JOURNAL
OF THE
RIO GRANDE VALLEY HORTICULTURAL SOCIETY

Volume 16, 1962

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Published By
RIO GRANDE VALLEY HORTICULTURAL SOCIETY
Box 107, Weslaco, Texas

Editor, Edward O. Olson

Associate Editors, Bailey Sleeth and Roger Young

Aims and Objectives of the Society

The Rio Grande Valley Horticultural Society represents an amalgamation of the former Valley Horticultural Club, the Texas Avocado Society, and the Valley Grape Association.

The purpose of the Rio Grande Valley Horticultural Society is the advancement and development of horticulture in the Lower Rio Grande Valley. It is the aim of the Society to stimulate interest in research and its practical application to Valley problems with fruit, vegetables and ornamentals.

At monthly meetings subjects of interest are presented by specialists in their fields. These presentations are followed by open forums. The Newsletter announces and discusses the monthly programs and brings other news of interest to Society members.

The Society has sponsored 16 annual Institutes, where outstanding speakers from all parts of the country present new developments in the field of horticulture. Panel discussions, social get-togethers and a barbecue round up the all-day program.

Talks given at the Institute and reports of Valley research are published in the Journal of the Society, which provides a continuing record of horticultural progress in the Valley.

Anyone interested in horticulture can become a member of the Society. The annual fee is $4.00, which includes the Journal. Applications for membership, and annual dues should be sent to the Secretary-Treasurer, Rio Grande Valley Horticultural Society, Box 107, Weslaco, Texas.

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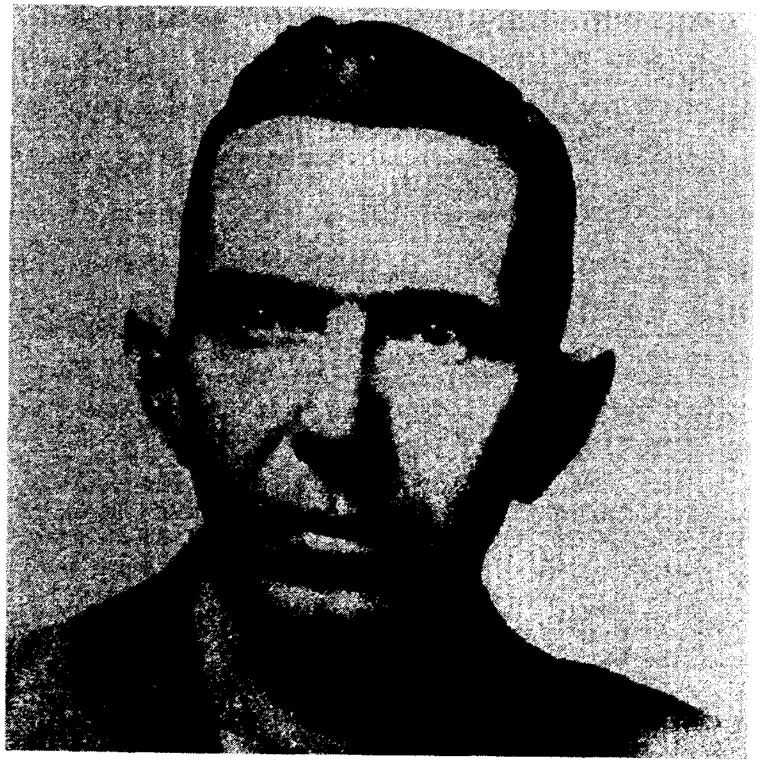

W. H. "Bill" Friend

W. H. "Bill" Friend

Recipient of the Arthur T. Potts Award

January 23, 1962

William Heartsil Friend was an apt pupil of Professor Arthur T. Potts at Texas A. and M. College several decades ago.

He was to become the winner of the Arthur T. Potts award set up by the Valley Horticultural Society but did not live to accept the honor in person although he knew of his selection before his passing.

He will be sorely missed by the hundreds of farmers with whom he visited personally in their orchards and farms, by the thousands who witnessed his demonstrations and the many thousands more who read his articles or heard him over radio and television.

And he will be missed by countless fellow workers with whom he consulted on various horticultural problems. He left a deep imprint on Valley agriculture through his labors. Intimate with few, he was a friend of thousands.

He was born October 31, 1897 in Marshall in Harrison County, Texas but he never revealed his birthday to friends, reflecting an innate reserve.

He went to California as a student to gain experience with citrus with the idea of perhaps going to South Africa. While working in the California nursery he noticed citrus trees were being sent to Texas and that changed the course of his career.

In December, 1921 he became manager of the Edgar J. George orchard near Rio Hondo and the same time taught vocational agriculture in the local school.

He became first superintendent of the Valley Experiment Station in 1923 when the Valley shipped its first solid rail car of citrus fruit to market.

He remained in this position until 1948 when he was made extension horticulturist for Cameron, Hidalgo and Willacy counties. About a year ago his duties were extended to cover 30 South Texas counties.

He died January 8, 1962 on the eve of the record breaking freeze as the result of an incurable illness.

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January 23, 1962

Texas A&I College Citrus Center

Institute Director – Dr. Bailey Sleeth

MORNING PROGRAM

FIRST SESSION

CHAIRMAN .... Dr. Ernest H. Poteet
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Address of Welcome .... Stanley B. Crockett, Jr.
President, Rio Grande Valley Horticultural Society

Recent Developments in Tomato Breeding .... Paul W. Leeper
Horticulturist, Texas Agricultural Experiment Station

Citrus Rootstock Resistance to the
Burrowing Nematode .... Dr. Harry W. Ford
Horticulturist, Florida Citrus Experiment Station,
Lake Alfred, Florida

SECOND SESSION

CHAIRMAN .... John C. Hobson
President, Texas Citrus Mutual

Chemical Weed Control in Vegetables .... Dr. Robert M. Menges
Horticulturist, USDA Crops Research Division, Weslaco

Marketing Citrus in Florida .... Don Lins
General Manager, Florida Citrus Exchange, Tampa, Florida

AFTERNOON PROGRAM

THIRD SESSION

CHAIRMAN .... Fred R. Brison
Professor, Texas A. & M. College

Arthur T. Potts Award Presentation .... Stanley B. Crockett, Jr.
President, Rio Grande Valley Horticultural Society

Efficient Grove Management Practices .... Paul W. Moore
Research Director, Willits & Newcomb Nursery,
Thermal, California

FOURTH SESSION

CHAIRMAN .... Eugene M. Goodwin

Citrus and Vegetable Forum

The panel will consist of the program speakers; Gene Winn, N. P. Maxwell, Art Shull, Bruce Lime, Dr. P. W. Rohrbaugh, Dr. W. C. Cooper, Dr. R. C. Lambe and Dr. E. O. Olson.

EVENING PROGRAM

CHAIRMAN .... Dr. J. B. Corns
Head, Department of Agriculture, Pan American College

Distinctive Valley Ornamental Trees and Shrubs ..... Harry Foehner
Editor, Texas Farming and Citriculture

Nature Studies:

Embraces Biology of Insects and Plant Hosts .... Dr. Norman Flitters
Bio-climatologist, USDA Entomology Research Center,
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Texas A&M College,
College Station
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Harry Swofford
703 Upas Street, McAllen
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CITRUS AND AVOCADO SECTION

Trends in Citrus Orchard Management Practices in California[1]

PAUL W. MOORE[2]

Citrus growers in all four of the citrus producing states of California, Arizona, Texas and Florida share a common desire—to increase their net income. Whether their status may be the owner-operator of a small orchard or the manager of a corporation empire of thousands of acres, each one is looking for ways of growing his crop more cheaply or increasing his yields without increasing his cost. It is these two fundamental desires that have resulted in many changes in cultural practices in California over the last two decades.

During this period, California has become highly industrialized. Industrial wage rates have forced agricultural wages upward until they are the highest in the nation. Material and equipment costs have also risen. Yet the returns to the grower from fruit sales have not increased or have been below the cost of production. These economic pressure have forced the citrus grower to seek greater efficiency in the use of labor and materials and find ways of improving income by increasing his production and improving the quality of his fruit.

He has had an invaluable ally in the agricultural research agencies of the U. S. Department of Agriculture, the State Universities and private industry. These untiring, dedicated, and capable research men have been the first to give us new machines, improved means of pest and disease control, new herbicides, new rootstocks, new varieties and the more effective tools of our trade.

The answer of high agricultural labor costs is, in most cases, mechanization. Many notable advances have been made in harvesting machinery for many of our fruit and vegetable crops. For example, grapes, properly trellised and trained, can now be harvested and laid on paper in the sun to dry into raisins, entirely by machine. Most of our nuts and dried fruit crops are now harvested by mechanical tree shakers, catching frames, and machines that can pick the crop off the ground, clean and load it into boxes or bins. A new tomato variety has been developed that matures all its fruit at once. This permitted the development of a successful tomato harvesting machine. All of these machines have been instrumental in reducing harvest costs that were becoming prohibitive.

In the citrus industry advances have been made in bulk handling of our fruit from the orchard through the packing house that have cut several cents per box from handling and packing costs.

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[1] Part of a talk given before annual Institute of Rio Grande Valley Horticultural Society, January 23, 1962.

[2] Research Director, Willits and Newcomb Nursery, Thermal, Calif.

Most of the lemons produced in the United States are grown in California. Until 1954 most of the acreage was pruned by hand. Following that year, machines were developed and placed in the field that pruned the sides and tops of the trees and have reduced pruning expenses to about one third of former costs. Hedging and topping machines are also being used to correct and prevent overcrowding in our older orchards through inexpensive mechanical pruning. In many cases increases in yield and improvement in fruit size have followed this type of pruning.

An attack is currently being made on our harvesting costs by a team of engineers and economists. After several years of study and trials a pilot machine is about to be placed in the field that may have the potential of increasing a picker's output two or three fold.

Turning to cultural practices, a relatively new instrument, the tensiometer, has helped our growers to perform their irrigations with a greater degree of intelligence. This simple instrument probably comes closer to measuring the availability of soil moisture to the tree than any others.

The experience of many orchardists is that they have often been able to safely withhold scheduled irrigations and save the water cost. In some of our citrus districts where water may run as high as $60.00 per acre foot, this may mean an appreciable saving. Tensiometers also warn of dangerously low levels of available soil moisture and are helpful in scheduling irrigations before damage to crop and trees can take place. In the past five years, use of tensiometers has increased tremendously with an over all improvement in soil moisture control.

Close and accurate nitrogen control through the use of leaf analysis is a relatively new practice which is being used and more extensively and which has brought about appreciable savings in fertilizer costs. Briefly, the technique is to take leaf samples of spring flush leaves in August, by which time they are 4 to 6 months old. A nitrogen level of 2.4% to 2.6% is considered adequate for good production. Nitrogen applications are adjusted upward or downward as required.

For years a rule of thumb prevailed that approximately 3 pounds of nitrogen per tree were required for good production. Using leaf analysis as a tool, we know now that many orchards require only one pound or less to maintain top production.

It has been proven that in some areas not only is production maintained but fruit quality and fruit size are markedly improved under a lower nitrogen program.

This statement is not meant to infer that all orchards should go on a reduced nitrogen program but that leaf analysis is becoming a more frequently used aid in managing the fertilizer program.

For many years non-tillage has been the standard practice on most of the citrus acreage in California. No weeds or grass are allowed to grow and are controlled by herbicides. This practice is definitely preferred to cultivation on our soils. A better soil structure is maintained under a non-tillage program and water infiltration rates are better.

Until about 7 years ago the principal herbicide was high aromatic content petroleum oil. For orchards changing from tillage to non-tillage, the costs, using oil herbicides, often exceeded tillage costs for 2 or 3 years. With the introduction of Monuron, the cost of non-tillage during the initial years has been greatly reduced. More recently simazine has been licensed for use in citrus orchards and is now being used extensively in the non-tillage program. There is no doubt that non-tillage and use of these herbicides is the cheapest and best system of soil management available to us at present.

In the late 1930's Tristeza or Quick Decline made its appearance in the San Gabriel Valley of California. Ten years later most of the oranges on sour orange rootstock in that area were dead. The disease is still ravaging in other parts of Southern California. The recognition that sour orange was rendered useless as a rootstock by the disease led to an extensive research program to find tristeza-tolerant substitutes. As a result we now have a number of superior rootstocks that almost permit us to select a specific rootstock to meet the requirements of any orchard site. We now have stocks which are superior to sour in *Phytophthora* root rot resistance; more tolerant of boron, salinity, and high lime soils; more vigorous; and less subject to minor element deficiencies.

Our most important stock now is the Troyer citrange. A little more than a decade ago it was almost unknown. Its orchard performance has been excellent. A number of other rootstocks show promise and will probably gain in importance as more is known about them. Among these are Carrizo citrange, *Citrus taiwanica, Citrus macrophylla,* Citremon 1449 and a few citrumelos.

Along with the rootstock research, has been a search for better performing, virus-free varieties. The trend in varieties in California has been to the nucellar strains such as Dr. H. B. Frost's nucellar clones of Washington navel, Valencia, lemons and grapefruit. With few exceptions nucellar lines have exhibited superior performance compared to the old lines. The combinations of superior rootstock and high performing variety selections have already produced some outstanding young orchards that promise to maintain top production for many years. There is little doubt but that the orchards being planted in suitable soil and climatic situations will be superior to those planted a generation ago.

Closer planting is another trend evident in the new plantings in California. This is a product of high-priced land, high cost of bringing an orchard into bearing, and an attempt to get an early return on investment.

In past years the standard planting distance was something like 22 feet x 22 feet. The number of trees per acre ranged from about 90 to 105. The long-time production records of several older orange and lemon orchards in our State has shown that close planted orchards—for example 11x22 feet—have maintained a production lead of from 40% to 60% more fruit over a period of 20 to 30 years. Such evidence has encouraged close planting on a wider scale.

In summary, economic pressures have forced California growers to seek ways of decreasing costs and increasing income by increasing production of high quality fruit.

To counteract high labor costs, a higher degree mechanization of fruit handling from orchard through the packing house has already been accomplished. Pruning costs have been reduced by the development and use of hedging and topping machines. Mechanized picking aids are being pushed and a prototype machine is now under test. More effective use of irrigation water has been accomplished by the use of tensiometers. Leaf analysis, to determine the nitrogen status of the tree, has resulted in reduced and controlled applications of nitrogen fertilizer. Fruit quality and fruit sizes have frequently been improved under the controlled nitrogen program. New herbicides have brought about economies in the non-tillage program, the prevailing system of soil management in California.

Improved rootstocks and nucellar selections of commercial varieties are resulting in better orchards with greater long term bearing potential compared to the orchards planted a generation ago.

An increase in close planting to obtain maximum early returns on investment is evident in the newer plantings.

