California Avocado Society 1969 Yearbook 53: 79-96

SUMMARY OF AVOCADO RESEARCH

INTRODUCTION

Boysie E. Day

This report provides a brief summary of research and related extension work on problems of the avocado industry now in progress by the University. I hope that each member of the Avocado Research Advisory Committee will be able to thoroughly review the material prior to the meeting on February 6 to facilitate full discussion and analyses of problems of major interest to the industry.

Although the research and extension budgets of the University have been reduced over the past few years, both in numbers of positions and levels of support for these positions, an even greater effect has been the curtailment of efforts by inflation. On the other hand, at the expense of other research and extension efforts, we have been able to continue work on avocados at past levels and, indeed, have modestly expanded the work on avocados.

It is appropriate that we give our research and action program a particularly critical review at this beginning of the decade of the 70's. The industry faces major technical and economic problems in an inflationary and increasingly urban environment. The University, likewise, faces the problem of dealing with reduced public support for searches for solutions to agricultural problems. In this atmosphere, we must redouble our effort to see that we get maximum benefit from the limited resources available. Thus, it is well that we should sit down to a careful review of our research and extension efforts in the interest of the best possible job with the wherewithal at hand.

AVOCADO RESEARCH ADVISORY COMMITTEE* MEETING AT THE CITRUS RESEARCH CENTER AND AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF CALIFORNIA, RIVERSIDE

February 6, 1970

C. P. Teague
Presiding Chairman
Walter Beck
Vice-Chairman
R. G. Platt
Secretary

AVOCADO DISEASES

Since the last meeting of the Avocado Research Advisory Committee, the emphasis in avocado disease research has continued to be on Phytophthora root rot, with some studies on several minor problems.

Phytophthora Root Rot Studies

G. A. Zentmyer

RESISTANT ROOTSTOCKS — The collecting and testing program for resistance to root rot was continued at Riverside and in Mexico. In 1968 and 1969, 4,043 seedlings or cuttings were tested in the tanks in our greenhouse. These tests involved principally various Duke seedlings, but also included other miscellaneous materials, including some seed material sent to us from Costa Rica and Guatemala. A cooperative arrangement was begun with Dr. Robert Hunter, who is in charge of the Associated Colleges of the Midwest program in Costa Rica. One of Dr. Hunter's assistants spent considerable time looking up locations of possible collections (avocados and other species of *Persea)* in Costa Rica. Several collections of avocado and of *Persea caerulea* were sent to Riverside, and assistance was given in shipping seeds obtained from different avocado areas in Costa Rica.

Additional collections were also made in Guatemala, with the cooperation of Dr. E. Schieber, plant pathologist with the Ministry of Agriculture. In conversation with Dr. Wilson Popenoe in Guatemala, additional locations for possible collections of interest from the resistance standpoint were obtained.

In the Mexican program, headquartered at Chapingo, approximately 1,000 seedlings have been tested during the past year. The program has been somewhat reduced because of unavailability of personnel to spend a substantial amount of time on the project and because of reduced funds. Survivors from the tank tests in Mexico have been planted out in poorly-drained soil at a field station at El Porgreso, south of Mexico City. Survivors in the field include several seedlings of *P. liebmanni* and one *P. americana* type from Michoacan. Graftwood of these collections was obtained in a trip to Mexico in June, 1969, and the *P. americana* type is established at Riverside. The other collections were not compatible with *P. americana.*

None of the seedlings tested in the tank tests at Riverside has shown outstanding resistance; however, a number of Duke seedlings have survived with 50 to 70 per cent root rot (compared to the usual 80 to 100 per cent for Topa Topa used as a standard) and have been transplanted for further screening in the greenhouse and field. The following table gives examples of the performance of Duke and Topa Topa seedlings in the resistance test:

Variety	Percentage of Seedlings with Rotted Roots			
	70% or less	75-80%	85-90%	95-100%
Topa Topa	0	2	55	43
Duke 1	3	17	67	13
Duke 2	2	10	58	30
Duke 3	0	11	89	0
Duke 4	0	12	38	50
Topa Topa	2	4	16	78
Duke 5	0	7	50	43
Duke 6	3	10	50	37
Duke 7	0	0	30	70
Topa Topa	6	30	40	24
Duke 8	25	61	14	1
Duke 9	20	58	25	3
Duke 10	0	5	60	35

During 1968-69, the cooperative arrangement was continued and expanded whereby E. F. Frolich has been rooting many cutting at UCLA, particularly of the Duke 6 clone, for expansion of the field testing program. In 1969, several more field plots were established, using cuttings, in Santa Barbara and San Diego counties. The planting site has been treated with a fumigant, in all cases, to permit the young tree to become establish before a heavy population of the root-rot fungus builds up in the immediate root zone.

