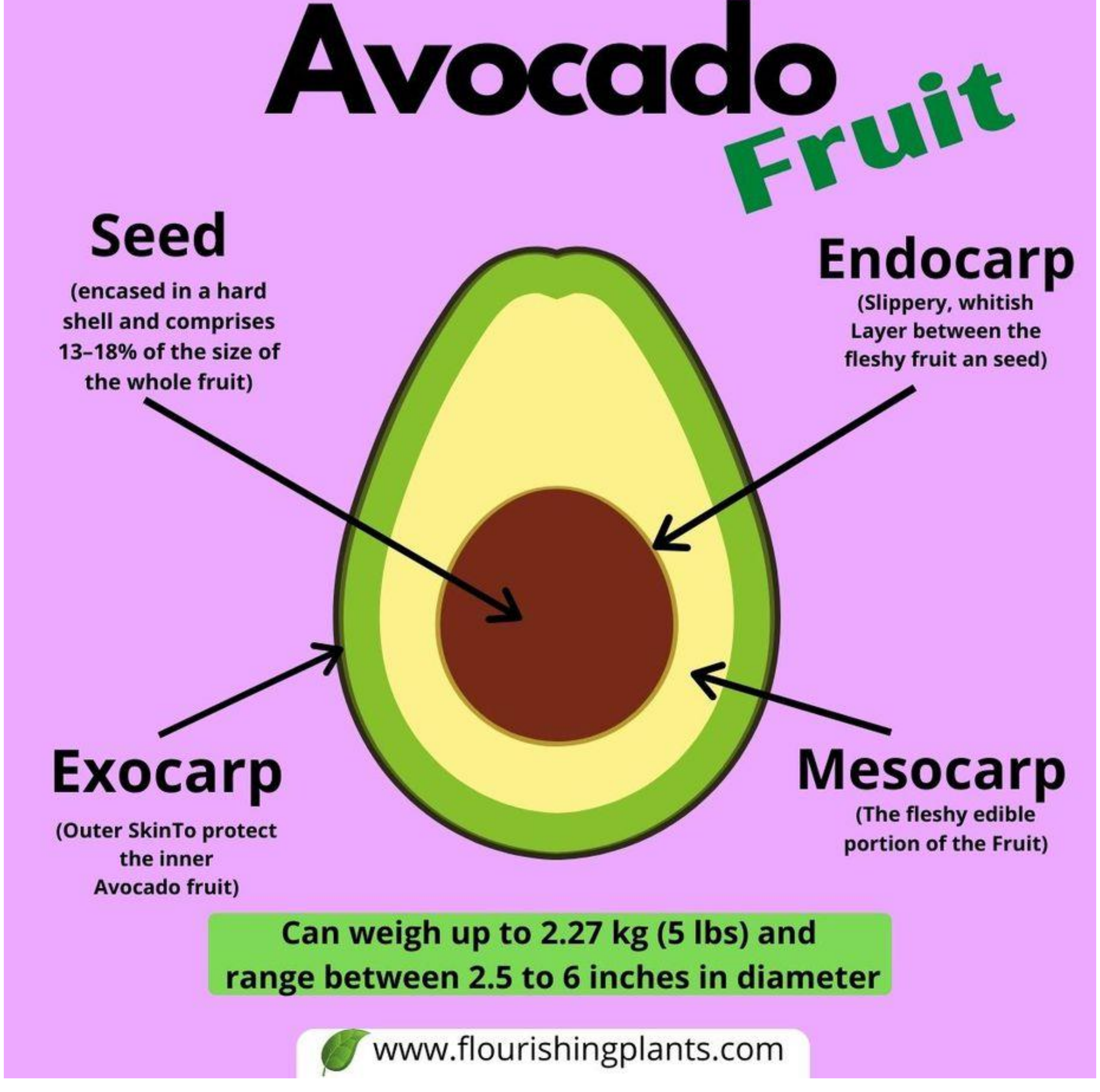
The avocado fruit is a climacteric, single-seeded berry, due to the imperceptible endocarp covering the seed, rather than a drupe. The pear-shaped fruit is usually 7–20 cm (3–8 in) long, weighs between 100 and 1,000 g (3+1⁄2 and 35+1⁄2 oz), and has a large central seed, 5–6.4 cm (2–2+1⁄2 in) long.