Effects of Winter Oil Spray on Cold Hardiness of Red Blush Grapefruit Trees[1]

Roger H. Young, Herbert Dean, A. Peynado, and Jack C. Bailey[2]

Oil sprays have been successfully used on citrus for the control of certain scale insects in California (Boyce, 1948), Florida (Thompson and Griffiths, 1949), and Texas (Dean and Bailey, 1961). Its use during the winter has been questionable, primarily because of an adverse effect on the cold-hardiness of the tree (Thompson, 1947; Woglum, 1940).

While oil sprays are not normally applied in the winter for scale control, sometimes a winter scale control program is required. The purpose of this report is to summarize several trials designed to estimate the effects of applications of oil sprays in winter on the cold-hardiness of Red Blush grapefruit trees.

METHODS AND MATERIALS

Plant materials used were 9-year-old Red Blush grapefruit trees on sour orange rootstock and 1-year-old Red Blush grapefruit seedlings.

On January 16, 1961, 2 trees were sprayed with 1.6% oil. The oil contained the following properties: unsulphonated residue (ASTM) 96.4%; molecular weight (mills) 330; oil, 99.75%; and viscosity, SSU at 100°F., 73.4. Ten to fifteen days later, between January 26-31, 1961, these trees and 2 unsprayed trees were exposed to 23°F. for 4 hours.

On February 2, 1961, 60 Red Blush grapefruit seedlings were sprayed with 1.6% oil. Ten seedlings were subsequently exposed to 23°F. for 4 hours 4, 7, 12, 19, and 28 days after spraying. Ten unsprayed seedlings were also frozen and served as controls.

Leaf and twig injury were estimated 2 weeks following freezing. Fruit samples for determining freeze injury were harvested March 6, 1961. Samples consisted of 100 fruit from each tree, 50 from the outside perimeter and 50 from the inside. Each 50-fruit sample was divided into 10-fruit lots of the following diameter sizes: 10.5, 10.0, 9.5, 9.0, and 8.5 cm. Each fruit was cut transversely in three places: ½ inch into the flesh of the stem-end, the center of the fruit, and ½ inch into the flesh of the stylar-end. Total injured segments in each cut were counted and tabulated. Freeze-injured segments were similar to those previously described (Burdick, 1951).

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[1] The work was a cooperative project of the Agricultural Research Service, U. S. Department of Agriculture, the Texas Agricultural Experiment Station, and Rio Farms, Inc., Monte Alto, Texas.

[2] Physiologist, U S. Dept. of Agriculture; Entomologist, Texas Agricultural Experiment Station; Chemist, U. S. Dept. of Agriculture; and Entomologist, Texas Agricultural Experiment Station, respectively, of Weslaco, Texas.

RESULTS AND DISCUSSION

The effect of an oil spray application in winter on subsequent freeze injury to 9-year-old Red Blush grapefruit trees is summarized in Table 1. Unsprayed trees had 8 percent defoliation and no twig injury, while oil-sprayed trees had 45 percent defoliation and 10 percent twig injury. These results indicated an adverse effect of oil sprays applied in winter on the cold-hardiness of Red Blush grapefruit trees. Similar results were reported by Thompson (1947) and Woglum (1940).

Table 1. Effects of a winter oil spray on subsequent freeze injury to 9-year-old Red Blush grapefruit trees exposed to 23°F. for 4 hours.

			Freeze damage	
Treatment	*No. of trees*	*Ease-of-bark peeling of twigs*[a]	*% defoliation*	*% twig damage*
Control	2	1.0	8	0
Oil sprayed	2	1.0	45	10

[a] 0 = bark does not peel; 1 = bark barely peels; 2 = bark peels easily; 3 = bark peels easily and is moist.

Oil sprays had little or no effect on total freeze-injured segments in Red Blush grapefruit (Table 2). More injured segments occurred in outside fruit and in small fruit. Oil sprays had little or no effect on the distribution of freeze-injured segments in the center and stylar-end sections of the fruit (Table 3). There appeared to be an adverse effect on freeze-injured segments in the stem-end of the fruit.

Table 2. Effects of a winter oil spray on the number of freeze-injured segments in various-sized Red Blush grapefruit picked inside and outside the tree.

Fruit	*Inside fruit*		*Outside fruit*	
size (cm)	*Control*	*Oil sprayed*	*Control*	*Oil sprayed*
8.5	7.0	6.8	9.2	15.2
9.0	3.7	5.2	8.9	8.3
9.5	3.3	2.8	5.6	7.4
10.0	2.4	1.2	5.9	3.3
10.5	2.7	1.5	....	1.0
Average	3.8	3.5	7.4	7.0

Table 3. Effects of a winter oil spray on the distribution of freeze-injured segments in sectioned Red Blush grapefruit.

Section of fruit	*Control*	*Oil sprayed*
Stem-end	4.2	5.3
Center	3.3	3.6
Stylar-end	2.8	2.0

Previous results (Table 1) indicated Red Blush grapefruit trees 10-15 days after spraying with oil were less cold-hardy than unsprayed trees. To better understand the duration of the oil effect on cold-hardiness, young Red Blush grapefruit seedlings were exposed to 23°F. for 4 hours at various times up to 28 days after spraying with oil (Table 4).

Table 4. Effects of a winter oil spray on subsequent freeze injury to Red Blush grapefruit seedlings exposed to 23°F. for 4 hours.[a]

	Freeze injury	
Days after spraying	*% defoliation*	*% twig injury*
4	40	2
7	88	9
12	96	20
19	59	17
28	40	15

[a] Unsprayed seedlings exposed to 23° F. for 4 hours had 47% defoliation and no twig injury.

Reduced cold-hardiness as a result of an oil spray application in winter was apparent 7 days after spraying, with maximum injury occurring 12 days after spraying. Twig cold-hardiness was still decreased by oil sprays 28 days after spraying. These results would suggest that the greatest reduction in cold-hardiness resulting from an oil spray application in winter occurred within 28 days after spraying.

SUMMARY

Nine-year-old Red Blush grapefruit trees and 1-year-old Red Blush grapefruit seedlings were exposed to 23°F. for 4 hours following winter application of oil sprays. Large Red Blush grapefruit trees were less cold-hardy 10 days after application of 1.6% oil sprays. One-year-old Red Blush seedlings were less cold-hardy 7, 12, 19, and 28 days after application of oil spray.

The application of oil spray in winter on Red Blush grapefruit trees for the control of scale insects appeared to be a risk because it reduced the cold-hardiness of the tree.

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Chemical Control of Brown Soft Scale on Citrus in the Lower Rio Grande Valley of Texas

H. A. Dean, Jack C. Bailey, and Rex Reinking[1]

Brown soft scale, *Coccus hesperidum L.*, became a major pest of citrus in the Lower Rio Grande Valley of Texas during the fall of 1959. The pest spread during 1960 and by the fall of that year, became the most damaging citrus insect pest in the middle portion of the Valley's citrus-producing area. The need for an effective chemical-controlling-agent was indicated since the recommended oil sprays failed, in certain instances, to give adequate control. Research was initiated during 1961 to evaluate various pesticides and pesticide mixtures as sprays for control of the insect.

The spread of the scale paralleled that of citricola scale, *Coccus pseudomagnoliarum* (Duwana), as described by Ebeling (1950). Citricola scale has not been recorded from this area. The scale insect increased uniformly over the trees and throughout the orchards, rather than as isolated colonies on portions of the trees or on just a few trees. In order that true identity of the insect could be made, scale was collected from selected groves in the mid-Valley area and sent on November 18, 1960 to Mr. Howard McKenzie of the University of California, Davis, California for identification. All specimens were identified as brown soft scale. Specimens, submitted on request during December 1960 to Dr. W. H. Ewart, University of California Citrus Research Center and Agricultural Experiment Station, Riverside, California, were also identified as brown soft scale.

The scale in 1960 had attained serious economic levels similar to that reported in California during 1951 by Bartlett and Ewart (1951) and in South Africa during 1956 by Annecke (1959). In both California and South Africa, the outbreaks were reported to be indirectly related to the application of parathion to the groves for the control of other scale insects. The California workers also reported that parathion killed very few or none of the scale while susceptible parasites were annihilated. Bartlett and Ewart (1951) reported the residue on parathion-treated trees in California to be lethal to adults of the most important controlling parasite species, *Aphycus luteolus Timb.*, from 6 weeks to 3 months or more. Outbreaks in South Africa and California were, therefore, associated with the use of parathion within the grove as an upset in the parasite-scale relationship.

In Texas, brown soft scale spread to other plants following the outbreak on citrus. The scale infested numerous plants in ornamental nurseries which were not considered host plants under ordinary circum-

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[1] Respectively, Associate Entomologist and Junior Entomologist, Texas Agricultural Experiment Station and Assistant Entomologist, jointly employed by Texas Agricultural Experiment Station and Texas College of Arts and Industries.

stances. Various plants under citrus trees were found to be reservoir hosts where trees were sprayed for scale control and no particular attention was given to these plants. Seedlings of anaqua, *Ehretia anacua*, and hackberry, *Altis lasvigata*, often served as reservoir hosts. Other plants that were suspected as reservoir hosts include sunflower, horsetail or marestail, *(Conyza canadensis)*, and *Aster exilis* (tentative identification). It seemed important, therefore, to remove these plant hosts from citrus groves if the groves were chemically treated for brown soft scale control. Otherwise, the trees freed of the scale by chemical control might become reinfested from these scale hosts.

Grapefruit trees were generally more heavily infested by the scale than orange trees. This was clearly evident in a grove where grapefruit was heavily infested while adjacent Valencia oranges had noticeably smaller scale populations. However, Jaffa oranges were observed to have greater scale numbers than adjacent Valencia oranges.

METHODS AND MATERIALS

A method for estimated scale populations was necessary which was not too time consuming and yet would give a good estimate of variable scale populations. The procedure adopted was similar to that of Ebeling (1950) and Elmer *et al.* (1951). Three or four, 1-foot terminals per quadrant were selected on sample trees from 2-6 feet above the ground. However, 6-inch terminals were used in experiments 1 and 7. Terminals which had 200 or more live stages of the scale were considered to be heavily infested and were recorded as "plus" without counting. Terminal counts proved to be an effective procedure particularly where populations varied from replication to replication as was frequently encountered. During the late summer and fall of 1961, it was necessary to use 2.75X headband magnifiers to ascertain whether or not certain smaller stages of the scale were alive in experiments 4, 5, and 6.

Spray was applied from either hand gun or boom sprayer. Single-nozzle hand guns were used in hand gun application with a pressure of 600 psi (at rig) in experiments 2, 4, 5, and 6, while 500 psi was used in experiment 1. The boom sprayer was used in experiments 3 and 7 and application was made from both sides of the trees at 500 psi pressure. Treatments were applied as full coverage spray. Gallonage per acre depended on tree size. Increases in gallonage were necessary under conditions of greater wind velocities.

Plots were 2-rows wide with at least one tree at each end as plot buffer trees in experiments 2, 3, 4, 5, and 6 while plots were 1-row wide in experiments 1 and 7. In the former, scale was counted on the inside quadrants of the same record trees at each count, while 3 terminals per quadrant were sampled on the east side of 2 trees in experiments 1 and 7.

The following materials were used in evaluation for control of brown soft scale:

Agri-mycin 17 (Streptomycin sulphate . . . 21.3%)
DDT
Diazinon® O, O-diethyl O-(2-isopropyl-6-methyl-4-pyrimidyl) thiophosphate
ethion
malathion
parathion
rotenone
Sevin® 1-naphthyl N-methylcarbamate
Various petroleum oils (see Table 1)

Other materials added to various mixtures for control of citrus rust mites or Texas citrus mites were as follows:

Kelthane® 1, 1-bis (p-cholorphenyl) 2,2,2-trichloroethanol
Tedion® p-chlorophenyl 2,4,5-trichlorophenyl sulfone
zineb

Table 1. Summary of spray oil properties.

	Oils[a]						
Property	*A*	*B*	*C*	*D*	*E*	*F*	*G*
Gravity, °API	33.4	35.7	35.3	30.5	29.5	33.6	31.5
Molecular Weight	340	338	330	303	350	288	313
Viscosity, SSU @ 100 F	86.6	76.2	73.4	73.6	103.7	57.7	77.1
Oil, %	97.0 Approx.	99.75	99.75	99.75	99.75	99.2	80.0 Approx.
Unsulphonated Residue, (ASTM) %	98.2	99.0	96.4	94.0	93.0	88.4	85.4
Distillation at 10 millimeters pressure, 50% point, °F	462	460	447	404	442	413	448

[a] Oils A, B, C, F, and G are paraffinic; oils D and E are naphthenic.

The data was subjected to an analysis of variance and differences were measured by means of Duncan's multiple range test when appropriate.

RESULTS

Experiment 1. — Evaluation of certain pesticide formulations for control of brown soft scale was made in the Kiester grove north of La Feria during the fall of 1960. A single row was sprayed with each treatment and treatments were duplicated. A scale count was made on each 6-tree row.

Results of these preliminary evaluations of test materials are shown in Table 2. Populations of the scale were rather small at the outset and

Table 2. Preliminary evaluation of materials for control of brown soft scale on grapefruit trees in the Kiester grove treated September 15, 1960.

Treatment per 100 gallons water[a]	*Average No. scale per 6-inch terminal*[b]		
	9-14	*9-30*	*11-16*
1. 1 quart 46.5% ethion	16.42	1.58	.67
2. 1.5 gal oil F, 3/5 pint 46.5% ethion	11.00	2.30	.00
3. 1.5 gal oil F	15.46	1.25	.00
4. 1 gal oil F, 4/5 pint 46.5% ethion	15.21	.50	.08
5. 1 gal oil G, 4/5 pint 46.5% ethion	10.96	.17	.00
6. Check – No treatment	9.88	7.42	.42
Significance	NS	NS	NS

[a] Zineb not added to mixtures; 17 gallons per tree (13 feet high) applied from hand rig (500 psi).

[b] 12 terminals per row; 2 rows each treatment.

offered some basis for selection of a combination for later testing. Due to parasite activity, scale numbers were so small when the final count was made in mid-November that no differences were found between treatments. There were no significant differences in scale populations between the various treatments on any of the 3 sampling dates.

Experiment 2. – Various formulations were selected to compare with oil for brown soft scale control, as shown in Table 3. During the winter period, the parasite activity of *Coccophagus lycimnia* (Walk.) was very great, but did not afford a controlling effect on the scale. Scale numbers were greater in the eastern portion of this grove. However, average numbers were sufficient to result in good comparative differences. Tedion was added to those formulations which might result in increases of Texas citrus mites.

Table 3. Effect of various treatments for control of brown soft scale on 10 foot grapefruit trees at the Martin grove treated January 16-17, 1961.