In previously established field plots, trees on Duke cuttings or seedling rootstocks continued to show more resistance to root rot than trees on Topa Topa rootstock. The root rot resistance plot in Ventura County was severely damaged in 1969, first by a freeze, then by fire. Prior to this damage, however, trees on Duke rootstock were in better condition and producing more fruit than those on Topa Topa, as shown in the report in 1967 and as summarized to December, 1968, immediately prior to the damage, in the following table:

VENTURA COUNTY ROOT ROT RESISTANCE PLOT

Scion/Rootstock Combination	No. of Trees	No. with *Phytophthora cinnamomi*	No. with Root Rot Symptoms	Avg. Stage* Disease-Dec. 1968
Hass on Topa Topa	21	13	16	1.1
Hass on Duke open-pollinated (SB)	17	5	3	0.15
Hass on Duke open-pollinated (CRC)	22	16	9	0.3
Hass on Duke self-pollinated (H)	24	8	8	0.4
Hass on Duke cutting (3-#3, 3-#6,1-Parent)	7	5	2	0.1

*Stage of disease on scale: 0 = healthy, 5 = dead

Over 500 trees have been replanted on the Stubblefield property in Fallbrook during the past eight years. As examples of the results with some of these plantings, the following tables are presented for plots established in 1961 and 1963:

1961 ROOT ROT RESISTANCE PLOT

Variety	No. of Trees	No. with *Phytophthora cinnamomi*	No. with Root Rot Symptoms	Avg. Stage Disease*
Topa Topa seedlings	10	2	10	5.0
Fuerte/ Topa Topa	10	3	10	5.0
Duke seedling SB 14-9	10	6	7	3.5
Fuerte/Duke seedling 15-7	10	5	5	2.5
Duke #6 cutting	10	2	4	2.0
Fuerte/Duke 6	10	4	8	4.0
Duke parent cutting	10	4	7	3.5
Fuerte/Duke parent	10	5	9	4.5

*Stage of disease on scale: 0 = healthy, 5 = dead

1963 ROOT ROT RESISTANCE PLOT

Topa Topa	8	8	6	3.8
Duke 6	8	7	0	0.0
Fuerte/Duke 6	8	8	1	0.1
Duke parent	8	7	1	0.6
Fuerte/ Duke parent	8	7	1	0.6
Scott cutting	8	5	0	0.0

(A trend may be noted in the 1961 plot above, which has been seen to some extent before; on cuttings grafted to Fuerte scions, root rot developed more severely.)

Over 1,000 young trees have been replanted in root rot areas on the Red Mountain Ranch during the past ten years. The trend in resistance is the same as indicated above. The following table shows results from one plot planted in 1963:

RED MOUNTAIN RANCH PLOT

Variety	No. of Trees	No. with *Phytophthora cinnamomi*	No. with Root Rot Symptoms	Avg. Stage Disease*
Topa Topa	9	8	7	3.9
Fuerte/ Topa Topa	8	8	8	4.9
Hass/ Topa Topa	5	5	5	4.8
Duke SB15-5 seedling	9	7	5	2.8
Fuerte/ Duke SB15-5	8	6	7	3.6
Hass/ Duke SB15-5	7	6	6	4.1
Duke 6 cutting	11	10	5	2.3
Fuerte/Duke	6	6	3	2.7
Hass/Duke 6	5	4	3	3.0
Duke parent	12	12	4	1.7
Fuerte/ Duke parent	9	8	7	3.5
Hass/ Duke parent	4	4	2	1.8
Scott cutting	8	6	6	3.7
Hass/Scott	8	6	8	4.2

*Stage of disease on scale: 0 = healthy, 5 = dead

Additional test plots to compare various cuttings will be established in 1970 in San Diego, Riverside, Ventura, and Santa Barbara Counties.

SOIL FUNGICIDES.—The laboratory and greenhouse screening program for soil fungicides that could be used to treat established trees was continued, with 16 chemicals tested in the laboratory and 14 in the greenhouse test on avocado seedlings. In the laboratory screen, new chemicals submitted by various chemical companies are tested against 12 soil fungi, including *P. cinnamomi;* tests are run in agar and also in soil. Several chemicals were very effective against *P. cinnamomi* in the agar test, but only a few were effective in soil as well as in agar. In the greenhouse tests to protect avocado seedlings from root rot, two materials containing copper showed some promise and are being investigated further. To date, their effectiveness has not been equal to Dexon under similar conditions.

Several of the Dexon field plots were discontinued because of gradual deterioration of the trees. Dexon is still the only chemical that has given good results in retarding root rot on trees in the field in several plots. In some cases, it has not been effective. The expense of the treatment makes it impractical at the present time.

In tests in the greenhouse, using naturally-infested soil adjusted to pH 4, 5, 6, 7, and 8, Dexon was somewhat more effective in preventing root rot development at pH 7 and pH 8 than at the lower pH levels.