Bearing Habit for Avocado Trees. Trees produce flowers and vegetative growth from enlarged lateral buds on one year wood.



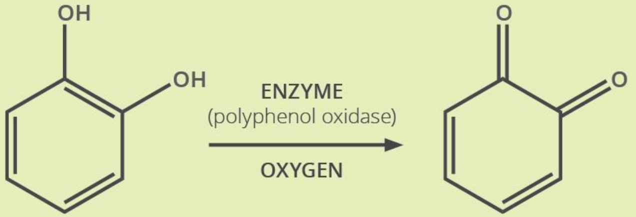

Avocado
Flowers and new
vegetative
growth.
(Bing.com)

Avocado Flowers (Bing.com)


Avocado
Fruit
Seed
(encased in a hard shell and comprises 13–18% of the size of the whole fruit)
Endocarp
(Slippery, whitish Layer between the fleshy fruit an seed)
Exocarp
(Outer SkinTo protect the inner Avocado fruit)
Mesocarp
(The fleshy edible portion of the Fruit)
Can weigh up to 2.27 kg (5 lbs) and range between 2.5 to 6 inches in diameter
www.flourishingplants.com

THE CHEMISTRY OF AN AVOCADO

WHAT MAKES AVOCADO GO BROWN?



CATECHOL
(type of polyphenol)

1,2-BENZOQUINONE

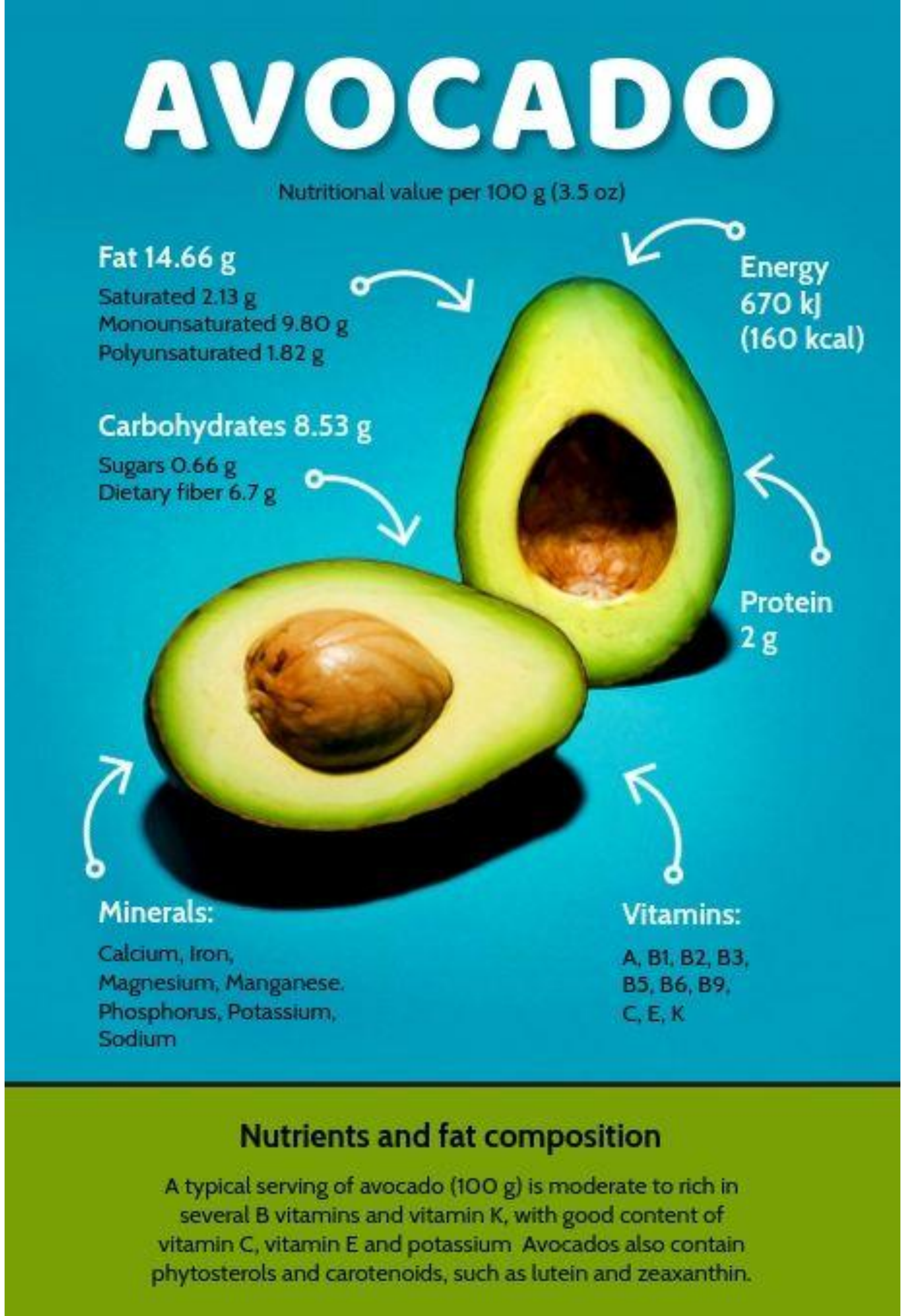
Avocados contain a class of compounds called phenols. These compounds can be converted to compounds called quinones when exposed to oxygen in the air - this process is hastened by the enzyme polyphenol oxidase.

