

## RELATION OF MATURITY OF FLORIDA AVOCADOS TO PHYSICAL CHARACTERS

**Mortimer J. Soule Jr. and Paul L. Harding<sup>1</sup>**

*USDA, AMS, Quality Maintenance and Improvement Section*

*USDA Agricultural Marketing Service Orlando*

Growers and shippers of Florida avocados have had difficulty for many years in determining the degree of maturity of fruit of the numerous varieties which are grown in the State. Persistent complaints of immature fruit and low market prices led the industry to make an avocado marketing agreement with the U. S. Department of Agriculture in 1954. About 400,000 bushels (1)<sup>2</sup> were shipped during the 1954-55 season under regulated dates of picking and minimum weights for some 40 varieties.

The present investigation was a continuation of research on maturity of avocados reported by Harding (2). The objectives were to obtain additional data on the relation of palatability of avocados to picking date and fruit weight and to obtain information on other factors that might be associated with maturing and softening of fruit, such as diameter, number of days required to soften, and loss in weight.

### MATERIALS AND METHODS

Most of the avocados used in this investigation were grown in Dade County, but a few samples were obtained from groves in Highlands and Palm Beach Counties, Florida. The samples, which were shipped to Orlando by express, had a transit period of 2 or 3 days. During the 1954-55 season (June 2, 1954 to

Jan. 10, 1955) samples of avocados of 31 varieties from 16 groves were tested at Orlando. The varieties studied were Fuchs, Nadir, Hardee, Waldin, Trapp, Pinelli, Tonnage, Fairchild, Booth 8, Nirody, Simpson, Vaca, Booth 5, Booth 7, Collinson, Lula, Hickson, Nelson, Ajax (Booth 7 B), Booth 3, Hall, Taylor, Booth 1, Linda, Wagner, Choquette, Nabal, Eagle Rock, Itzamna, McDonald and Schmidt.<sup>3</sup>

The samples were composed of about 30 fruit of each variety. Fruit were picked at random and were of a wide range in sizes. Most varieties were tested over a fairly long period by sampling at intervals of 7 to 10 days.

On arrival at Orlando each fruit was numbered, weighed and calipered. Five hard fruit of each sample were tested immediately. The remainder of the sample was stored at 80° F. for softening. Daily inspection of individual fruit was made. When it attained the desired degree of softness, each fruit was removed to 50° F. until the entire sample had softened. The tests included weight, diameter, number of days required to soften at 80° F. and flavor of the softened avocados. Fruit which tasted poor was considered green and immature while that which tasted good was considered mature. Fruit of the good

category were smooth, mellow, tasty, rich, and nutty with a buttery texture. Each sample was rated on its own merit and no attempt was made to compare palatability ratings of different varieties.

## RESULTS AND DISCUSSION

The findings herein are for a single season and should be regarded as tentative. However, the results for most of the varieties were in substantial agreement with the data previously reported by Harding (2).

**Summer Varieties:**— Earliest picking dates, minimum weights, number of days required for softening at 80° F., and loss in weight of summer varieties of avocados which met consumer approval are shown in Table 1. Good quality was attained by 16-ounce fruit of Fuchs on July 9, 17-ounce fruit of Hardee on July 30, 15-ounce fruit of Trapp on July 30, 31-ounce fruit of Pinelli on Aug. 24, and 13-ounce fruit of Waldin on Aug. 2 or Aug. 9. The number of days required for softening at 80° F. ranged from 2 to 7. Loss in weight during softening varied from 5 to 7 percent. There was apparently little connection between flavor and number of days required for softening or loss in weight.