EFFECT OF pH ON ACTIVITY OF DEXON

Treatment	Per cent of Healthy Roots at: pH4	pH5	pH6	pH7	pH8
Control	8	7	10	7	9
Dexon drench-10 ppm	60	50	65	80	80
Dexon drench-20 ppm	55	60	40	70	75

Laboratory tests showed that the principal effectiveness of Dexon was in reducing formation of sporangia and of chlamydospores; it inhibited development of both of these spore stages at low concentrations (from 10 to 20 ppm). The chemical was less effective in preventing germination of zoosporas and chlamydospores and in retarding mycelial growth.

Tests were run of the effectiveness of chlorox, formaldehyde, and alcohol in killing *Phytophthora* in soil, for use in sterilizing tools used in sampling for the fungus or for other operations in a diseased area. Chlorox (10% and 20%) and formaldehyde (5% and 10%) were as effective as 50% and 70% alcohol. To obtain more information on the toxicity of these materials, disks were cut from, agar cultures of *P. cinnamomi* and placed in the above solutions for 1, 5, and 10 minutes. Under these conditions, chlorox (10% and 20%) and formaldehyde (5% and 10%) killed the fungus in the one-minute dip, whereas the alcohol treatment was less effective, killing the fungus only in the 10-minute dip.

SOIL FUMIGANTS.—To obtain additional information on the toxicity of methyl bromide to *P. cinnamomi,* naturally infested field soil was fumigated with different concentrations of this fumigant in containers in the greenhouse. Methyl bromide killed *P. cinnamomi* at dosages of 3/4 lb. per 100 cu. ft. and higher, but did not kill the fungus at a dosage of 1/2 lb. per 100 cu. ft. In a field plot involving one small diseased tree, fumigation with methyl bromide at the rate of 2 lbs/100 cu. ft. has apparently eliminated the fungus, based on cultures taken up to one year after fumigation.

Plots were initiated with George Goodall in Santa Barbara to test the combination treatment of fumigation, with either Vapam or Shell SD 345, and use of Duke cutting rootstocks in relation to re-establishment of avocado trees in an area with root rot. In another plot with George Goodall, the effects of Dexon, gibberellin, and Vapam, separately and in combination, are being tested on the establishment of Duke 6 cuttings in a root-rot area. Two plots treated during the past year with fumigants by growers have been sampled for *P. cinnamomi* before and after fumigation and are being re-sampled to further follow the effect on the fungus. In one case, a combination treatment of a heavy dosage of Vapam, followed by a heavy dosage of D-D was used. In the other case, methyl bromide was used. In both cases to date, we have not been able to recover *P. cinnamomi* following fumigation.

SYSTEMIC FUNGICIDES.—Several new systemic fungicides are providing control of disease such as Verticillium wilt of cotton, powdery mildew, various leaf spots, etc. Tests with these chemicals for control of *Phytophthora* have not given good results to date; they are apparently not effective against this type of fungus. Further tests will be

made as new systemics are developed.

CHEMICAL BARRIERS.—During the past two years, *P. cinnamomi* has been found across chemical barriers in San Diego and in Santa Barbara Counties. It is not known how it was transported across the barrier or whether the fungus had been there for a considerable time and gradually increased in concentration in the soil. New barrier trials were established in Santa Barbara County in cooperation with George Goodall.

BIOLOGICAL CONTROL.—Studies of several aspects of the possible biological control of avocado root-rot fungus were continued. Thick mulches of eucalyptus sawdust, woodchips, and chopped leaves, or similar material mixed with naturally infested soil did not retard the progress of root rot in avocado seedlings in the greenhouse. In one test, the mulch was applied to the surface of the soil, the soil watered to keep good moisture, and then avocado seedlings were planted in the soil three months later. No response was noted.

A mixture of soil bacteria, obtained from the Ambassador College in Texas was added to soil containing the root-rot fungus in an attempt to determine whether this treatment reduced the progress of root rot in avocado seedlings. No response was obtained.

Chopped leaves, stems, and roots of a species of *Persea* highly resistant to *P. cinnamomi (Persea borbonia)* were incorporated in infested soil to determine if this would reduce the activity of the root-rot fungus. Small seedlings of the susceptible species, *Persea indica,* were planted in small containers with the treated soil. An initial retardation of root-rot symptoms was observed, but after one month seedlings were affected similarly in treated as well as untreated soils.

In relation to this response, however, one of our graduate students, Mr. V. Sing, has found that leaves of *Persea borbonia* contain a preformed substance that is toxic to *P. cinnamomi* and other fungi. This substance does not occur in leaves of susceptible varieties such as Topa Topa or Mexicola. Further studies are under way in an attempt to determine the identity of the toxic substance and to test leaves and roots of other resistant species of *Persea,* as well as roots of *P. borbonia,* and leaves of other susceptible varieties of avocado and susceptible species of *Persea.*

STUDIES OF THE FUNGUS.—During the past year, for the first time, we have been able to obtain sporangia of *P. cinnamomi* under sterile conditions in the laboratory, following the research of Prof. Dah-wu Chen, visitor from Taiwan, who developed the method in our laboratory. This involves use of very young cultures and extensive washing of mycelial mats with a salt solution (containing Ca, Mg, and Fe). Previous studies had required the use of a non-sterile soil extract for production of the sporangial stage. The sterile culture method will facilitate studies of the fungus life cycle and permit the development of further information on nutritional requirements for production of this important spore stage which should be of significance in control.