Treatment per 100 gallons of water[a]	*Average no. scale per foot of terminal*[b]		
	1-12	*2-23*	*4-20*
1.4 lb 85% WP Sevin, 1 lb 25% WP Tedion	86.12	0.40	0.37 a
1.3 gal oil C	91.12	1.95	2.00 a
2 lb 25% WP Diazinon, 1 lb 25% WP Tedion	93.32	5.15	1.32 a
1.5 gal oil D	126.70	6.22	1.92 a
1.5 lb 50% WP DDT, 1.5 gal kerosene, 1 lb 25% WP Tedion	155.07	8.25	7.00 a
1.5 lb 25% WP malathion, 1 lb 25% WP parathion	152.35	8.75	11.37 a
0.5 gal oil C, 4/5 pint 46.5% ethion	148.35	26.55	33.80
Significance	NS	NS	*

[a] All treatments contained 1 lb 75% WP zineb; 12 gallons per tree applied by hand rig.

[b] Four replications; 48 terminals each replicated plot.

Difficulty was experienced during the January-February period in determining whether or not a scale was dead. Scale was considered alive when the liquid in the body would exude when mashed with the finger nail. Many scale appeared to be non-functional and at the same time contained body liquid. Post-treatment counts of scale were delayed during that season until a more valid estimate of live scale numbers could be made.

The oil C-ethion treatment gave significantly poorer control of the scale at the second post-treatment count than the 6 other mixtures. The oil C-thion, malathion-parathion, and DDT-kerosene treatments had higher scale populations at the first post-treatment count which remained at a higher level until the experiment was terminated. Although the scale count in the naphthenic oil plots was somewhat greater at the first post-treatment count than in the paraffinic oil plots, there was no difference at the second post-treatment count. After the 1960 season, citrus growers in this area began general usage of paraffinic oils because of their expected longer residual control of scale insects. Naphthenic oils would not have been expected to dissipate as rapidly during the winter season when oils are not generally recommended for use on citrus) as during the summer period. Diazinon was likewise slow about showing control of the scale. Plots treated with Sevin had the smallest scale population. The experiment was terminated after the April 20th scale count due to the grower's desire to retreat plots 7, 6, and 5.

Removal of black sooty mold fungus with various treatments varied. The fungus soon began to flake-off following oil and the DDT-kerosene treatments; however, the fungus began to again build-up when scale, not controlled, secreted honey dew again. The fungus mold began to flake from those trees treated with Sevin, Diazinon and malathion-parathion when drying winds became prevalent.

Experiment 3. – Treatments 2, 5, 6, and 7 in experiment 2 were further tested at the Rogers grove. Scale numbers were thought to have been reduced somewhat by *Aphycus* parasites during the course of the experiment. The experiment was terminated in May due to the grower's desire to apply chemicals for the control of other pests.

Scale numbers did not differ significantly in the first post-application count, as shown in Table 4. All populations were reduced to small num-

Table 4. Effect of various treatments for control of brown soft scale on 10 foot grapefruit trees at the Rogers grove treated January 23 and February 1, 1961.

Treatment per 100 gallons water[a]	*Average no. scale per foot of terminal*[b] *1-18*	*3-16*	*5-3*
1.3 gal oil C	96.8	0.6	0.1 a
0.5 gal oil C, 4/5 pint 46.5% ethion	95.9	1.3	0.1 a
1.5 lb 50% WP DDT, 1.5 gal kerosene 1 lb 25% WP Tedion	127.1	1.9	0.6
1.5 lb 25% WP malathion, 1 lb 25% WP parathion	149.4	2.7	0.9
Significance	NS	NS	*

[a] All treatments contained 1 lb 75% WP zineb; 18 gallons per tree (10 feet high) applied from boom sprayer (500 psi).

[b] Four replications; 36 terminals per replicated plot.

bers. Black sooty mold fungus was more abundant in plots treated with the malathion-parathion combination. It was also difficult to ascertain dead scale in this experiment for some time following treatment, as was found in experiment 2. Scale populations were significantly smaller on May 3 in the oil and the oil-ethion treatments, however, populations were so small that further testing was considered advisable.

Experiment 4. – Comparisons were made between Sevin, oil, and oil plus rotenone or ethion for brown soft scale control in the Dressler grove north of Mercedes, as shown in Table 5. The rotenone powder was mixed with the oil for 15 minutes prior to mixing in the tank. The 95% Technical ethion was used in preference to formulations with high solvent percentages.

Table 5. Effect of various materials with oil for control of brown soft scale on citrus in the Dressler grove treated July 24-26, 1961.

Treatment per 100 gallons water[a]	*Average no. scale per foot of terminal*[b] 7-20	8-15	9-6	10-10	11-21
0.5 lb 25% WP Tedion, 1.3 lb 80% WP Sevin	105.85	0.91 a	9.84	10.08	4.35
1.6 gal oil C, 4 oz 95% tech. ethion	99.75	1.55 a	13.13	5.91	3.83
1.6 gal oil C, 1 lb 5% WP rotenone	127.82	1.67 a	12.00	7.39	3.71
1.6 gal oil C	130.03	3.48	16.58	7.92	3.97
Significance	NS	*	NS	NS	NS

[a] All treatments contained 1 lb 75% WP zineb; 16 gallons per tree (13 feet high) applied from hand rig.

[b] Five replications; 48 terminals each replicated plot.

There was a significantly greater scale population in the oil plots on August 15. No differences in scale population were found on the other count dates between the 4 treatments. Parasites were increasing during September and probably reduced populations thereafter. Although no count of diaspid scale was made, live California red scale and chaff scale were readily observed in the Sevin plots 30-60 days following treatment.

Experiment 5. – Experiment 5, as shown in Table 6, was initiated to compare somewhat lower dosages of Sevin or rotenone mixed with oil-zineb for control of brown soft scale. Although wide differences in scale populations were found 21 and 22 days after application, statistical analysis showed no significant difference. The oil-Sevin plots showed significantly smaller scale populations than the oil plots on September 18 and November 17. The oil-Sevin plots also showed significantly smaller scale populations on November 17 than in the oil-rotenone plots. Rather wide extremes in populations of scale between replications did not result in significant differences between replications.

Table 6. Effect of various pesticides for control of brown soft scale on grapefruit trees at Substation No. 15 treated August 7-8, 1961.

Treatment per 100 gallons water[a]	*Averge no. scale per foot of terminal*[b] 8-1	8-30	9-18	11-17
1.6 gal oil C, 0.6 lb 80% WP Sevin	158.8	0.16	2.47 a	7.16 a
1.6 gal oil C, 0.75 lb 5% WP rotenone	132.8	11.05	29.75 a b	69.53 b
1.6 gal oil B	149.1	37.37	57.04 b	80.40 b
Significance	NS	NS	**	**

[a] All treatments contained 1 lb 75% WP zineb; 10 gallons per tree (8 feet high) applied from hand rig.

[b] Eight replications; 36 terminals each replicated plot.

Experiment 6. – Lower dosages of Sevin or rotenone mixed with oil seemed to merit investigation due to the possibility that reduced deposit of oil would result from the higher quantities of the wettable powder in the spray mix. Results of experiment 6 are shown in Table 7. There was no significant differences between treatment plots on August 25 and January 4. However, 27 days after application, the oil-Sevin and Sevin plots had significantly smaller scale populations than in plots of the 2 paraffinic oils, while there was no difference in the scale populations in the oil-rotenone and the 2 paraffinic oil plots. The scale populations in the oil-Sevin and the Sevin plots were not reduced to the smaller levels in this experiment as expected.

Experiment 7. – Various materials in wettable powder and emulsifiable concentrate forms were combined with oil for comparison of their relative effectiveness in the control of brown soft scale. In experiment 7,

Table 7. Effect of various treatments for control of brown soft scale on grapefruit trees at Substation No. 15 treated August 29-31, 1961.

	Average no. scale per foot of terminal[b]		
Treatment per 100 gallons water[a]	*8-25*	*9-26*	*1-4-62*
1.6 gal oil C, 0.3 lb 80% WP Sevin	141.88	5.17 a	5.61
1.25 lb 80% WP Sevin, 1 quart 18.5% EC Kelthane	147.69	5.34 a	6.27
1.6 gal oil C, 0.5 lb 5% WP rotenone	136.47	32.56 a b	19.62
1.6 gal oil B	144.33	61.78 b	36.07
1.6 gal oil C	140.91	65.81 b	36.21
Significance	NS	*	NS

[a] All treatments contained 1 lb 75% WP zineb; 15 gallons per tree (12 feet high) applied from hand rig.

[b] 4 replications; 48 terminals each replicated plot.

as shown in Table 8, the post-application scale population counts showed oil-alone to have a significantly greater population than in the other treatments. The Sevin with oil treatments showed the smallest scale population while the oil plus EC ethion treatment had the next greatest scale population. Only one post-application count was possible due to the grower's desire to retreat to bring the scale to a smaller population level.

Other Tests. — A small block of citrus trees at Substation No. 15 were heavily-infested with brown soft scale and presented an opportunity to gather further relative information on control. Four rows of grapefruit trees were sprayed with hand rig on August 9-10, 1961 with each of the following treatments per 100 gallons of mixture: (1) 1.6 gal. oil C plus 1 lb. 80% WP Sevin and (2) 1.6 gal. oil E. Four rows of oranges were sprayed with 1.3 lb. 80% WP Sevin plus 1 quart 18.5% EC Kelthane, (3). Zineb was used at 1 lb. 75% WP in each mixture for rust mite control. Scale was counted on 160, 1-foot terminals (5 terminals per quadrant) in each treated area, and populations averaged more than 200 per terminal. The numbered treatments and their respective averages of brown soft scale per foot of terminal on 9-1, 10-6, and 11-29 are given as follows: (1) .33, 16.49, and 36.41; (2) 80.98, 58.89, and 90.15; and (3) .26, 5.98, and 16.79. Treatments 3 and 1 gave better scale control than oil E. However, it should be pointed out that the scale preference for grapefruit probably accounts for the greater increase of scale in treatment 1 compared to treatment 3.

Table 8. Comparison of materials for the control of brown soft scale on grapefruit trees at the Jones and Collier Foundation treated August 11 and 12, 1961.

	Average no. scale per 6-inch terminal[b]	
Treatment per 100 gallons water[a]	*8-3*	*9-28*
1.3 gal A oil, 1.2 lb 80% WP Sevin	9.44	.02 a
1.3 gal A oil, 0.6 lb 80% WP Sevin	9.75	.08 a
1.3 gal A oil, 1.6 lb 25% WP ethion	6.31	2.00 a
1.3 gal A oil, 1 pint 25% EC Diazinon	6.25	2.23 a
1.3 gal A oil, 4/5 pint 46.5% EC ethion	10.10	3.12 a
1.3 gal A oil	4.98	5.46
Significance	NS	*

[a] All treatments contained 1 lb 75% WP zineb; 16 gallons per tree (15 feet high) applied from boom sprayer (500 psi).

[b] 12 terminals per row; 4 count rows.

Two dosages of Agri-mycin 17 (2 and 4 ounces per 100 gallons of water) were investigated for control of the scale on grapefruit trees. Initial infestations of scale on 40 terminals of 2 trees each dosage averaged more than 200 scale per terminal. Average numbers of scale per foot of terminal 1 and 4 weeks following hand rig application on October 18, 1961 were 155 and 171 at the suggested dosage and 184 and 194 at the higher dosage. The material was ineffective at the dosages used.

DISCUSSION

Control of scale appeared to vary somewhat in greater versus smaller scale populations and in winter versus summer applications. The potential for increase of a greater population is much greater than for a small population, although this potential may increase only to a certain level. A greater population is generally more difficult to control than the smaller population, and maintain at the smaller level. Parasite activity has been observed to have more effect on lowering the population during the winter than during the summer and early fall period. Oil spray gave effective control during the winter period when oil sprays are generally not recommended, but did not give adequate control of greater populations during the summer period.

Results from replicated experiments showed the most effective treatment for control of high populations of brown soft scale (where diaspid scale, spider mites and citrus rust mites are of concern) was 1.6 gallons oil plus 0.6 lb. 80% WP Sevin and 1 lb. 75% WP zineb per 100 gallons of mixture applied as a full coverage spray. Such a mixture separated immediately in the spray tank when the rig was shut down. It was difficult to adequately suspend the ingredients after separation. The full contents of the tank should be expended before the rig is shut down. Higher dosages of Sevin in the above mixture did not result in increased control in these experiments.

Several complications were evident where 1.25 lb. 80% WP Sevin were applied alone for control of the scale, even though control of this scale was similar with the above mixture. Texas citrus mites, purple scale, and chaff scale increased following applications of Sevin alone. Inadequate control of California red scale was evident in the experiment at the Dressler grove. Other pests should therefore be considered when Sevin is applied.

Both naphthenic and paraffinic oils gave control of the scale during the season in which oils are not generally recommended. During the summer (and early fall period of 1961), oils A, B, and C (paraffinic) and oil E (naphthenic) failed to give adequate scale control under high infestation levels. Control was increased somewhat with the addition of rotenone to the oil mixture, but not to the degree desired.

Other materials were either slow bringing about control or gave inconsistent results in various experiments. Diazinon was slow to bring about control in experiment 2 while in the only post-treatment count taken in experiment 7, the material was not too effective on that date. Ethion-oil gave as good or better control than oil in certain instances and was comparable with Sevin in experiment 4, but the mixture was the poorest of the 7 treatments in experiment 2 and gave only fair control in experiment 7. The DDT-kerosene and malathion-parathion mixtures did not give as good control as other materials in experiments 2 and 3.

Black sooty mold fungus was most effectively removed from the trees with the various treatments which contained oils.

SUMMARY

The most effective treatment in the control of brown soft scale was 1.6 gallons oil plus 0.6 pounds 80% WP Sevin per 100 gallons applied as a full coverage spray. Increases of Texas citrus mites, purple scale, chaff scale, and California red scale were observed when Sevin was used alone. Oil gave control during the winter season when oils are not recommended for use, but poor control resulted during the summer with greater infestation levels. The following materials gave fair to poor control: oil-ethion, Diazinon, DDT-kerosene, and malathion-parathion. Treatments containing oil were more effective in the removal of black sooty mold fungus from the trees.

Following the outbreak of brown soft scale on citrus, the scale spread to various plants such as weeds, ornamental plants and other trees. The scale showed a preference of grapefruit to oranges. Parasites appeared to affect populations of this scale more during the October-April period than during the summer period.

ACKNOWLEDGEMENTS

Thanks are due W. H. Ewart of the University of California Citrus Research Center and Agricultural Experiment Station, Riverside, California for his assistance in selection of a method for estimating scale populations and the early selection of pesticides for control evaluations, and the Data Processing Center, Texas Engineering Experiment Station, College Station, Texas for analyzing most of the data.