**Fall Varieties:** — Earliest picking dates, minimum weights, minimum diameters, number of days required for softening at 80° F., and loss in weight of fall varieties of avocados which met consumer approval are presented in Table 2. In most instances the minimum weight for fruit of good quality decreased steadily as the season of picking for a variety progressed. There were, however, variations in the earliest picking dates for fruit of the same weight picked from different groves. For example, 19-ounce Lula fruit from grove A were of good quality on Nov. 1 and from grove C on Oct. 11. Fruit of given weight and variety had a rather narrow range in diameter which remained constant over the entire period of picking. Palatability of fruit at any date of picking was associated with a minimum weight and a corresponding minimum diameter. For example, Booth 7 fruit weighing 11 ounces had a minimum diameter of 3.4 inches on Nov. 15, Dec. 6 and Dec. 13. The number of days required for softening at 80° F. ranged from 1 to 6. Loss in weight varied from less than 2 to 8 percent. There seemed to be little connection between flavor and physical characters other than picking date, weight or diameter.

**Winter Varieties:** — Earliest dates of picking, minimum weights, minimum diameters, number of days required for softening at 80° F., and loss in weight of winter varieties of avocados which met consumer approval are given in Table 3. Good quality was attained by 23-ounce Linda fruit on Dec. 13, 10-ounce Wagner fruit on Jan. 10, 33-ounce Choquette fruit on Nov. 15, 16-ounce Nabal fruit on Dec. 13, and 22-ounce Eagle Rock fruit on Dec. 13. Minimum diameter for consumer approval ranged from 3.1 inches for 10-ounce fruit of Wagner and Nabal to 4.6 inches for 33-ounce fruit of Choquette. The number of days required for softening varied from 4 to 6. Loss in weight during softening was from 3 to 5 percent.

**Progress of Maturity in Fruit of Similar Weight:**— When samples of any variety were divided into sub samples according to predetermined weight classes, large fruit received a higher flavor rating than small fruit after softening. This trend remained fairly consistent throughout the picking period of a variety. Data for Lula are presented in Figure 1.

Table 1. Earliest picking date, minimum weight, number of days required for softening at 80° F. and loss in weight of summer varieties of Florida avocados which met consumer approval in tests at Orlando, 1954-55.

Variety <sup>1/</sup>	Grove	Picking period	Earliest picking date for minimum maturity	Minimum fruit weight	Softening period 80° F.	Loss in weight
		<u>1954-55</u>	<u>1954-55</u>	<u>Ounces</u>	<u>Days</u>	<u>Percent</u>
Fuchs	A	June 14-July 9	July 9	16	2	5
Hardee	K	July 30	July 30	17	2	6
Trapp	K	July 30	July 30	15	4	5
Pinelli	P	Aug. 24	Aug. 24	31	6	7
Waldin	C	Aug. 2-Sept. 7	Aug. 9	13	7	6
	F	Aug. 2-Sept. 7	Aug. 2	13	5	7
			Aug. 9	17	6	6
G	July 19-Sept. 7	Aug. 9	13	5	6	

<sup>1/</sup>Samples of Nadir did not meet consumer approval during the picking period for the variety.

Lula fruit weighing 16 to 18 ounces reached acceptable quality about 10 days earlier than the 13 to 15-ounce size, and the latter about a week earlier than the 10 to 12-ounce size.

**Evaluating Maturity:**— Data for Booth 8, Booth 7, Lula, Hickson, Hall, Taylor, and Booth 1 avocados were subjected to a series of regression analyses in which individual factors, such as picking date (expressed as weeks after the first picking), fruit weight, fruit diameter, ratio of weight to diameter, percentage loss in weight, number of days required for softening at 80° F., weight of hard fruit tested immediately on arrival at Orlando and diameter of hard fruit, were tested singly and in combinations of 2 or 3 against flavor rating. Representative analyses for Lula variety are listed in Table 4. It will be noted that analyses in which picking date was included as one of the independent variables always gave very large correlation coefficients. Fruit weight or fruit diameter used as independent variables in simple regression analyses gave lower correlation coefficients but still too large to be the result of chance variations in sampling. The multiple correlation coefficient with flavor rating resulting when three independent variables, picking date, fruit weight, and fruit diameter, were used was essentially identical to the multiple correlation with numerical taste rating when two independent

variables, picking date and the ratio of fruit weight to fruit diameter, were used. Percentage loss in weight and number of days required for softening, individually or in combination, were poorly related to numerical taste rating so are not given in Table 4. Weight or diameter of hard fruit gave lower correlations with numerical taste rating than the respective measurements for soft fruit. Similar results were obtained with other varieties.