Continuing studies of chemotaxis of the zoospores of the fungus showed that there is a definite attraction to specific amino acids; this response is apparently at least partly responsible for the attraction to roots and the subsequent invasion and development of root rot. Electrotaxis studies with zoospores indicated some accumulation of zoospores in an electrical field, primarily around the anode.

Thirty additional cultures of *P. cinnamomi* were added to the culture collection for studies of variation in morphology and pathogenicity. Several new isolates from camellia were obtained; these were all of the less common or A^1 mating type. More isolates from California are being collected and studied to detect any variation.

Variation in pathogenicity of some *P. cinnamomi* isolates to avocado was found, using the stem inoculation method. Isolates from camellia (some Isolates), macadamia, and pear were not pathogenic or only slightly pathogenic to avocado stems. The original isolate of *P. cinnamomi,* obtained from cinnamon trees by Rands in 1922, is pathogenic to avocado terns. Additional inoculations showed no significant differences in pathogenicity to avocado stems of several other isolates from camellia (4), cypress, and other avocado isolates. Further studies of various isolates of the fungus should provide information on possible origins of *P. cinnamomi* and on the possibilities for development of new strains.

Attempts to obtain quantitative data on the population of *Phytophthora cinnamomi* in the soil, using a method reported to be effective in pineapple soils in Hawaii, have not been successful in California avocado soils.

Germination of chlamydospores of *P. cinnamomi* was stimulated by amino acids and root exudates — particularly of susceptible species of *Persea.* Thus, the presence of such materials in soil will tend to increase the population of the fungus in the soil.

Oospores of *P. cinnamomi* were germinated for the first time, and some colonies established. Information is being obtained on mating type of the progeny and any variations in morphology or pathogenicity.

Sun Blotch Investigation

J. M. Wallace

Except for observations on field plantings established previously, work on sun blotch has dealt largely with indexing of budwood and rootstock source trees for use by the avocado industry.

Meetings have been held with avocado nurserymen and State of California Bureau of Nursery Service in relation to initiating a certified nursery-tree program.

Because of the interest in container-grown avocado nursery trees, some additional studies are in progress on propagation of very young trees using soft buds and the "wedge bud" technique developed in our investigations some years ago for the production of experimental bud-ling trees. From tests made at different times of the year, it appears that the spring months, February-April, may be the only time when this method of propagation will prove successful. Other tests are planned for the spring of 1970.

Dr. Ralph Schwarz of South Africa has indicated that he found some evidence of a

fluorescent marker in sun blotch-infected tissue. Because he has very little material from known infected trees to work with, arrangements are being made to send healthy and infected bark tissues to him for further testing. If this provides a positive identification of sun-blotch infection, we shall proceed to set up the necessary laboratory equipment locally for use in selection of sun blotch-free propagative material.

AVOCADO PEST CONTROL

Entomology—Insects and Mites

J. S. Ortega and W. H. Ewart

SUMMARY FOR 1968.—Field research was conducted for the second year on the use of oil sprays for the control of the avocado brown mite on the Haas variety. The performance of narrow-range oil and light-medium soluble oil sprays at 1 gallon and $1^1/_2$ gallons per 100 gallons of water were compared with tetradifon at 1 pound of the 25% wettable powder per 100 gallons of water. All three sprays gave satisfactory control of the avocado brown mite as evidenced by the moderate to high mite populations present on the control trees during the field trials. Data obtained in 1967 and 1968 were forwarded to the State Department of Agriculture and to all manufacturers and formulators of narrow-range and citrus-spray oils for use as supporting evidence should they desire to add recommendations for the control of the avocado brown mite to container labels.

SUMMARY FOR 1969.—Treatments were applied for the control of the greenhouse thrips *Heliothrips haemorrhoidalis* (Bouche) infesting Haas avocado near Goleta, California, on May 1, 1969. At the time of harvest on October 7, 1969, a minimum of 900 fruit were examined from each plot. Results are summarized in the following table.

Material - Amt. 100 gals.	Percent of fruit showing injury				
	None	Trace	Light	Med.	Heavy
1) Malathion (25WP) 2 lbs. + Tetradifon (Tedion®) (25WP) 1 lb.	87.1	0.5	6.5	3.7	2.2
2) Pyrethrum (2.5%) 1 pt. + Narrow-Range Oil 1 gal.	66.4	2.1	12.2	10.1	9.2
3) Carbofuran (Furadan®) (75WP) 5.3 oz.	80.6	3.9	9.1	4.3	2.1
4) Formetanate (Carzol®) (90%) 4.2 oz.	49.0	7.2	16.4	14.1	13.3
5) Control	36.8	10.5	14.9	14.3	23.5

On the basis of fruit injury evaluations, the standard malathion treatment was the most effective. Furadan showed much promise at the relatively low dosage used. At the

dosages applied, neither carbofuran nor formetanate showed phytotoxic or other adverse effects. Although Pyrethrum-oil was less effective, it is a useful treatment since it offers little chance of a biological balance upset and is relatively nontoxic to mammals.