Thanks are also due the following insecticide companies for supplying various pesticides: California Chemical Co., Dennison's, Humble Oil & Refining Co., Niagara Chemical Division, Rohm & Haas Co., Stauffer Chemical Co., Tide Agricultural Chemicals, and Union Carbide Chemicals Co.

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Zineb Versus Maneb For Citrus Rust Mite Control

JACK C. BAILEY and H. A. DEAN[1]

Materials which will effectively control the citrus rust mite, *Phyllocoptruta oleivora* Ashm., for several months, with one application, are important to Rio Grande Valley citrus growers. It is necessary to reduce the population to very low levels with one application, due to the mites ability to increase from a few individuals to high population levels in 1½ to 2 months under favorable climatic conditions. One material (zineb, zinc ethylene bisdithiocarbamate) now commonly used for rust mite control has long-residual-control properties (Dean and Sleeth, 1959). An experiment was initiated in the spring of 1959 to compare the residual toxicity of zineb and maneb, manganese ethylene bisdithiocarbamate, against the citrus rust mite.

Several types of injury have been associated with infestations of the rust mite. The most common injury has been russeting of the fruit. Yothers and Mason (1930) reported other damage by the mite as: reduced fruit quality, size and keeping quality, and the devitalization of the trees. Citrus growers of the Lower Rio Grande Valley area have applied control measures for rust mites even though control of other pests was not necessary.

A selective mite-control program was initiated in this experiment. Control of Texas citrus mites, *Eutetranychus banksi* McG., and false spider mites, *Brevipalpus* spp., was also considered important. No further pest control would be necessary if natural controlling agents of other pests could work effectively under such a selective mite control program.

MATERIALS AND METHODS[2]

The spray materials were applied from a ground rig. Single nozzle guns (6/64 orifice size) were used with a pressure of 550-600 psi at the tank. Each tree was sprayed from each quadrant-position to accomplish thorough coverage. Trees averaged 12 feet high at the last spraying, requiring about 15 gallons per tree for coverage. The experiment grove was located at Substation No. 15 and was 7 years old when the experiment began.

Tedion®, 2,4,5,5'-tetrachlorodiphenyl sulphone, was added to each treatment at post-bloom for Texas citrus mite control. Kelthane®, 1,1-bis(p-cholorphenyl)-2,2,2-trichloroethanol, was added in each treatment at the summer application for the control of Texas citrus mites and false spider mites. Triton B-1956 was added to each mixture for possible extended residual control.

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[1] Entomologists, Texas Agricultural Experiment Station, Weslaco.

[2] Thanks are due Niagara Chemical Division and Rohm and Haas Co. for supplying miticides for this experiment.

Counts of the various phytophagus mites on 160 leaves are shown for each treatment in Table 1. One outside and one inside leaf per

Table 1. Spray treatments applied in a Substation No. 15 grove and their effect on citrus rust mites, Texas citrus mites, and false spider mites.

	Zineb plus Tedion or Kelthane[1]					*Maneb plus Tedion or Kelthane*[1]				
Date	*RM*[2]	*TCM*[3]	*TCME*[4]	*FSM*[5]	*FSME*[6]	*RM*[2]	*TCM*[3]	*TCME*[4]	*FSM*[5]	*FSME*[6]
4- 7-59	32	----	----	----	----	22	2	----	----	----
4-29-59	46	----	----	----	----	56	----	----	----	--
5- 6-59		Zineb – Tedion					Maneb – Tedion			
5-25-59	----	----	----	----	----	----	----	—	—	—
6-26-59	----	----	12	----	----	6	4	----	----	—
7-28-59	40	10	16	----	----	14	6	2	2	----
8-18-59	92	44	66	----	----	180	42	48	10	----
8-20-59		Zineb – Kelthane					Maneb – Kelthane			
9-14-59	8	----	----	----	----	----	----	----	----	----
11-11-59	4	----	----	----	----	----	4	4	----	----
12-16-59	8	2	4	----	----	4	----	----	----	----
1- 4-60	6	----	----	----	----	12	----	----	4	----
2-11-60	10	----	2	----	----	8	----	----	----	----
3- 9-60	6	4	8	----	----	28	2	6	----	----
4-11-60	12	4	4	----	----	24	----	----	----	----
4-19-60		Zineb – Tedion					Maneb – Tedion			
5-25-60	----	----	2	----	----	6	2	4	----	----
6-17-60	----	----	----	----	----	2	----	----	----	----
7-25-60	4	2	6	6	4	42	6	8	2	----
8-17-60	36	28	30	----	----	34	44	10	4	----
8-24-60		Zineb – Kelthane					Maneb – Kelthane			
9-16-60	----	----	----	----	----	2	----	2	----	2
10-18-60	----	----	----	----	----	----	2	----	----	----
11-15-60	6	----	----	----	4	----	----	----	----	----
12-16-60	10	----	----	----	----	10	----	----	----	----
1-23-61	8	----	----	----	----	10	----	2	----	----
2-20-61	8	2	----	----	4	16	2	6	2	2
3-30-61	176	2	2	----	----	208	----	----	----	----
4-17-61		Zineb – Tedion					Maneb – Tedion			
5-18-61	----	8	4	----	8	----	----	----	----	----
6- 8-61	6	----	8	----	4	----	----	----	----	----
7-14-61	----	----	14	8	6	2	2	2	----	2
8- 3-61	----	----	2	----	2	----	8	2	----	----

[1] Dosages of the following materials per 100 gallons of mixture: 1 lb. 75% WP zineb, 1 lb. 80% WP maneb, 1 lb. 25% WP Tedion and 1 quart 18.5% EC Kelthane, Triton B-1956 was added to each maxture at the 2 ounce rate.

[2] Citrus rust mites on 160 leaves.

[3] Texas citrus mites on 160 leaves.

[4] Texas citrus mite eggs on 160 leaves.

[5] False spider mites on 160 leaves.

[6] False spider mite eggs on 160 leaves.

quadrant were collected until 40 leaves were collected in each replication. Post-bloom treatment was applied without consideration of mite populations. Later application was based on mite populations on leaves or on periodic inspection of mites on fruit. Mites were brushed from the leaves with a mite-brushing machine onto a 5-inch plate. Mites were then counted on ½ the area under a stereoscopic microscope.

RESULTS AND DISCUSSION

Various phytophagous mites were rather slow to increase during the spring of 1959. The May application just preceded an expected May-July increase of Texas citrus mites (the greatest increase period during the year, according to Dean, 1959). A small increase of rust mites occurred by the pre-treatment count in August. In prior years, rust mites have particularly increased in September, the month of greatest rainfall. False spider mite control was considered with the August application since these mites increased on leaves during the July-December period, according to Dean, 1959. Kelthane showed promise as a controlling agent for false spider mites, according to Dean and Sleeth, 1959. The minimum duration for testing such a selective miticide program was 3 years, even though the first years' results appeared very promising.

Control of these mites continued with the selective miticide program during 1960 and 1961. Texas citrus mite populations declined and became very small during 1961. False spider mites were found particularly in the July and August counts but were in very small numbers before control applications were made in August. Citrus rust mites showed a similar trend of increase under zineb and maneb treatment and remained under good control for extended periods.

Leaf counts have been reliable indicators of citrus rust mite increases, even though fruit was examined at periodic intervals. However, the population was low on leaves during the July-August period of 1960 while the numbers on fruit had shown a particular increase. Leaf counts failed to satisfactorily indicate the increasing trend of rust mite populations during this particular period, and justification for treatment was based on fruit examination.

At the outset of the experiment, several pest conditions prevailed which were worthy of consideration. Only sulphur dust had been used for the control of mites. However, certain insects were present in rather large numbers, a condition which was considered due indirectly from drift of insecticides from row crops. Florida red scale, *Chrysomphalus aonidum* (Linnaeus), and white flies were present in greater numbers than desired, and mealy bugs and California red scale, *Aonidiella aurantii* (Maskell), were also present in numbers questionable as to possible increase to damaging levels. Thus, damaging infestations could have resulted if the selective miticides exerted an adverse effect on the parasites and predators of these pests.

Florida red scale parasites were followed throughout the course of the experiment. *Prospaltella aurantii* (Howard) and *Pseudhomalopoda prima* Giralt, were the only 2 parasites of this scale in the grove. In July 1959, the Florida red scale parasite, *Aphytis holoxanthus* DeBach, was released in the grove from introductory shipments from Israel (Dean and Bailey, 1960). The scale was plentiful enough that it required 1 man only 1 hour to randomly collect 5 samples of infested leaves for examination under the microscope of 100 young and mature females per sample, similar to the method by Dean (1961). A January 1960 count showed *A. holoxanthus* to be parasitizing 4.4% of Florida red scale with 2.05% of the parasitized scale containing live parasite forms in a 2.5% live scale population. In June 1960, the live scale averaged 2.5% while 19% of the scale was parasitized with 9.25% by *A. holoxanthus* and 9.75% by *P. prima.* Scale was in smaller numbers in June 1960 since it took 1 man 2 hours to collect sufficient leaves for the 500 counts. The population of scale was so small in May 1961 that it required 1 man 5 hours to collect the samples, and even then, leaves had to be collected at any location in the grove where scale could be found. Live scale averaged 2.2% while 33.7% were parasitized by *A. holoxanthus* with 0.4% live parasite forms. *A. holoxanthus* became the dominant parasite of Florida red scale in this grove.

Populations of white flies, mealy bugs and California red scale declined during the first year. A very small population of brown soft scale, *Coccus hesperidum L.*, was present during the summer in 1961 with a very favorable parasite relationship. The grove was subjected to drift of methyl parathion from treated cotton to the east and west. The effect was evident in the sudden loss of parasites and the sudden increase of the brown soft scale during late summer. The experiment was terminated due to the necessity of treatment for brown soft scale control.

SUMMARY

No difference was found in the residual control of citrus rust mites with sprays of zineb or maneb during a 28-month period. Tedion gave good residual control of Texas citrus mites through the greatest population-increase period (May-July) when the material was applied at post-bloom. Kelthane gave excellent control of false spider mites and extended control of Texas citrus mites from the August applications. The selective miticide program did not appear to be detrimental to certain parasite-pest relationships in the grove.

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Control of Texas Harvester Ants, *(Pogonomyremex Barbatus Molefaciens)*, with Baits

Rex B. Reinking[1]

Texas harvester ants, *(Pogonomyremex barbatus molefaciens)*, can be a serious pest in young orchards by completely defoliating the young trees that are near the nests or hills. They can also inflict a painful sting on workers in the orchard. There is a record in Oklahoma of one death due to stings from the Texas harvester ant (Brett, 1950). They are particularly a pest in permanently sodded orchards (Schuster and Dean, 1957).

Brett and Rhodes (1956) found a three percent chlorodane solution, poured into the ant nest to be effective against the harvester ant. Carbon tetrachloride or 95 percent alcohol were used as solvents. Wene and White (1952) and Schuster and Dean (1957) obtained good control by pouring one gallon of 0.2 percent aldrin, dieldrin, or heptachlor into the mound entrance.

Poison baits have been used against various species of ants for many years. A classic example is the use of a sweet bait containing either sodium arsenite or thallium sulphate for the control of the Argentine ant, *Iridomyrmex humilis* Mayr. (Bartlett and Lofgren, 1961). Hays and Arant (1960) found that the imported fire ant,*Solenopsis saevissima* v. *richteri* Forel could be controlled with peanut butter bait containing 0.125% Kepone.

This paper is a report on tests with baits to control Texas harvester ants at the Texas College of Arts & Industries, Citrus Center, Weslaco, Texas.

PROCEDURE

Two materials were compared; pelletized Kepone and bait containing 0.125% Kepone in peanut butter, and J & J Multipurpose Insect Bait containing 0.9% Dieldrin plus 1% Malathion in wheat bran.

Ten nests were treated with each material and two nests were left untreated as checks. Nests 1 through 10 were treated with J & J Ant Bait, and 11 through 20 with Kepone ant bait.

All nests were treated on July 13, 1961, 4 oz. to each nest. Five nests in each treatment were re-treated on July 25, 1961. The results are recorded in Table 1.

RESULTS

Immediately after bait was placed at the entrance of the nest, workers would carry bait out to the edge of the cleared area around the nest. They seemed agitated as if some invader was trying to enter their nest. In a few minutes activity slowed down and the workers began carrying the bait into the nest and eventually moved all the bait into the nest.

Table 1. Comparison of two bait materials for control of Texas harvester ant, *(Pogonomyremex barbatus molefaciens)*.

Material	*Nest*	*7-17-61*	*7-25-61*	*8-8-61*	*8-15-61*
J & J Multi-purpose Ant Bait 4 oz. per Nest	1	All bait carried down. Ants active	Re-baited No ants	Active ants	Active ants
	2	"	Re-baited Active ants	No ants	No ants
	3	"	"	"	"
	4	"	"	Active ants	Active ants
	5	"	"	"	"
	6	"	Active ants	"	"
	7	"	"	No ants	"
	8	"	"	Active ants	"
	9	"	"	"	"
	10	"	"	"	No ants
Kepone Ant Bait 4 oz. per Nest	11	"	Re-baited No ants	No ants	No ants
	12	Some ants dead	"	"	"
	13	No ants dead	Re-baited Few active ants	Few ants	"
	14	Many ants dead	Re-baited No ants	No ants	"
	15	Some ants dead	"	Active ants	"
	16	Many ants dead	Few ants	No ants	"
	17	Some ants dead Some bait left	No ants	"	"
	18	Active & dead ants	"	"	"
	19	"	"	"	"
	20	"	Active ants	"	"
Control	1	Very active	Very active	Very active	Very active
	2	"	"	"	"

Kepone ant bait achieved 100% control after about one month. Retreatment of nests 11 through 15 was apparently not necessary because nests 16 through 20 were controlled with the initial treatment. Only three nests were controlled with J & J Ant Bait and re-treatment did not seem to improve the results.

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[1] Entomologist, Texas College of Arts & Industries and Texas Agricultural Experiment Station, Weslaco.

DISCUSSION

The slow decline of the ant population indicates that probably the larvae are not killed by the poison and mortality results after emerging adults feed on the bait.

This method for control of the Texas harvester ant is faster and more economical than the earlier recommended methods.

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The Citrus Industry's Need for New Varieties

William C. Cooper[1]

The rapid shift in the citrus industry from fresh-fruit to processed-fruit consumption requires a citrus breeding and variety-improvement program with this new kind of product as an objective. To spread the season for citrus concentrates, citrus researchers must develop new early- and late-maturing round oranges of the Valencia type. Citrus breeders also must develop for fresh-fruit purposes attractive and delicious varieties with superior external and internal qualities and which peel readily by hand.