Some of these quinone compounds are toxic to bacteria, and so the process is beneficial for the fruit. However, the quinones can also react with themselves to form long polymer chains, causing the brown colouration. This also occurs in many other fruits. Avocados brown quickly as they have a large amount of polyphenol oxidase.

The polymeric compounds causing the brown colouration are melanin pigments. Melanin is also the primary pigment determining skin colour in humans.

PREVENTING THE BROWNING OF AVOCADOS

Contrary to popular belief, leaving the stone in the avocado or guacamole doesn't slow browning, as it doesn't block oxygen. Covering with clingfilm can block oxygen, and hence delay browning. Adding lemon or lime juice, or chilling the avocado, can also delay browning, as it inhibits the activity of the polyphenol oxidase enzyme.


AVOCADO
Nutritional value per 100 g (3.5 oz)
Fat 14.66 g
Saturated 2.13 g
Monounsaturated 9.80 g
Polyunsaturated 1.82 g
Energy 670 kJ (160 kcal)
Carbohydrates 8.53 g
Sugars 0.66 g
Dietary fiber 6.7 g
Protein 2 g
Minerals:
Calcium, Iron, Magnesium, Manganese, Phosphorus, Potassium, Sodium
Vitamins:
A, B1, B2, B3, B5, B6, B9, C, E, K
Nutrients and fat composition
A typical serving of avocado (100 g) is moderate to rich in several B vitamins and vitamin K, with good content of vitamin C, vitamin E and potassium Avocados also contain phytosterols and carotenoids, such as lutein and zeaxanthin.

Chapter 20 Recipes
Avocado Pasta
Guacamole


Avocado
pasta

Avocado Pasta (McNeil, 2024)

By Dr. Robert J McNeil, Professor Emeritus, Cal Poly State University, San Luis Obispo, CA 93407

Directions: Cook 1 lb penne pasta for 7 minutes in boiling water until slightly firm (al dente). Drain and allow to cool in a large bowl. Peel and slice four avocados. Slice four plum tomatoes. Chop four cloves garlic very fine. Tear 14 basil leaves. Mix all ingredients with the penne pasta. Thoroughly wet all with olive oil. Lightly sprinkle with salt. Serve at room temperature. Add shrimp if desired.

Second prize. American Society for Horticultural Science photography content several years ago. Culinary category.

Guacamole

Guacamole (McNeil, 2024)
Four Hass avocados
2 tsp lime juice
1 tsp or more ground coriander seeds
1 small chopped onion
1 small chopped jalapeno pepper
light salt sprinkle
light pepper sprinkle
garlic powder to taste or 2 cloves garlic chopped finely
Add cilantro if desired

References Cited

References are cited on each page of the text.

Health Benefits of Avocados. See the following website: https://www.healthline.com/nutrition/avocado-nutrition#antioxidants

Health benefits of avocados include:

Containing an array of vitamins, minerals, antioxidants, healthy fats, and fiber.

Improving gut health.

Lowering the risk of developing heart disease.

Promoting a healthy weight.

Enhancing brain function.

Providing anti-aging and disease-fighting antioxidants.

Being rich in vitamins E and K, magnesium, and potassium.

Helping with weight management.

Supporting heart, eye, and skin health.

Aiding in the absorption of other nutrients.

(https://www.bing.com/search?q=health+benefits+of+avocados.)