Naled (Dibrom®) at 8 ounces of actual compound per 100 gallons was relatively ineffective in controlling the omnivorous looper in San Diego County. Galecron®, a candidate material for the control of the omnivorous looper and the Amorbia, showed no phytotoxicity or other adverse effects when applied to Haas, Fuerte, and Bacon varieties at 8 oz. of actual compound per 100 gallons of water.

BIOLOGICAL CONTROL OF INSECTS AND MITES

J. A. McMurty

Experiments to determine the effectiveness of mass releases of the ladybird beetle *Stethorus picipes* Casey for suppressing populations of the avocado brown mite were continued in 1968 and 1969. In 1968, releases were made in two orchards at a rate of 200 adult beetles per tree in plots of 64 trees. Although releases were started too late in one orchard, the release plots in both orchards had lower mite populations and less leaf injury than the check plots, the results being generally comparable to those of 1967 when plots were smaller (16 trees) and the release rates were higher (400 *Stethorus* per tree).

In 1969, a 64-tree plot was used to determine if a release of only 100 beetles per tree could effectively suppress the avocado brown mite population. Conclusive results were not obtained as the mite infestation appeared much later than normal, and the population levels varied widely within plots as well as between plots.

A new technique is being developed for mass-rearing *Stethorus picipes* and initial observations indicate a considerably higher efficiency than previous methods. Trials have also been initiated on cold storage of beetles, so that large stocks can be built up for use when mite infestations develop.

Six imported species of predatory phytoseiid mites which feed on avocado brown mite were liberated during 1968. Four of the species were recovered several weeks after the releases,

A long-term experiment is being conducted in cooperation with the Division of Economic Entomology to determine the effects of sprays for greenhouse thrips on populations of avocado brown mite and its natural enemies.

PHYSIOLOGY

Fruit Development and Maturation

L. C. Erickson

UPTAKE OF RADIOACTIVE PHOSPHATE BY PULP AND EMBRYO OF FUERTE AND HASS AVOCADOS.—In a continuing study of fruit development and maturation with the view of improving maturity criteria, the uptake of phosphate by disks of fruit pulp and embryo has been measured.

Fruit of both Fuerte and Hass avocados have been sampled during development. Disks 2 mm thick and 10 mm in diameter were incubated in 1 mm phosphate at pH 7.00 and with 0.025 uc 32P per ml. During incubation, seven disks per sample were placed in a shaker bath maintained at 25°C and oscillated at 120 cycles per minute. At the end of the incubation period, which varied from 1 minute to 24 hours, the disks were blotted prior to drying at 70 °C and measuring their radioactivity in counts per minute with a Tracerlab thin window counter.

The uptake of phosphate by the disks followed a similar pattern in the two varieties. Of the activity found in the disks after two hours, about 1/3 was present after the first two minutes. Between two hours and 24 hours, the rate of phosphate uptake accelerated greatly.

Immature fruit showed a slightly more rapid initial uptake than mature fruit. However, the total uptake of phosphate after 24 hours was greater in mature fruit than in immature fruit. Later in the season, the mature fruit were less active in absorbing phosphate.

The uptake of phosphate by disks of embryo followed the same general pattern as the pulp except that there were two points of difference: (1) young embryos initially absorbed phosphate more rapidly than pulp of the same age, and (2) long-term uptake (24 hours) by embryos was less than 1/2 of that in the pulp. The first point indicates that embryo cells were more permeable than pulp cells and thus absorbed phosphate at a greater initial rate. The second point indicates that during a longer-term uptake the pulp had a greater requirement or a greater capacity for accumulation of phosphate than did the embryo.

In conclusion, the results of the study showed that as the fruit developed there were changes in ability to take up phosphate from a bathing medium. The magnitude of the changes was small and therefore did not indicate the possibility of an inflection point which might be of value in establishing a physiological maturity.

FERTILIZATION AND NUTRITION

T. W. Embleton and W. W. Jones;

NITROGEN STUDIES.—Damage from the freeze of December 21, 1968, made it necessary to discontinue two nitrogen experiments on Hass and one on Zutano. Remaining are two Bacon experiments, one in Ventura County and one at the South Coast Field Station.

The experiment at the South Coast Field Station is a cooperative irrigation-fertility investigation. Two levels of nitrogen have recently been established, but no data is available as yet.

The Ventura County experiment was initiated in January, 1967. To date, rates of nitrogen varying from 1/4 to 4 pounds per tree annually with four different timings of application, have not influenced the nitrogen concentrations in the leaves or yield.