Scion varieties with greater cold hardiness are especially needed to stabilize the citrus industry in Texas. The devastating freeze in Texas in January, 1962 revealed some mandarin types which are more cold hardy than the commercial citrus varieties and which can be used as a starting point for breeding desirable varieties with more cold resistance. Preliminary work by USDA breeders at Indio, California, where these cold-hardy types were crossed with Temple orange, resulted in increased cold hardiness in the progeny.

Improved rootstock varieties with footrot resistance and tolerance to tristeza virus and to the burrowing nematode are sorely needed in Florida. New rootstocks with salt and cold tolerance are needed in Texas. In Arizona and California, rootstocks with footrot, lime, and salt tolerance are imperative. In all areas, rootstocks which result in high quality fruit as well as high yields will enhance the competitive position of the citrus industry.

The USDA citrus research program includes basic and long-range work on diseases, nematodes, rootstocks, nutrition, climatology, and cold hardiness, as well as breeding. This work is conducted at three field stations: the U. S. Horticultural Station at Orlando, Florida; the U. S. Fruit, Vegetable, Soil and Water Research Laboratory at Weslaco, Texas; and the U. S. Date Field Station at Indio, California. The research leader responsible for planning and coordinating the research at the 3 field stations is headquartered at the U. S. Horticultural Station at Orlando, Florida. The research is administered by the Fruit and Nut Crops Research Branch, Crops Research Division, Agricultural Research Service, Beltsville, Maryland. The citrus breeding program of the Department is now a fully coordinated effort among the three stations, with exchange of ideas and materials for breeding and testing, to effect the maximum benefit to each area, according to its needs. Not only are new hybrids exchanged freely, but also there is occasionally an exchange of workers. During the 1962 flowering season in Florida, the citrus breeder

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[1] Leader, Citrus Research Investigations, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Orlando, Florida.

at Weslaco, Texas, made crosses for Texas at Orlando because the freeze in Texas had prevented a normal bloom there.

The Department of Agriculture, in its citrus collections, has a wealth of material carrying heritable genes for a wide range of desirable characters. Its workers know how many of these characters are inherited and have extensive background information on which varieties may prove most successful in providing new improved progeny. They have land available to fruit out the many thousands of hybrid seedlings required before superior varieties can be finally selected.

In 1960 the Crops Research Division, Agricultural Research Service, USDA, released budwood of 3 new varieties of hybrid tangerines. These originated at the U. S. Horticultural Station, Orlando, Florida, and were selected by Philip C. Reece and Frank E. Gardner. These varieties, selected under Florida climatic conditions, are probably best suited to Florida and Texas, where climatic conditions are similar. In hardiness they may be classed with the Dancy tangerine. All are sister hybrids of a cross of Clementine (Algerian) tangerine x Orlando tangelo. *Robinson* is a large, bright orange-red, sweet tangerine hybrid, at its prime during October and November. *Osceola* is a hybrid that produces exceptionally high-colored orange-red fruit. It is somewhat lower in sugar and higher in acid and slightly smaller than Robinson and is several weeks later in ripening. *Lee* somewhat resembles a Temple orange in size, shape, and peeling characteristics. It ripens about three months earlier than a Temple orange.

Figure 1. An aerial view of the 500-acre Foundation Farm located near Leesburg, Florida.

The Foundation Farm (Fig. 1), now largely undeveloped, will provide land needed by the USDA citrus breeding program in Florida for "fruiting out" new hybrids, testing the more promising hybrids on various rootstocks, and a site for the citrus variety collection. The Florida Citrus Research Foundation, composed of citrus industry leaders of Florida, purchased the land by voluntary contributions from growers and related industries and leased it to the USDA under a 99-year lease, at no expense to the government. The Florida Citrus Commission aided the program by furnishing funds for an irrigation system, fencing, and erection of a greenhouse.

A collection of citrus varieties, for use in future breeding programs, and thousands of hybrid seedlings are being established on the land recently made available to the U. S. Department of Agriculture through the Florida Citrus Research Foundation. Seedlings are growing in the greenhouse at the Foundation Farm. These seedlings will soon be planted in the variety plots and in "fruiting out" areas where new types will receive preliminary testing.

Figure 2. Pollinating citrus to obtain new hybrids.

During the 1962 blooming season in Florida, Philip C. Reece, in charge of citrus breeding at Orlando, and his assistants made 52 types of cross-pollinations. These crosses were designed to combine certain desired characteristics, such as cold hardiness, high quality, earliness, high color, thereby producing new varieties of oranges, grapefruit, and tangerines, as well as disease- and cold-resistant rootstocks. Buds are opened and the stamens removed before they have begun to shed pollen, so that self-pollination is prevented. Then pollen from the selected male parent is applied to the receptive pistils. In Figure 2, Valencia pollen is being applied to Umatilla tangelo blossoms. Edward O. Olson, in charge of the Weslaco, Texas, station, assisted Dr. Reece in this year's hybridization work at Orlando, devoting attention particularly to breeding for cold hardiness, so greatly needed by the Texas growers as evidenced by their disastrous freezes of 1951 and 1962.

An important adjunct to the USDA breeding program is the basic work being conducted on cold hardiness at the U. S. Fruit, Vegetable, Soil and Water Research Laboratory at Weslaco, Texas. Scientists at Weslaco working on this problem have developed procedures for testing large populations of citrus hybrids for cold hardiness. They have also developed an 18- x 18- x 18-foot portable tree freezer, shown in Figure 3, for studying cold hardiness of large citrus trees.

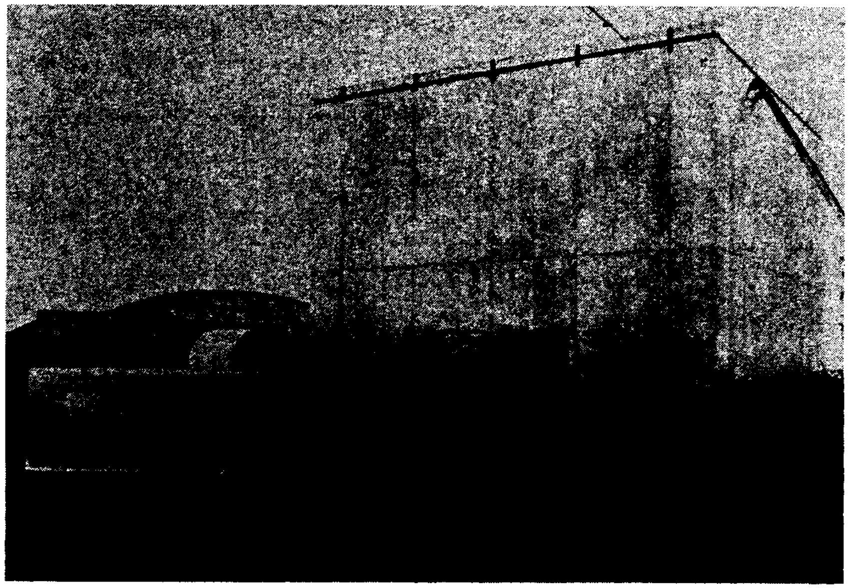

Figure 3. Portable tree freezer in use at Rio Farms, Inc., Edcouch, Texas.

Rio Farms, Inc., a non-profit resettlement corporation located near Edcouch, Texas, has provided the USDA with land for the breeding, variety, and cold-hardiness testing. The coordinated breeding program in the 3 states permits the use of the Rio Farms test plots for the testing of cold hardiness of Florida and California hybrids as well as Texas hybrids.

J. R. Furr is the citrus breeder in charge of the U. S. Date Field Station, Indio, California. In Figure 4, he is shown entering a screened cage that encloses a Temple orange tree. Insects that may have visited

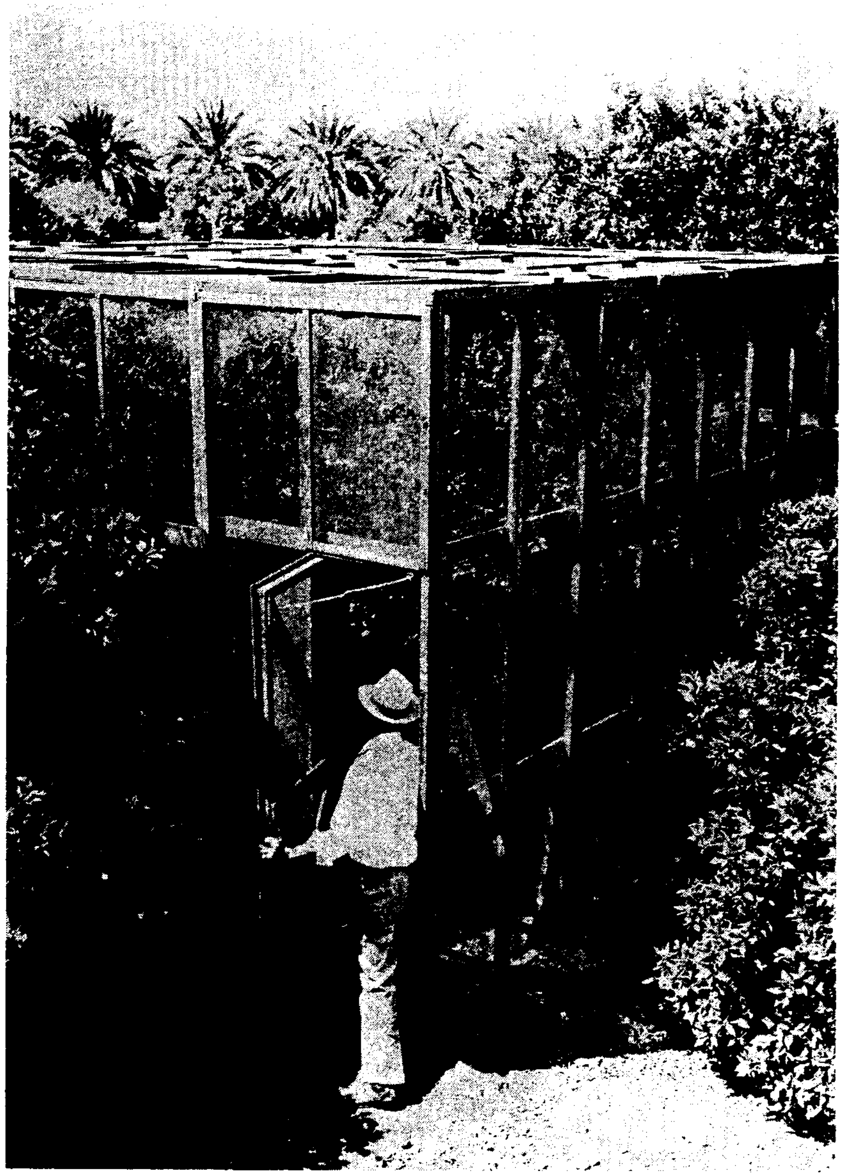

Figure 4. Screened cage used for self-pollination of Temple orange at Indio, California.

flowers of other varieties are excluded by the screen; therefore, all fruits set under such conditions will be the result of self-pollination. Superior strains are often produced by such methods if they are followed by careful selection of individuals in following generations.

The ground work has been laid by workers in Federal and State experiment stations. With the wealth of breeding material and the increase in interest in this field, research in citrus breeding may be expected to show great progress in the years to come.

Laboratory Evaluation of Certain Citrus Rootstock Selections for Resistance to the Burrowing Nematode[1]

Harry W. Ford and William A. Feder[2]

The burrowing nematode, *Radopholus similis* (Cobb) Thorne, an endoparasite, is the primary cause of the serious disease of citrus in Florida known as spreading decline (Suit and DuCharme, 1953). The term "spreading decline" is actually a description of the symptoms commonly observed in commercial citrus groves. Mature trees showing symptoms of the disorder exhibit sparse foliage, small leaves, reduced growth, and of course a drastic reduction in yield. The trees do not die from the disease unless they are abandoned. The disease gradually spreads in all directions from the initial infested site. The rate of spread may be one to three trees a year so that a relatively large number of trees may become infested within a period of a few years.

The first Florida grove showing symptoms of spreading decline was observed in 1937, and the causal agent was identified in 1953. Extensive surveys by the Division of Plant Industry of the Florida State Department of Agriculture and the Plant Pest Control Division of the United States Department of Agriculture indicate that more than 12,000 acres of Florida citrus have been infested with burrowing nematodes prior to 1962.

Several methods have been proposed and evaluated for area control of spreading decline. A comprehensive "push and treat" program was initiated in 1955. At present it is limited to voluntary participation in local areas. Chemical barriers have been used to a certain extent in an effort to contain the spread of the nematode in selected grove properties. A chemical known as "Nemagon" has been used as a soil treatment around diseased trees and found to be too expensive for the limited short term response obtained (Anonymous, 1961).

The research program, in progress at the present time, for controlling the burrowing nematode is concerned primarily with chemical and biological treatments. The search for a satisfactory rootstock resistant to the burrowing nematode is one phase of the biological program aimed at finding a way to control spreading decline. The program was initiated in 1951 by searching for "healthy looking" citrus trees in areas infested with spreading decline. In 1957, the Florida Citrus Experiment Station and the U. S. Department of Agriculture at Orlando began a cooperative screening program. By 1962, seedlings of more than 1,200 citrus species, varieties, hybrids, and relatives had been screened for resistance to at-

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[1] A portion of a talk given before the 16th Annual Institute of the Rio Grande Valley Horticultural Society, January 23, 1962.

[2] Horticulturist, Florida Citrus Experiment Station, Lake Alfred and Nematologist, U. S. Horticultural Station, Orlando, Florida, respectively.

tack and damage by the burrowing nematode. Most of the seeds for these studies were obtained from Florida and California collections, although about 10 per cent have been received from foreign countries. At least 4,200 kinds of citrus are known in more than 40 countries.

Citrus selections were first evaluated by a standard screening program in which the seedlings were grown in large soil tanks infested with the burrowing nematode (Feder and Ford, 1958). Each selection that appeared promising in the initial screening was also evaluated by comparing the growth, in pots in a large shaded greenhouse, of 10 seedlings in sandy grove subsoil infested with burrowing nematodes and 10 seedlings in steam sterilized soil.

Less than 1 percent of the citrus evaluated in soil tanks and greenhouse growth tests has been found worthy of field testing. Numerous field rootstock trials have been initiated. By 1962, 12 selections have been reported tolerant or resistant to the burrowing nematode in greenhouse tests (Ford, 1956; Ford and Feder, 1961). This paper gives brief descriptions of the performance of these 12 selections.

RESULTS AND DISCUSSION

Certain terminology used by the authors should be clarified to minimize misinterpretation. The term "immune" has been reserved for a plant in which the nematode neither penetrates nor feeds upon the root tissues. Such a plant has not been found at the present time. A plant is called "resistant," even though invaded by the nematode, if growth is not retarded and the nematode population gradually diminishes to a low level or completely disappears. Five rootstock selections qualify as "resistant." At the present time, a plant is called "tolerant" if growth is not reduced more than 20 per cent and the nematode population is maintained at a relatively high level. Seven rootstock selections qualify as "tolerant" to the burrowing nematode after extensive growth tests in the greenhouse.