Table 2. Earliest picking date, minimum weight, minimum diameter, number of days required for softening at 80° F., and loss in weight of fall varieties of Florida avocados which met consumer approval in tests at Orlando, 1954-55.

Variety <sup>1/</sup>	Grove	Picking period	Earliest picking date for	Minimum fruit weight	Minimum fruit diameter	Softening period at 80° F.	Loss in weight
			minimum maturity	Ounces	Inches	Days	Percent
		1954-55	1954-55				
Tonnage	K	Aug. 25-Sept. 24	Sept. 17	16	--	5	6
Fairchild	K	Aug. 25-Sept. 24	Sept. 3 Sept. 17	24 24	-- --	3 1	4 2/
Booth 8	A	Aug. 23-Oct. 11	Oct. 11	13	3.3	4	4
	C	Aug. 16-Nov. 1	Oct. 11 Nov. 1	13 10	3.3 2.9	5 5	4 4
Booth 7	C	Sept. 20 Sept. 13-Dec. 13	Sept. 20	24	4.3	4	8
			Nov. 15	11	3.4	4	6
	M	Nov. 29-Dec. 6	Dec. 6	11	3.4	5	7
			Dec. 13	11	3.4	4	4
			Nov. 29	10	3.0	5	5
N	Nov. 15	Nov. 15	8	2.9	6	5	
Lula	A	Aug. 23-Dec. 27	Nov. 1	19	3.9	6	5
			Nov. 8	13	3.2	5	4
	C	Aug. 23-Dec. 27	Oct. 11	19	3.7	5	5
			Nov. 1	16	3.5	6	4
			Nov. 15	14	3.4	5	4
Nov. 29	13	3.3	5	4			
Ajax(Booth 7B)	A	Nov. 1-Nov. 8	Nov. 1	13	3.5	6	4
Booth 3	B	Nov. 8-Nov. 29	Nov. 29	16	3.7	4	4
	G	Nov. 1-Nov. 8	Nov. 1	19	3.9	5	5
Hall	B	Nov. 1-Nov. 15	Nov. 1	22	3.8	5	5
			Nov. 8	17	3.5	5	4
			Nov. 15	14	3.3	5	4
	G	Nov. 1	Nov. 1	28	4.1	5	5
M	Nov. 29-Dec. 6	Nov. 29	14	3.3	6	4	
Taylor	G	Nov. 1-Dec. 13	Nov. 29	13	3.2	5	3
Booth 1	B	Nov. 1-Nov. 29	Nov. 15	16	3.7	4	5
			Nov. 29	16	3.8	5	3
	G	Nov. 1-Dec. 13	Dec. 13	13	3.4	6	4

<sup>1/</sup> Samples of Nirody, Simpson, Vaca, Booth 5, Collinson, Hickson, and Nelson did not meet consumer approval during the picking period for the variety.

<sup>2/</sup> Less than 2 percent.

Table 3. Earliest picking date, minimum weight, minimum diameter, number of days required for softening at 80° F., and loss in weight of winter varieties of Florida Avocados which met consumer approval in tests at Orlando, 1954-55.

Variety <sup>1/</sup>	Grove	Picking period	Earliest picking date for		Minimum fruit weight	Minimum fruit diameter	Softening period at 80° F.	Loss in weight
			1954-55	minimum maturity 1954-55				
					Ounces	Inches	Days	Percent
Linda	N	Dec. 13-Jan. 10	Dec. 13	Jan. 10	23	3.8	4	4
					19	3.7	5	4
Wagner	N	Dec. 13-Jan. 10	Jan. 10		10	3.1	6	4
Choquette	B	Nov. 1-Nov. 15	Nov. 15		33	4.6	4	3
					29	4.4	5	4
Nabal	N	Dec. 13-Jan. 10	Dec. 13		16	3.6	5	3
					11	3.2	6	4
					10	3.1	6	5
Eagle Rock	N	Dec. 13	Dec. 13		22	3.7	6	4

<sup>1/</sup> Samples of Itzanna, McDonald, and Schmidt did not meet consumer approval during the picking period for the variety.