F. T. Bingham

SODIUM INJURY.—Mature Hass avocado trees growing in large outdoor sand-cultures under variable sodium treatments (sodium adsorption ratios - SAR) for approximately 12 months show a progressive accumulation of sodium in all parts of the tree with some trees being fatally injured by substrate sodium concentrations of SAR 4 and higher. Rootstocks apparently exhibit considerable variation in controlling sodium uptake. Leaf tissue concentrations of approximately 0.3% Na are associated with development of necrotic tissue between the main veins of the leaf. Further increases in sodium leads to extensive leaf abscission, twig dieback, and fruit drops. Research activities will be directed to mechanisms of sodium uptake and transport and mode of injury.

IRRIGATION

S. J. Richards and J. E. Warneke

Bacon avocado trees were planted at the South Coast Field Station in 1958 for an irrigation-fertility experiment on mature trees. Differential irrigation management treatments that were initiated in 1967 have not shown any effect on fruit yields for the three years of record. Irrigation plots were subdivided in 1969 for differential fertility levels. Half of the trees received 1 Ib. of N per tree, and the remaining trees received no nitrogen.

Additional information on pruning was obtained in 1969 by topping the guard trees around each yield plot. Because of picking difficulty, the trees were topped to approximately 15 feet before bloom. The yields dropped from 185 Ibs/tree in 1968 to 50 Ibs/tree in 1969. The trees in the plots that were not topped produced 150 Ibs/tree in 1969.

BREEDING

B. O. Bergh

During 1969, some 40 additional selections were made at the South Coast Field Station, chiefly from among Hass, Yama, Thille, Nabal, and Linda "selfed" seedlings. These selections are now being propagated for testing as grafted trees. A hybrid of Hass by Clifton, originally designated "17-51", has been given the tentative name of "Haston".

Special University funds have made possible a major attempt this coming spring to cross the harrier between the commercial avocado and related species that are resistant to root rot. An able technologist has been hired to try to determine just where the hybridization barrier is, with the hope that this knowledge will make a breakthrough possible.

AGRICULTURAL EXTENSION

C. D. Gustafson

Summary of Agricultural Extension avocado projects currently in progress:

Los Angeles County

R. E. Puffer

Annual avocado meeting held with Orange County, primarily for new growers. Farm calls to old and new growers.

Orange County

H. L. Francis

Annual avocado meeting held with Los Angeles County, primarily for new growers. Farm calls to old and new growers.

Riverside County

A plot on testing mulches for root-rot control was eliminated due to last winter's freeze. A plot is being established to test effectiveness of soil fumigants on eliminating root-rot fungus in replanting situations, and resistant rootstocks will be evaluated.

Trials are underway to evaluate new types of frost-protection equipment, including

artificial fog, new types of pipeline heaters, and helicopters.

San Diego County

BIO-CLIMATOLOGY.—A complete weather station has been in operation for the past four years in an attempt to obtain data on climatic conditions, though more information can be obtained on how climate influences avocado fruit quality. The first three years, the station was located on Rancho Taza, east of the community of Fall-brook. The last year, the station has been on the Oliver Atkins Nursery growing grounds in Bonsall, south of Fallbrook.

FUERTE CLONE IMPROVEMENT.—This project was specifically set up to compare heals of trees budded from high-producing trees with buds taken from low-producing trees. This project was started in 1963, and production records will be taken this year to ascertain the results of this six-year study.

AVOCADO BROWN MITE.—The four-year study on avocado brown mite continues in cooperation with Dr. Jim McMurtrey and the Division of Biological Control of the Citrus Research Center. Studies in the release of stethorus beetles in an attempt to control brown mite have continued. In addition to these mass releases, work has continued for a synthetic-type food or a natural occurring food placed in the trees in an attempt to build up stethorus beetle population prior to invasion of brown mite.

DRIP IRRIGATION PROJECT—A new system of irrigation introduced from Israel is being tested on a five-acre avocado planting, The young trees will be planted in the spring of 1970, after the installation of the drip irrigation system designed and manufactured in Israel. Drip irrigation will be compared to the conventional sprinkler irrigation, with all types of records being maintained to accurately measure the feasibility of using drip irrigation on avocados.

AVOCADO ROOT-ROT DISEASE.—Various types of test plots are being continued in the fight against avocado root rot. Dr. Zentmyer and his staff in cooperation with the farm advisors and growers are watching new projects in an attempt to find an answer to this serious disease. Fuerte and Hass trees grafted on Duke cuttings have been planted in a number of orchards in an attempt to find a resistant root-stock against the fungus.

AVOCADO VARIETIES.—Avocado varieties project continues in hope of finding better producing varieties. This work is in cooperation with Dr. Bergh of the Citrus Research Center. In addition to the breeding work and the field testing work, observations on established trees showing good production characteristics are being carried out.