Rough lemon A. and B.—These two clones were found growing in infested soil in two commercial groves in 1951 and 1952. The two clones were classified as tolerant to the burrowing nematode because the growth of young cuttings was not reduced more than 18 percent even though the root system supported relatively high populations of the burrowing nematode.

The parent tree of Rough lemon B. has been in burrowing nematode infested soil for 21 years. It has been under observation since 1952 and has not shown visible symptoms of spreading decline. It is considerably larger than surrounding trees and yields 3 to 5 times as much fruit. In 1958, root studies of the parent tree indicated that feeder roots were present to a depth of 11 feet. The deepest root penetration of adjacent trees with visible symptoms of spreading decline was only 5 feet.

Clone X hybrid was found in an infested commercial grove in Florida in 1954. It has been classified as resistant because of the unique property of reducing the population of *R. similis* in the root cortex. Certain characteristics of the fruits, seeds, and leaves indicate that "Clone X" is probably a hybrid between Rough lemon and Sour orange.

"Clone X" seedlings and cuttings have consistently eliminated the *R. similis* populations in growth tests of 6 to 9 months duration. Tests with budded plants of this candidate indicate that the scion variety does not alter the nematode resistant properties of the rootstock.

Pineapple R.S.–156.—In 1957, seeds from several different Pineapple orange trees in the U. S. Department of Agriculture collection in Florida were screened routinely for nematode susceptibility. Seedlings from one tree had vigorous, normal-looking feeder roots when grown in burrowing nematode infested soil tanks. The roots from seedlings of other Pineapple trees were injured and showed visible nematode lesions with significant populations of *R. similis*. Growth tests in pots in the greenhouse have shown that after four months the *R. similis* populations of these plants consisted of only 1 to 16 nematodes with no depression of growth. In comparison, ordinary Rough lemon seedlings under the same conditions had more than 300 burrowing nematodes on the root systems.

Citropsis gilletiana P. I. 109622 is a citrus relative that does not support a population of burrowing nematodes. Preliminary data indicate that the resistance may be caused by the inability of the nematode to penetrate the tough root epidermis. The root epidermis has been found to consist of two layers of cells compared to only one in citrus. Additional *Citropsis* seed was obtained from various forests in the Belgian Congo in 1960. In the greenhouse all of the seedlings appeared to be monoembryonic. After 11 months in infested soil in the greenhouse all of the seedlings tested from the various sources in the Belgian Congo except one were free of *R. similis*. The plant is cold tender under Florida conditions and there may be bud union incompatibilities between the stock and scion. The immediate use of *Citropsis gilletiana* will be as the female parent in a breeding program.

Algerian navel sweet orange is a tree growing in the citrus collection of the U. S. Horticultural Station, Orlando. Burrowing nematodes did not damage the root systems and the growth of plants in nematode infested soil was equal to that of plants in non-infested soil. Algerian navel is considered resistant to the burrowing nematode. Fortunately, for rootstock purposes, Algerian is a seedy navel.

Cuban navel sweet orange was obtained from Riverside, California in 1959. Unfortunately, the variety contains very few seeds. Cuban navel has been classified resistant to the burrowing nematode since growth was satisfactory and the nematode populations were at a low level in a 10 months growth test in the greenhouse.

Sanguine Grosse Ronde P. I. 105014 is considered tolerant to the burrowing nematode because shoot growth was not reduced, even though burrowing nematodes were present in the root system. In 1958, seeds of

Sanguine Grosse Ronde were obtained from Algeria and Riverside, California, to determine whether plant material under the same name from other areas would also tolerate the burrowing nematode. The seedlings from California were from the same original budwood source as the Sanguine Grosse Ronde source in Florida. Greenhouse growth tests indicated that the Florida and California sources were identical in their response to the effects of the burrowing nematode. The source from Algeria, although appearing tolerant to the burrowing nematode, was not as vigorous as the Florida and California plants.

Carrizo citrange (Navel orange x Poncirus trifoliata) has been classified as tolerant to the burrowing nematode. Variations in growth have been found between different sources of Carrizo seed. Carrizo citrange seedlings obtained from Florida and Texas were found to be less vigorous than seedlings obtained from California. In general, the California source of Carrizo exhibited the best growth and tolerance to *R. similis*. The variation between Carrizo sources is confused by the fact that the original parent trees of Carrizo are located at Carrizo Springs, Texas. The Florida and California sources were undoubtedly obtained from Carrizo Springs, but it has not been ascertained whether propagation was by budwood or seedlings.

Blood Valencia sweet orange was obtained from Riverside, California in 1959. This variety grew equally well in infested and non-infested soil with a population of burrowing nematodes on the roots. It has been classified tolerant to the burrowing nematode. Unfortunately, the number of seeds per fruit is relatively low.

Higho sweet orange is a seedy variety growing at Riverside, California. Plants of Higho showed no root loss from feeding injury of the burrowing nematode in spite of a high population of *R. similis* on the root system. Higho is, therefore, considered tolerant to injury from the burrowing nematode.

East Highlands—Winn 58-7 sweet orange is a seedy variety from Riverside, California. It is rated tolerant to the burrowing nematode because plant growth was not reduced more than 16 per cent, even though nematode populations were maintained at a relatively high level in greenhouse growth tests.

SUMMARY

The results of greenhouse growth tests indicate that seedlings of "Clone X" hybrid, Pineapple 156, Algerian navel sweet orange, Cuban navel sweet orange, and *Citropsis gilletiana* 109622, are resistant to the burrowing nematode. Seedlings of Sanguine Grosse Ronde sweet orange 105014, Blood Valencia sweet orange, Higho sweet orange, East Highlands Winn 58-7 sweet orange, Carrizo citrange 45109B, and Rough lemon A and B, are tolerant. Final evaluations of these citrus types for use as nematode tolerant or resistant rootstocks must await the completion of field scale tests which have now been underway for one year.

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Size and Yield of 12-Year-Old Valencia Orange Trees on Various Rootstocks in Presence or Absence of Exocortis and Xyloporosis Viruses[1]

E. O. Olson and A. V. Shull[2]

Horticultural evaluation of rootstocks is difficult or impossible when scions carry the bud-transmitted viruses causing xyloporosis or exocortis of citrus. Consequently much early work on certain citrus rootstocks is without meaning or actually misleading. The differences in growth caused by viruses was indicated in an earlier report; six-year-old Valencia orange trees on each of 17 rootstocks fell into 2 general groups: one with larger trees and apparently free of xyloporosis and exocortis, the other with smaller trees with exocortis or xyloporosis symptoms on the rootstock (Olson, Cooper, and Shull, 1957). Six years after the first survey, 12-year-old trees in the same grove were compared to provide more information on effect of xyloporosis and exocortis on tree growth and yield.

The original objective of the experiment reported herein was to determine the relative growth and yield of Valencia trees on various rootstocks. A second objective is to compare the yield and vigor of virus-free trees on various rootstocks with those of exocortis- and xyloporosis-infected trees on the same rootstocks, some of which are sensitive to one or the other of the viruses.

METHODS AND MATERIALS

This planting was described previously (Olson, Cooper, and Shull, 1957). The budded trees on various rootstocks were set out in early 1950 at 25- x 25-foot spacing. Most rootstocks were set in replicated 3-tree blocks. Some trees were lost during the freezes of 1950-51, which in some cases reduced the stand to less than the original 12 trees on each rootstock. A critical feature of this experiment was that the trees in the rootstock planting were propagated from buds collected from various trees in a grove. When indexed for virus, some of the probable budwood-source trees were virus-free and others were infected with both exocortis and xyloporosis viruses (Olson, Cooper, and Shull, 1957).

To determine the virus status of trees on rough lemon rootstock and non-sensitive rootstocks, such as sour orange and Cleopatra mandarin, buds from each of 35 Valencia trees were grafted to 3 seedlings each of Orlando tangelo, an xyloporosis indicator, and Rangpur lime, an exocortis indicator. The indicator plants were observed at intervals, over 42 months, for symptoms.

RESULTS

Trees in the rootstock plots showing no recognizable symptoms of exocortis or xyloporosis included those on sour orange and Cleopatra mandarin. Some trees on rough lemon showed weak symptoms of xyloporosis, with pits and gum stain in the inner bark. When trees on these 3 rootstocks were indexed, some were virus free and some were not (Table 1). The virus-free trees on the 3 rootstocks were generally slightly bigger and slightly more productive than the virus-carrying trees. However, the populations of trees are small, and the variability so great that such differences may not be significant.

Table 1. Size, yield, and disease status of virus-indexed 12-year-old Valencia orange trees on 3 rootstocks.

Rootstock	*Visible rootstock disease*	*Virus found by indexing*	*Trees in test*		*Trunk*[1] *diam. Inches*	*Yield*[2] *thru 1961 Boxes*
			1951 No.	*1961 No.*		
Cleopatra Mandarin	None	None	5	5	8.6	9.7
Cleopatra Mandarin	None	Exocortis and xyloporosis	7	7	8.5	9.1
Rough lemon	None	None	1	1	9.9	18.3
Rough lemon	Xyloporosis	Exocortis and xyloporosis	10	10	8.4	18.1
Sour orange	None	None	5	5	9.6	11.5
Sour orange	None	Exocortis and xyloporosis	7	7	8.5	10.1

[1] Size of tree is indicated by diameter of trunk 4 inches above the bud union, in October, 1961.

[2] Average yield (70-lb. boxes) terminating with harvest in March, 1961, based on number of trees in 1951.

As shown in Table 2, virus-infected and symptom-showing trees generally yielded less and were smaller than apparently virus-free trees on the same sensitive rootstocks.

When the yields of probably virus-free trees are compared, yields from trees on certain rootstocks exceeded the yield from trees on sour orange rootstock. The heavier yields came from the trees on the following rootstocks: Morton citrange; rough lemon; Changsha and Chou Choo Tien Chieh mandarins; Kusaie, Rangpur, and "Rose lemon" mandarin-limes; Columbia sweet lime, and two tangelos (Tables 1 and 2).

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[1] These investigations are sponsored jointly by the Texas Agricultural Experiment Station and the Citrus Research Investigations group of the U .S. Department of Agriculture, with Rio Farms, Inc., cooperating.

[2] Respectively, Plant Pathologist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Weslaco, and Manager, Citrus Department, Rio Farms, Inc., Monte Alto, Texas.

Table 2. Size, yield, and disease status of presumed virus-free and virus-infected 12-year-old Valencia orange trees on exocortis- or xyloporosis-sensitive rootstocks.

Rootstock	Bud-transmitted disease visible on rootstock	Trees in test 1961 No.	Trees in test 1951 No.	Trunk[1] diam. Inches	Yield[2] thru 1961 Boxes
Citrange:					
Morton	None	4	4	9.1	16.7
Morton	Exocortis	1	1	3.8	2.2
Mandarin:					
Changsha	None	8	8	8.5	12.7
Changsha	Xyloporosis	2	2	10.3	13.0
Chou Choo Tien Chieh	None	3	3	9.1	14.0
Chou Choo Tien Chieh	Xyloporosis	8	6	4.8	3.5
Dancy	Xyloporosis	10	10	8.3	10.1
Satsuma	None	6	6	8.5	10.9
Satsuma	Xyloporosis	6	5	6.4	4.0
Mandarin-lime:					
Kusaie	None	1	1	11.7	14.4
Kusaie	Exocortis	11	11	6.1	5.6
Rangpur	None	6	6	9.2	16.7
Rangpur	Exocortis	3	3	5.9	7.6
"Rose lemon"	None	7	7	9.7	21.1
"Rose lemon"	Exocortis	5	5	6.6	12.1
Poncirus trifoliata:	None	2	2	7.1	9.0
Poncirus trifoliata:	Exocortis	1	1	4.3	1.9
Cuban shaddock	Exocortis	12	10	5.4	7.5
Sweet lime:					
Columbian	None	5	5	9.2	18.5
Columbian	Xyloporosis	5	5	4.7	7.0
Tangelo:					
Altoona	None	9	9	7.9	11.7
Altoona	Xyloporosis	2	1	7.0	3.2
D-14-C	None	7	7	10.9	11.7
D-14-C	Xyloporosis	3	3	7.3	11.1
Leonardy	None	2	2	7.5	10.9
Leonardy	Xyloporosis	4	4	7.7	11.1
Minneola	None	6	6	9.0	11.3
Minneola	Xyloporosis	6	5	8.1	7.4
Orlando	None	1	1	11.7	12.1
Orlando	Xyloporosis	8	4	4.8	1.7
Seminole	None	3	3	8.1	15.3
Seminole	Xyloporosis	2	2	5.6	10.9
Sunshine	None	5	5	8.8	11.3
Sunshine	Xyloporosis	3	3	9.4	13.6
Thornton	None	2	2	8.6	11.5
Thornton	Xyloporosis	10	10	6.8	8.6
Yalaha	None	6	6	7.1	6.5
Yalaha	Xyloporosis	4	3	6.8	6.1

[1] Size of tree is indicated by diameter of trunk 4 inches above the bud union in October, 1961.

[2] Yield in 70-lb. boxes, terminating with harvest in March, 1961. Average yield based on number of trees in 1951.

DISCUSSION AND SUMMARY

The results indicate that—

1. Twelve-year-old virus-free trees generally grew faster and yielded more than trees infected with exocortis and xyloporosis viruses. The degree to which yield and growth were suppressed depended upon the relative sensitivity to the 2 viruses of the stock-scion combination.

2. Rootstock data—even from apparently healthy trees in this experiment—are confusing when virus status of the trees is unknown. Rootstocks, apparently healthy, may have done poorly because of an obscure virus effect, or because of innate qualities which make them unadapted to Texas conditions. The full potentialities of virus-sensitive rootstocks can be evaluated only with virus-free tops. However, striking differences in both tree size and fruit yield occurred on some of the sensitive rootstocks on trees which showed no symptoms and were presumably virus-free as compared with those expressing symptoms.

3. Since the data are based on small populations, it is subject to revision when new virus-free plantings mature.

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Survival, Size and Yield of Xyloporosis- and Exocortis-Infected Old-Line Red Grapefruit Trees on 100 Rootstocks[1]

E. O. Olson, W. C. Cooper, N. Maxwell and A. V. Shull

The measure of the success of a rootstock is its capacity to survive local hazards, to grow and to support a variety in a satisfactory manner so that it will yield fruit. Satisfactory yield of fruit is perhaps the best single yardstick. Important factors influencing rootstock performance of young grapefruit trees in Texas was found to be the rootstock's tolerance to xyloporosis and exocortis viruses. Three groups of rootstocks based on sensitivity were recognized: those sensitive to xyloporosis; those sensitive to exocortis, and those tolerant of both viruses. Experiments are now in progress to determine orchard performance of virus-free grapefruit trees composed of nucellar tops on several virus-sensitive rootstocks. These plantings are young, and the long-time performance of nucellar grapefruit trees in Texas is unknown. In the meantime, information has accumulated on survival, tree growth and fruit yield of virus-infected old-line grapefruit trees on rootstocks of variable sensitivity.