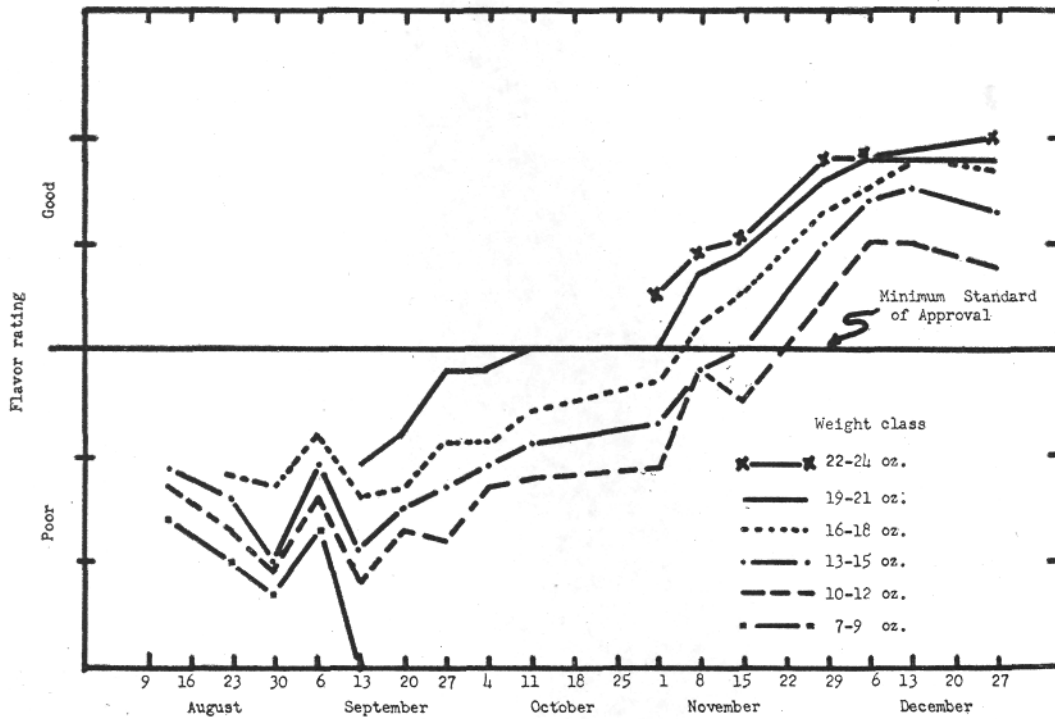


Figure 1. Relation of average flavor ratings of Lula avocados in various weight classes to picking dates, 1954. Each average is based on fruit from 2 or 3 groves.

Table 4. Correlation coefficients, standard errors of regression, and regression equations for analyses of various independent factors with taste ratings of Lula avocados, 1954-55.

Analysis number <u>1/</u>	Independent variable	Correlation coefficient (r or R) <u>2/</u>	Standard error of regression ( $s_{y.x}$ ) <u>3/</u>	Regression equation <u>4/</u>
1	Picking date (X) <u>5/</u>	r = .9807**	2.72	$\hat{Y} = 2.57X + 59.30$
2	Fruit weight (X)	r = .940**	4.78	$\hat{Y} = 8.93X - 63.56$
3	Fruit diameter (X)	r = .9264**	5.22	$\hat{Y} = 123.2X - 354.34$
4	Picking date ( $X_1$ ); fruit weight ( $X_2$ )	R = .9864** y12	2.40	$\hat{Y} = 1.94X_1 + 2.48X_2 + 24.44$
5	Picking date ( $X_1$ ); fruit diameter ( $X_2$ )	R = .9832** y12	2.67	$\hat{Y} = 2.14X_1 + 23.50X_2 - 20.22$
6	Picking date ( $X_1$ ); ratio fruit weight/diameter ( $X_2$ )	R = .9905** y12	2.05	$\hat{Y} = 1.80X_1 + 15.73X_2 - 6.13$
7	Picking date ( $X_1$ ); fruit diameter ( $X_2$ ); fruit weight ( $X_3$ )	R = .9900** y123	2.19	$\hat{Y} = 2.06X_1 - 80.35X_2 + 7.79X_3 + 221.47$