AVOCADO ROOTSTOCKS.—The only rootstock plot remaining in San Diego County is the one on Al Von Norman's property in Fallbrook. This is the one where Hass and Fuerte have been grafted on their own rootstock. Yields have been accumulated over the years, and plans are to continue the project until some type of trend in production is observed,

AVOCADO ROOTED CUTTINGS.—The propagation of avocados has been primarily by seed. In order to obtain clonal stocks, a method to propagate avocados by cuttings must be found. A project in cooperation with the Avocado Nurserymen's Section,

C.A.S., the Citrus Research Center, and the farm advisor has been initiated in an attempt to find out if propagating avocados by cuttings is commercially feasible. Individual nurserymen will be conducting the experiments in their respective greenhouses in a cooperative project with the University.

San Luis Obispo County

J. H. Foott

VARIETY TRIALS.—Six variety trials, using Bacon, Creelman, Hass, MacArthur, Rincon, and Zutano, as well as several numbered hybrids, are being continued and expanded from Nipomo at Cayucos.

Santa Barbara County

G. E. Goodall

The field research program was expanded considerably during the past year to concentrate more on the avocado root-rot disease. The old "citrus field research" orchard at the Santa Barbara General Hospital grounds was reactivated, and the two acres of avocados were put in good condition. The main values in this planting are to provide bud-wood and seed sources, particularly those indexed for sunblotch freedom; to supply fruit for fungus culturing; to serve as a clone garden; and to provide on public property trees that can be treated with experimental chemicals without fear of killing grower's trees, contaminating marketed fruit, or spreading the root-rot fungus. This project is maintained by Santa Barbara County Extension personnel with part-time help, hired in part by grant funds from the California Avocado Society.

The County Orchard, as well as all the other avocado root-rot trials, is conducted in cooperation with Dr. G. A. Zentmyer, UCR plant pathologist, and his staff. Expanded field trials also include the planting of several hundred rooted cuttings of the resistant Duke rootstock. Sixty-four of these trees are involved in a replant growth-stimulation trial that included preplant soil fumigation, monthly fungistat drenches, and semi-annual growth-stimulant foliage sprays. This replaced a previous trial in which Duke seedlings were used.

Two new trials were established to test two new chemical-control treatments in the field to compliment the laboratory trials of these materials at Riverside. The previously operated trials of chemical drench fungistats were all completed and analyzed in the past year.

Other older trials on resistant rootstocks, chemical barriers, inarches, and soil amendments were continued. As a service to local growers, we culture samples for *P. cinnamomi,* since no commercial laboratory is available for this.

The iron chlorosis control trials were terminated after four years with encouraging results due to light, frequent irrigations and no practicable benefit for iron foliage sprays. This trial, in cooperation with Dr. E. F. Wallihan, UCR soil scientist, found tensiometers to be practicable in evaluating the moisture conditions in the Zaca clay soil involved. A

randomized, statistically analyzable trial was never able to be operated, so the attempt to do so was abandoned. The block will continue to be operated as a demonstration and to look for long-range complications.

A new trial was initiated in cooperation with Jack Ortega, UCR entomologist, and the County Agricultural Commissioner's staff to test four chemicals on the control of greenhouse thrips on Haas. Dr. James McMurtry, UCR entomologist, is to follow the mite and predator populations.

Other trials continued from previous years include two variety trials, seven rootstock trials and a soil application trial for zinc deficiency.

The annual Avocado Institute is held to provide growers with an opportunity to hear progress reports of research. A Newsletter is issued quarterly, and numerous avocado growers were aided in developing agricultural preserves.

Tulare County

B. W. Lee

Interest and activity in growing avocados in central California, and particularly Tulare County, is growing annually. Since this is a new area for commercial avocado production, there are many problems arising that are not encountered in the long-established areas of avocado growing in Southern California. At present, there are approximately 400 acres of commercial avocados in the San Joaquín Valley. All varieties planted are fall maturing, such as the Bacon, Zutano, and Suzan. Growers recognize it is impossible to compete with Southern California for the summer and winter markets. Fall maturing varieties in central California are the only ones, therefore, that are able to successfully compete and show a good return for the risks involved. These varieties must mature early, be resistant to frost, high in quality, and produce well to successfully capture a portion of the fall market.

For the past 15 years, there has been search for varieties which will fill the above requirements. The Agricultural Extension Service has been involved in variety plots during this time, trying to move promising varieties from Southern California to Tulare County and other areas in central California to test their adaptability to this new and more belligerent climate, both summer and winter. A few varieties were accepted for further trials, but most were rejected because of poor frost resistance, quality, and production.

In 1969, a large and comprehensive test plot for varieties was started at the Don Case orchard near Orange Cove. Thirty varieties were established there which have shown possibilities in Southern California. All are fall-maturing varieties which appear to be quite resistant to frost. Many of these varieties are numbered selections from Dr. Bergh's variety plot at South Coast Field Station.