The purpose of this present report is to add to our knowledge of how virus sensitivity of rootstocks influences survival, growth and yield of exocortis-and xyloporosis-infected red grapefruit trees in Texas. Previous reports have dealt with cold-hardiness, salt tolerance, virus-susceptibility, and chlorosis of trees in these experimental plantings (Cooper et al., 1956, 1957, 1957).

METHODS AND MATERIALS

The two rootstock plantings were at Rio Farms at Monte Alto, and at the Texas Agricultural Experiment Station (TAES) at Weslaco.

Trees in the Rio Farms planting were set in 1950; those at the TAES planting in 1947. Most rootstock varieties in both plantings were in 4 replicates of 3-tree blocks. The tops were Webb-Red Blush grapefruit, subsequently shown to carry both exocortis and xyloporosis viruses. Some of the trees were killed in freezes in 1949 and 1951.

The soil in the TAES orchard was Hidalgo fine sandy loam, was slightly calcareous, and had a pH of 7.7. The soil of the Rio Farms orchard was Brennan fine sandy loam, was non-calcareous, and had a pH of 7.0. The TAES orchard was flood-irrigated and was cultivated 6 times a year with weed covers growing between cultivations. The Rio Farms orchard was sprinkler-irrigated and was kept under Bermuda sod until January 1958, when it was cultivated 6 times a year; weed covers grew between cultivations. The trees were examined periodically for evidence of xyloporosis, exocortis, foot rot, and other disorders. It is believed that all trees in these tests carried xyloporosis and exocortis viruses, as bud inoculations from various trees, with and without symptoms, caused xyloporosis in sweet lime and Orlando tangelo and exocortis in Rangpur lime and Morton citrange seedling test trees (Olson et al., 1961).

In order to get an estimate of relative tree size, the diameter of tree trunks, 4 inches above the bud union, was determined by use of a calipering device.

Yield records were obtained by counting the number of boxes of fruit produced by each tree each year. Each box contained approximately 70 lbs. of fruit.

RESULTS

Certain rootstocks were tested at both Rio Farms and TAES locations (Table 1). The yields were generally similar, although the TAES trees were planted in 1947, and the Rio Farms trees in 1950. The trees on rough lemon rootstock appeared to outyield those on sour orange at TAES, but not at Rio Farms. The rough lemon is sensitive to "wet feet", and high-water-table situations developed in local areas at Rio Farms.

The outstanding rootstocks were generally those with low sensitivity to exocortis and xyloporosis virus; these include: sour orange, Uvalde citrange, citrumelo 4475, citremon, mandarin No. 117477, rough lemon, Precose de Valence sweet orange, and several grapefruit varieties. Other rootstocks, while showing virus symptoms, still yielded well; these included: "Rose lemon" (exocortis), Sunki (exocortis), Pina tangelo (xyloporosis), and tangelo I-13 (xyloporosis). Trees on Kalpi yielded well, but the trees were highly sensitive to cold in the 1951 freeze. Healthy trees on sweet orange rootstock yielded well, but foot rot caused by Phythopthora fungus was a major hazard, except for those on Precose de Valence sweet orange rootstock.

Unbudded red grapefruit seedlings are undoubtedly the biggest trees; they were slow in beginning to bear fruit, but have bright prospects for future yields.

DISCUSSION

These 2 rootstock experiments were planted to provide information on the adaptability of various rootstocks to Texas soil and climate. The results indicate that several rootstocks have possibilities if a new rootstock were needed to replace the sour orange presently used in Texas.

However, the full potentialities of many virus-sensitive rootstocks can occur only with virus-free budwood. Thus, a virus-sensitive root-

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[1] These investigations are sponsored jointly by the Texas Agricultural Experiment Station and the Crops Research Division, Agricultural Research Service, of the U. S. Department of Agriculture, with Rio Farms, Inc., cooperating.

[2] Respectively, Plant Pathologist and Plant Physiologist, U. S. Department of Agriculture, Weslaco and Orlando, Florida; Horticulturist, Valley Experiment Station, Weslaco; Manager, Citrus Department, Rio Farms, Inc., Monte Alto.

Table 1. Survival, size and yield of xyloporosis- and exocortis-infected old-line red grapefruit trees on rootstocks at Rio Farms (RF), Monte Alto, and Texas Agricultural Experiment Station (TAES), Weslaco.

Rootstock group and variety	*Number of trees in trial and, in ( ), losses since 1951*		*Tree size as trunk diameter in inches. Oct. 1961*		*Cumulative yield in 70-lb. boxes*		*Apparent major limiting factor*
	Rio Farms	*TAES*	*Rio Farms*	*TAES*	*Rio Farms*	*TAES*	
Citranges:							
Cunningham	3 (3)		----		7.1		Exocortis
Rusk	9		6.4		21.0		Salt-sensitive
Rustic	10		5.9		13.4		Salt-sensitive
Sanders	12 (12)	3	----	4.7	4.4	7.6	Exocortis
Savage	12	9	6.1	6.6	19.7	19.1	None
Troyer	9 (3)		7.1		15.7		Exocortis
Uvalde	12		8.1		24.0		None
No. 15137	3		7.5		20.3		----
Citrumelos:							
No. 4451	1		8.3		22.5		----
4475	12	2	7.6	6.4	26.6	27.8	None
4561		2		5.25		13.7	----
4606		2		6.7		28.8	----
C. Southwickii	3		6.2		15.1		----
Grapefruits:							
"Bergaldin"	11		8.4		22.2		None
Duncan	12	9	8.4	8.7	21.7	26.7	None
Leonardy		12		8.5		27.8	Xyloporosis
Red Blush	12		9.2		25.6		None
Red Blush seedlings (unbudded)	12	9	11.6		16.4	15.1	Slow fruiting
Kumquat hybrid:							
Calamondin	12 (12)	11 (3)	----	7.1	8.4	12.3	Bud union crease
Lemonquat	12 (12)		----		9.0		Bud union crease
Lemon-limes:							
Cuban "Shaddock"	12		6.5		17.3		Exocortis
Kalpi		5		8.6		28.7	Cold-sensitive
Lempum		7 (2)		4.4		5.2	Exocortis
Rough lemon	12 (2)	10	8.6	9.2	26.0	34.6	"Wet feet"
Mandarin:							
Altoona	12 (1)		7.4		16.3		Xyloporosis
Calashu	12		7.3		20.3		None
Changsha	12		7.3		18.8		None
Choa Chou Tien Chieh	10 (10)		----		2.1		Xyloporosis
Chu Koa		9		8.7		19.9	Xyloporosis
C. noblis	2 (1)		7.9		16.8		Xyloporosis
Clementine	12 (9)	6	5.9	7.6	12.0	19.9	Variability
Cleopatra	12	11	8.2	8.5	23.6	20.5	None
Dancy	12	11	8.6	8.7	21.9	17.7	Xyloporosis
Kara	3		7.5		13.9		Salt-sensitive
King	5	6	7.5	8.1	18.0	25.7	Salt-sensitive
Kinnow	6		6.2		12.3		Xyloporosis
Lau Chang	12		8.6		20.7		Xyloporosis
Oneco	10 (1)		8.1		15.8		Xyloporosis
Pong Koa	11 (3)		8.0		14.0		Xyloporosis
Ponkan	12 (2)		8.7		20.3		Foot rot
Sanguinea	10 (1)		6.8		14.0		Xyloporosis
Satsuma		9		7.3		20.4	Xyloporosis
Suenkat	12		7.8		20.2		Xyloporosis

Rootstock group and variety	Number of trees in trial and, in ( ), losses since 1951		Tree size as trunk diameter in inches. Oct. 1961		Cumulative yield in 70-lb. boxes		Apparent major limiting factor
	Rio Farms	TAES	Rio Farms	TAES	Rio Farms	TAES	
Mandarin—Cont'd.							
Sunki	6	10	7.3	7.8	23.6	25.1	Exocortis
Temple		5 (1)		7.2		13.7	Variability
Umatilla		6 (2)		7.0		10.8	Variability
Willowleaf	6 (4)		9.8		14.8		Xyloporosis
No. 10630	6 (3)		5.7		6.1		Xyloporosis
No. 117477	12		8.5		26.6		None
Mandarin-limes:							
Kusaie	12 (6)		7.2		16.0		Exocortis
Rangpur	13 (5)	10	7.0	5.6	16.8	15.8	Exocortis
"Rose lemon"	12		6.9		26.6		Exocortis
Shaddocks:							
African	12		7.2		19.1		None
Ichang	2		8.1		12.8		----
India Red	12		6.7		21.2		Salt-sensitive
Natsu Mikan		7		7.9		21.3	None
Siam		7		7.7		23.5	None
Thong Dee		4		7.4		21.6	None
Sour oranges:							
Bergamia		12		7.8		26.1	None
Bittersweet		6		7.9		24.0	None
Florida	11	11	8.1	8.3	24.0	24.8	None
Oklawaha		7		8.7		29.8	None
Sauvage		4		8.6		25.0	None

Rootstock group and variety	Number of trees in trial and, in ( ), losses since 1951		Tree size as trunk diameter in inches. Oct. 1961		Cumulative yield in 70-lb. boxes		Apparent major limiting factor
	Rio Farms	TAES	Rio Farms	TAES	Rio Farms	TAES	
Sweet lime:							
Butwal	12 (12)		----		8.1		Xyloporosis
Columbian	12 (12)		----		8.6		Xyloporosis
Palestine	12 (12)		----		20.2		Xyloporosis
Sweet oranges:							
Avena	12 (4)		9.0		20.9		Foot rot
Cadena panchosa	9 (3)		9.2		20.2		Foot rot
Florida sweet		3 (1)		9.2		22.3	Foot rot
Gzel Gzel	12 (3)		8.7		22.3		Foot rot
Hamlin	12 (10)	3	8.9	9.4	9.8	24.1	Foot rot
Louisiana sweet	12		8.2		24.5		Foot rot
Pineapple	11 (8)		9.5		15.9		Foot rot
Precoce	12		9.0		29.4		None
Weldon	12 (4)		8.2		20.4		Foot rot
Tangelos:							
Minneola	11	11	8.4	8.4	22.1	18.1	Xyloporosis
Orlando	4 (4)		----		9.3		Xyloporosis
Pina		8		8.7		26.2	Xyloporosis
Sampson	11	11 (1)	8.9	9.4	19.7	20.0	Chlorosis
San Jacinto	11		8.3		19.7		Foot rot
Seminole	3		6.1		14.5		
Sunshine		11		8.2		22.8	Xyloporosis
Suwanee		12 (2)		8.0		12.8	Xyloporosis
Thornton	13	9 (1)	6.9	7.8	12.4	16.0	Xyloporosis
Watt	12	9	7.5	7.7	18.0	19.3	Chlorosis
Webber	12		7.3		22.4		Variability
Williams	12	12	7.7	8.6	20.9	22.9	Exocortis
Yalaha		8		7.3		12.0	Xyloporosis

Rootstock group and variety	Number of trees in trial and, in ( ), losses since 1951		Tree size as trunk diameter in inches. Oct. 1961		Cumulative yield in 70-lb. boxes		Apparent major limiting factor
	Rio Farms	TAES	Rio Farms	TAES	Rio Farms	TAES	
Tangelos—Cont'd.							
D-14	12 (1)		7.7		19.2		Xyloporosis
E-7	6		6.7		10.2		Xyloporosis
I-13	8		8.5		25.1		Xyloporosis
K-9	12		7.9		19.3		Xyloporosis
N-7	12 (12)		----		10.7		Xyloporosis
Trifoliate hybrids:							
Citradia	9 (9)		----		1.9		Exocortis
Citraldin	5		6.6		17.1		Salt-sensitive
Citrandarin	3		6.2		17.5		----
Citrangeor 43301	7		7.4		22.7		Cold-sensitive
Citrangeor 45728		3		6.2		16.7	----
Citrangequat	7		6.1		14.4		Salt-sensitive
Citremon 46216	10 (1)		7.3		23.0		None

stock may have done poorly in these trials, but might be very productive with virus-free tops. Thus, other plantings now in existence, using nucellar virus-free tops, have great potential interest.

Most of the lessons learned from these 2 rootstock experiments is covered by earlier reports. Factors affecting usefulness of these citrus rootstocks included salt tolerance, viruses, lime-induced chlorosis, high water tables, fruit quality, cold hardiness, and dormancy. The yield of the trees is a rough average of the rootstock's adaptability to conditions in the test orchards. Since it is improbable that any new rootstocks in Texas will be intentionally used with virus-infected tops, rootstock trials with virus-infected trees are being replaced with newer trials with virus-free trees.

If any rootstock should replace the tristeza-susceptible sour orange in Texas, it probably will not be one which is outstanding in all respects; the perfect rootstock has not yet been found. It probably will be one which has no serious weakness and is only average in many respects. Trees on the tristeza-tolerant Cleopatra mandarin rootstock, used in commercial plantings for a few years, were above-average in tolerance to chlorides in irrigation water. However, they were chlorotic when grown on calcareous soils, and the Cleopatra mandarin is no longer a commercial rootstock in Texas. At the present time, as reported earlier, the hazard of using a new rootstock seems to be greater than the hazard of using the sour orange, presently the commercial rootstock in Texas.

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Performance of Nucellar Red Blush Grapefruit Trees on 13 Kinds of Rootstocks Irrigated with Saline and Boron-Contaminated Well Water Over a 3-Year Period[1]

A. Peynado and Roger Young[2]

Well water used for irrigation of citrus in the Rio Grande Valley in times of severe drouth often contains injurious levels of soluble salts. Salts in the irrigation water increase the soil salinity and cause toxic effects on the citrus tree because of excessive accumulation of specific salt constituents such as sodium, chloride, and boron (Cooper and Edwards, 1950; Cooper et al., 1952).

Toxicity and accumulation of salts in citrus trees on various rootstocks have been studied in Texas where the studies concerned were: (a) contrasts between varieties of rootstocks in the concentrations of various ions accumulated and the capacity of the tree to tolerate the accumulations, and (b) interactions of quantity and kind of ions presented to the roots and those accumulated by the tree (Cooper, 1962).