1/ In each case the dependent variable (Y) was flavor rating and the number of items (n) = 12.

2/ Significant values of r with (n-2) degrees of freedom at odds of 99 to 1 and 19 to 1 are .708 and .576, those for R with (n-3) degrees of freedom .735 and .602 and for R with (n-4) degrees of freedom .765 and .602.

3/ Variation in dependent variable (Y) not explained by changes in the independent variable (X).

4/  $\hat{Y}$  signifies the predicted or expected value of Y.

5/ Expressed as weeks after first picking; Sept. 13 = 1.

The values in Table 4 for Lula avocados indicate that tests for maturity and palatability of fruit would gain slightly in precision by the addition of fruit diameter to picking date and fruit weight as independent variables. There appeared to be a straight-line relation between picking date, fruit weight and fruit diameter and flavor rating from immaturity to post-maturity.

## SUMMARY

During the 1954-55 season, 209 different samples of avocado fruits of 31 varieties from 16 groves were tested for maturity and quality. — Earliest picking dates, minimum weights, minimum diameters, number of days required for softening at 80° F., and loss in weight of summer, fall and winter varieties of avocados which met consumer approval were determined. Variations in the minimum weight of fruit of good quality picked from different groves on the same date or of the same weight but picked on different dates were noted for a number of varieties. Fruit diameter of fall varieties ranged from 2.9

inches for 8-ounce fruit to 4.3 inches for 24-ounce fruit of Booth 7 and of winter varieties from 3.1 inches for 10-ounce fruit of Wagner and Nabal to 4.6 inches for 33-ounce fruit of Choquette. The number of days required for softening at 80° F. varied from 1 to 7. Loss in weight during softening ranged from less than 2 to 8 percent. Large fruit of a variety were rated higher than small fruit and this trend remained fairly constant throughout the picking season. There appeared to be a straight-line relationship between picking date, fruit weight and fruit diameter and flavor rating from immaturity to post-maturity for Lula, Booth 8, Booth 7, Hickson, Taylor and Booth 1 varieties. Percentage loss in weight and number of days required for softening were poorly related to flavor.

## LITERATURE CITED

1. Florida Avocado Administrative Committee, Homestead, Fla. Annual Report 1954-55 season (Processed).
2. Harding, P. L. 1955. The Relation of Maturity to Quality in Florida Avocados. Proc. Florida State Hort. Soc. 67: pp. 276-280.
3. Florida Avocado Administrative Committee, Homestead, Fla. Bulletin 1, July 14, 1954; 3, July 29, 1954; 5, September 8, 1954; 6, September 28, 1954; 7, October 11, 1954; 8, November 1, 1954. (Processed).

<sup>1</sup>/Appreciation is expressed to Charles H. Steffani, formerly Dade County agricultural agent, the Florida Avocado Administrative Committee, growers, and shippers for their generous support and for fruit used in the investigation and to Roy W. Harkness, associate chemist, Florida Sub-Tropical Experiment Station, Homestead, for his cooperation. Acknowledgment of assistance is made to W. T. Pentzer, chief, Biological Sciences Branch. Beltsville, Md., and to Earl F. Nelson and Ernest Forrest, formerly biological aids, Quality Maintenance and Improvement Section, Orlando, Florida.

<sup>2</sup>/*Italic numbers in parentheses refer to Literature Cited.*

<sup>3</sup>/*Varieties are listed in the order given by Florida Avocado Administrative Committee bulletins.*