An avocado variety plot established last year at Lindcove Field Station will parallel the tests now being conducted at the Case orchard. A large number of varieties will be tried, and those showing promise in this area will be continued as a budwood source for growers wishing to try these varieties throughout Tulare County and central California.

In 1970, the University of California acquired the Paul McEwen property adjoining the Lindcove Field Station on the east. Included in the acquisition is a 2-acre block of 9-year-old avocado trees. Since the original planting of these trees, the Agricultural Extension Service has conducted a variety plot in cooperation with Mr. McEwen, Many of the original varieties established in this plot now have been discarded and new ones added. Hopefully, out of the search and testing of new fall-maturing avocados a variety will be found which will gradually replace those now grown commercially in the San Joaquín Valley. There is much room for improvement in the present commercial avocado varieties.

Trees in the McEwen orchard were planted close, and a tree-removal program to reestablish production closer to the ground will be instituted in 1970. This program will serve as an example for what must be done in many other crowded orchards throughout the central California area. This will provide an opportunity to demonstrate what a tree-removal program and topping of the tall, slender-growing varieties will do to improve production closer to the ground.

Research by the Agricultural Extension Service on avocado production in central California is confined to those areas of production most necessary to establish this new industry in an area heretofore thought to be impossible for growing a commercial crop of avocados. The biggest problem has been the selection of correct varieties to take advantage of the marketing situation during the fall of the year. For those growers gambling on the fact that they can produce a commercial crop of avocados in this area, the problem of varieties is most important to them. They know that somewhere in central California or in Southern California there is a variety which may not be grown commercially at this time but has good potential as a commercial producer in this area. Testing, so far, has not produced the ultimate avocado variety; hopefully, the future will show a steady improvement in the variety situation in central California.

Ventura County

AVOCADO ECONOMICS.—Avocado sample cost of production and sample cost to develop an avocado orchard are revised every two years. Studies to be made during 1970 based on 1969 costs.

AVOCADO FERTILIZATION.—Information on the effect of rate and timing of production of Bacon and Hass varieties is urgently needed. A cooperative plot (UCR) was established in 1967. Due to severe frost damage, no information was available during 1969. Long-range experiment.

AVOCADO TREE THINNING.—Several field trials are under way to determine the effect of thinning trees in crowded orchards. Three treatments are usually employed: (1) every other tree in every row, leaving a square planting with a tree in the center of the square; (2) every other row, leaving a hedgerow planting; and (3) unthinned check. Early results indicate the hedgerow planting results in greatest production on a per-acre basis.

AVOCADO MICRONUTRIENT DEFICIENCIES.—A two-part project consisting of: (1) iron-deficiency control, and (2) effect of zinc-manganese on yield.

AERIAL APPLICATION OF ZINC.—Project completed. Object was to determine the efficacy of applying micronutrient sprays by air in crowded and hillside orchards. Results show it is an effective method of application. Results have been published.

AVOCADO VARIETY IMPROVEMENT.—A continuing project in the search for new and better avocado varieties. A three-phase project consisting of: (1) selfed seedlings in cooperation with UCR, (2) new hybrid testing (UCR), and (3) testing and observation of other new varieties.

AVOCADO SUN-BLOTCH INDEXING.—Avocado seed-source trees are being indexed for sun-blotch. In cooperation with local avocado nurserymen and UCR, 54 seed-source trees are now being indexed.

AVOCADO STUMP CONTROL.—A project initiated to evaluate the effect of various chemicals and methods for controlling regrowth from avocado stumps when trees are thinned.

Ammate X in a frill around the trunk gave best results. Results are being published in Avocado Yearbook. Project is being continued and expanded to involve other methods and rates.

EFFECT OF GIRDLING ON YIELD.—Reports from Israel indicate fall girdling improved fruit set where pink-bloom girdling did not. Limited trial initiated in 1968. Results were outstanding. Project being expanded to include Hass, Bacon, and Fuerte varieties.

AVOMATION.—A series of one-sheet information data sheets for avocado growers is being initiated.

STARTER TABLETS.—A field trial has been initiated to determine the effect of using starter tablets at the time of planting avocado trees. No results at this time.

AVOCADO ROOT ROT.—Continuing educational program with growers to point out the importance of the disease and methods of retarding spread if found. Assisting growers with detection of the disease. Cooperating with UCR with various test plots in Ventura County. Mr. Burns published results of project where Duke seed sources were tested for sunblotch.

AVOCADO NURSERY CONTAINERS—Most avocado trees in Ventura County are grown in containers. Tarpaper pots left something to be desired. Field tests indicate plastic sleeves make satisfactory-containers. Nurserymen are now changing over to the plastic containers. Mr. Burns published the results of his trials.

Riverside Campus

R. G. Platt and R. C. Rock

Extension specialists are involved in a number of projects and studies in cooperation with Farm Advisors, research personnel, and different segments of the industry, including the California Avocado Society, California Avocado Advisory Board, and California Avocado Development Organization.