In 1959 Cooper and Peynado reported that leaves of Red Blush grapefruit trees on Carrizo, Savage, and Troyer citranges and *Citrus moi* rootstocks accumulated excessive amounts of both chloride and boron. The foliage of trees on sour orange, Ponkan mandarin, citrumelo 4475, and Columbian sweet lime accumulated a moderate amount of chloride and an excessive amount of boron. Leaves of trees on Cleopatra, Timkat, and Sunki mandarins and Rangpur lime accumulated little chloride but excessive boron. The foliage of trees on *C. macrophylla* showed no toxic symptoms caused by excess boron or chloride.

The present paper reports the continuation of Cooper and Peynado's experiment through 2 additional years. The performance of nucellar Red Blush grapefruit trees on 13 kinds of rootstocks irrigated with saline and boron-contaminated well water was evaluated over a 3-year period.

METHODS AND MATERIALS

One-year-old nucellar Red Blush grapefruit trees on 13 kinds of rootstocks were planted in 1958 at a 10- x 10-foot spacing at Rio Farms, Inc., Monte Alto, Texas. They were irrigated with well water 7 times between March and September, 1958; 5 times between May and September, 1959; and 6 times between May and August, 1960. The irrigation water contained approximately 3300 ppm total soluble salts, 1200 ppm chloride, 5.5 ppm boron, and a sodium percentage of 85. There were 4 single-tree replicates of each rootstock except Sunki mandarin, *Citrus moi,* and Columbian sweet lime, which were replicated only 3 times.

Leaf samplings in September 1958, 1959, and 1960 consisted of 20 spring-flush leaves from each tree. Leaf preparation and analysis for chloride, sodium and boron are described elsewhere (Cooper et al., 1952).

Trunk circumferences were measured in centimeters at a mark 4 inches above the bud union with a flexible steel tape and converted to cross-sectional area (cm^2) at the measured point.

Roots were counted by a method used by members of the Soil and Water Conservation Research Division, Agricultural Research Service, U. S. Department of Agriculture, at Weslaco, Texas. A trench was excavated adjacent to one side of the tree trunk in a north-south direction so that it extended 4 feet beyond the trunk in both directions. The soil profile was smoothed out with a sharp, flat shovel and an area, 3 ft. to each side of the trunk and as far down as roots were present, was marked with a grid frame into 6-inch squares. The roots were counted in each square, using an ice pick to chip the soil to expose the roots. A 1-inch slice of the soil profile in 1-foot increments down to 5 feet was also taken for salinity analysis at this time. The soil was also sampled in 1958 and 1959, by taking a 1-inch slice of the top foot of soil.

Table 1. Concentration of boron, sodium and chloride in the leaves of nucellar Red Blush grapefruit trees on various rootstocks, Rio Farms, Inc., near Edcouch, Texas.

	Concentration in oven-dried leaves[a]		
Rootstock	*Boron (ppm)*	*Sodium (Percent)*	*Chloride (Percent)*
C. macrophylla	278	.28	1.62
C. moi	630	.34	2.14
Sour orange	678	.16	.91
Columbian sweet lime	751	.27	1.13
Rangpur lime	831	.26	.34
Carrizo citrange	861	.38	2.04
Salvage citrange	969	.37	1.70
Cleopatra mandarin	984	.39	.28
Troyer citrange	994	.44	1.93
Sunki mandarin	1112	.48	.24
Timkat mandarin	1192	.52	.33
Ponkan mandarin	1253	.52	.64
Citrumelo 4475	1300	.60	.80

[a] Each value is the mean of 4 replications for 3 sampling dates (September 1958, 1959, and 1960) except for Sunki mandarin, *Citrus moi,* and Columbian sweet lime, which had only 3 replicates.

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[1] Based on portion of cooperative citrus research of U. S. Department of Agriculture, Texas Agricultural Experiment Station and Rio Farms, Inc., Monte Alto, Texas.

[2] Chemist and Physiologist, respectively, of U. S. Department of Agriculture, Agricultural Research Service, Crops Research Division, and Agricultural Experiment Station, Weslaco, Texas.

All soil samples were taken in September. The saturated soil of the top foot had pH values of 7.4 in 1958 and 7.7 in 1959, and the extract electrical conductivities (millimhos per cm) of 2.8 in 1958 and 4.7 in 1959. In 1960, the extract of the saturated soil at various depths had conductivity readings in millimhos per cm as follows: first foot, 1.3; second foot, 2.0; third foot, 2.4; fourth foot, 2.3; fifth foot, 2.2. The lower values in 1960, compared with those in 1959 and 1958, are a reflection of heavy rains before sampling. Irrigation with well water was confined to the warm months of late spring and summer. During the remainder of the year, river water with approximately 700 ppm total soluble salts was applied as needed.

RESULTS

The uptake of sodium was correlated with boron uptake, but there was no correlation of sodium and chloride uptake in these rootstocks.

As the boron content increased in the foliage of trees on various rootstocks, the sodium content also generally increased (Table 1). A notable exception was the sour orange rootstock. Many mandarin rootstocks did not accumulate chloride but did accumulate excessive boron.

Table 2. Rootstock effects on chlorosis, bronzing, and boron-toxicity symptoms in the foliage and on root density, trunk growth, and survival of Red Blush grapefruit trees.

Rootstock	*Boron-toxicity rating*[a]	*Chlorosis rating*[a]	*Bronzing rating*[a]	*Root density in soil slice*[b]	*Increase in cross-sectional area of trunk* (*cm*^{2})[c]	*Dead trees*[d] *(No.)*
C. macrophylla	.7	.2	.4	1649	18.9	0
C. moi	1.8	.2	.8	863	10.9	1
Sour orange	1.8	.0	.6	970	18.9	0
Columbian sweet lime	2.0	.4	1.3	1263	24.5	0
Rangpur lime	2.3	1.2	1.6	1464	29.0	0
Carrizo citrange	2.2	1.8	1.9	720	7.4	1
Savage citrange	2.1	1.8	1.6	1068	12.2	2
Cleopatra mandarin	1.5	1.4	.8	880	11.7	0
Troyer citrange	2.4	3.0	1.8	462	9.6	1
Sunki mandarin	1.0	2.8	.3	476	6.4	0
Timkat mandarin	1.5	3.6	1.3	406	4.5	1
Ponkan mandarin	1.5	2.1	1.2	362	5.7	0
Citrumelo 4475	3.2	2.4	2.2	----	2.0	3

[a] Ratings: 0 = none, 1 = trace, 2 = slight, 3 = moderate, 4 = severe, 5 = severe with twig injury. Each value is the mean of 4 replications for 3 sampling dates (September 1958, 1959, and 1960) except for Sunki mandarin, *Citrus moi*, and Columbian sweet lime, which had only 3 replicates.

[b] Values represent number of roots occurring in the side of a trench, 3 feet to each side of the trunk and as far down as roots went. Values are the mean of a 2-tree sample.

[c] Grapefruit trunk was measured 4 inches above bud union.

[d] Trees dying during the 3-year period of the test.

Foliage of *Poncirus trifoliata* hybrids, such as citranges and citrumelo 4475, accumulated both chloride and boron. As the boron and sodium contents increased in the foliage of trees on various rootstocks, the leaves in general became more chlorotic.

Foliage of trees on *C. macrophylla* rootstock contained high amounts of chloride, but showed only a trace of toxicity symptoms. Chlorosis in the trees on mandarin rootstocks obscured the boron-toxicity and bronzing symptoms (Table 2).

The faster growing trees generally had more roots; those on *C. macrophylla* rootstock had the most roots; roots of *C. macrophylla* and sweet lime were more abundant at deeper levels in the soil than those of other kinds of rootstocks, (Fig. 1). Trees killed by the well-water treatments included one or more on *trifoliata* hybrid, *C. moi*, or Timkat mandarin rootstocks. *C. moi* and Carrizo, Savage, and Troyer citranges were chloride accumulators and Timkat mandarin and citrumelo 4475 were accumulators of sodium and boron. Root growth and tree survival were associated with tolerance to salt and boron in the irrigation water.

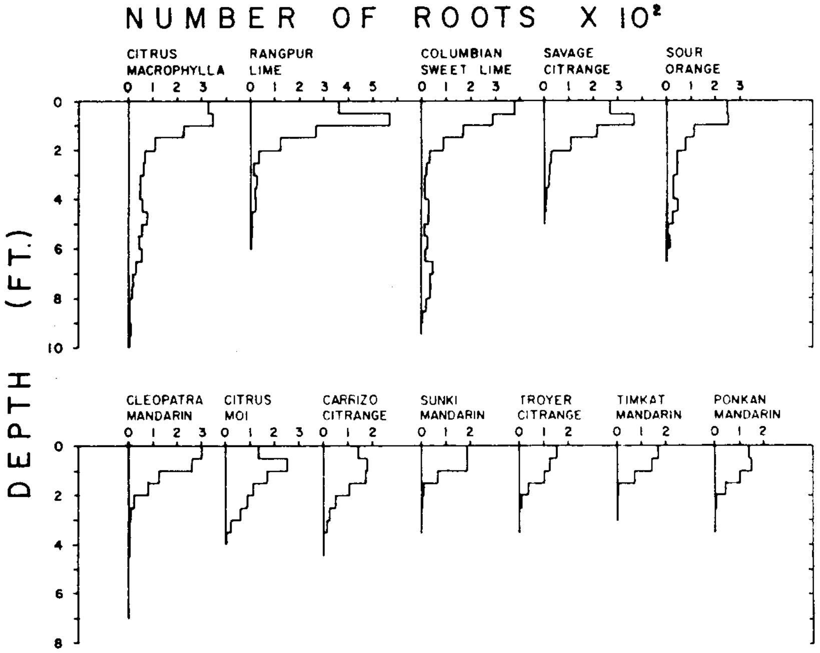

Figure 1. Profile of the root systems. Roots were counted on two trees of each rootstock. Roots on the single remaining tree on Citrumelo 4475 rootstock were not counted.

The grapefruit trees on various rootstocks performed generally in the same manner in the combined 3 years as they did the first year

(Cooper and Peynado, 1959). However, the present article adds new information on sodium accumulation in the foliage. The first year of the experiment, foliage of trees on Ponkan and Cleopatra mandarin and Troyer citrange rootstocks accumulated a moderated amount of sodium. By the end of the third year, sodium content of foliage of trees on sour orange rootstock remained low; those on *C. macrophylla,* Columbian sweet lime and Rangpur lime rootstock had a moderate amount of sodium and the foliage of trees on the remaining rootstocks was high in sodium (Table 3).

Table 3. Accumulation by years of boron, sodium, and chloride in spring-flush leaves of nucellar Red Blush grapefruit trees on 13 kinds of rootstocks irrigated with Rio Farms well water on 3 consecutive summers. Leaves were analyzed at the end of each summer treatment period.

	Concentration in oven-dried leaves for indicated years								
	Boron (ppm)			*Sodium (percent)*			*Chloride (percent)*		
Kind of rootstock	1958	1959	1960	1958	1959	1960	1958	1959	1960
Citrus macrophylla	282	285	267	.18	.31	.34	.67	1.65	2.54
Citrus moi	521	691	639	.22	.42	.39	1.69	2.36	2.37
Sour orange	786	594	654	.12	.19	.16	.46	1.14	1.12
Columbian sweet lime	762	725	767	.18	.34	.28	.79	.96	1.64
Rangpur lime	854	834	804	.19	.31	.28	.40	.40	.21
Carrizo citrange	742	862	980	.21	.45	.47	2.11	1.91	2.10
Savage citrange	939	1047	920	.14	.73	.25	1.34	2.19	1.58
Cleopatra mandarin	1134	990	829	.30	.58	.30	.22	.35	.28
Troyer citrange	873	1100	1010	.30	.62	.41	2.43	1.50	1.86
Sunki mandarin	787	1190	1360	.18	.61	.66	.10	.29	.32
Timkat mandarin	899	1169	1508	.20	.58	.78	.12	.31	.56
Ponkan mandarin	1174	1322	1263	.38	.68	.49	.66	.64	.62
Citrumelo 4475	904	1695	x	.26	.93	x	.83	.78	x

[a] Values represent mean of 4 single-tree replicates except for Sunki mandarin, *Citrus moi,* and Columbian sweet lime, which had only 3 single-tree replicates.

DISCUSSION

Foliage of trees on *C. macrophylla* rootstock accumulated high chloride and yet showed only slight toxicity symptoms. Usually when chloride-toxicity symptoms developed in citrus foliage, the oven-dried leaf contained 1.35 to 2.77% chloride (Cooper et al., 1952). Yet, foliage of trees on *C. macrophylla* rootstock contained up to 2.54 percent chloride with only a faint trace of bronzing and dots due to boron toxicity. While performance of *C. macrophylla* was exceptional in this test, it is not a practical rootstock for South Texas, because it tends to induce active growth into late November and thus make trees more susceptible to freeze damage than those on sour orange or Cleopatra mandarin rootstock (Young et al., 1960).

This study confirms other reports that *C. macrophylla* rootstock reduced boron uptake (Embleton et al., 1962) and that Rangpur lime and Cleopatra, Sunki, and Timkat mandarin rootstocks reduced chloride uptake (Cooper and Peynado, 1959). Foliage of trees on sour orange rootstock was low in sodium. Sunki, Timkat, and Ponkan mandarins and citrumelo 4475 accumulate 3 to 4 times as much sodium as sour orange and also very high amounts of boron.

The present data on sodium accumulations by various rootstocks indicated the value of salinity tests carried over a 3-year period. A one-year test may fail to reveal the accumulative effect of yearly increases in uptake of elements like sodium.

SUMMARY

There was good correlation between the sadium and boron uptake but not between sodium and chloride uptake in foliage of trees on 13 rootstocks.

As the boron and sodium contents increased in the foliage of trees on various rootstocks, the leaves in general became more chlorotic.

The faster growing trees generally had more roots. Root growth and tree survival were associated with tolerance to salt and boron in the irrigation water.

Foliage of trees on *Citrus macrophylla* remained low in boron but accumulated a concentration of chloride higher than published limits of symptom expression on other rootstocks yet showed only slight toxicity symptoms.

Rootstock performance over a 3-year period generally confirmed previous reports by Cooper and Peynado (1959). The 3-year test revealed changes in yearly uptake of boron, sodium and chloride. Sodium tended to accumulate in foliage of trees on 12 rootstocks, but not in foliage of trees on sour orange rootstock.

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Response of Citrus Replants to Soil Fumigation in South Texas

Bailey Sleeth[1]

The growth of young replanted citrus trees is usually slower than that of the trees that were first planted on the site. Similar retardation in growth has been observed in single tree replacements in established groves. The replant problem has been observed by growers and has been reported in the Lower Rio Grande Valley (Sleeth 1952, 1958), in California (Baines 1950, 1956; Martin 1952) and in Arizona (Reynolds 1958). Parasitic nematodes are suspected as the primary cause of the slower growth, particularly the citrus nematode, *Tylenchulus semipenetrans* Cobb. This nematode is widely distributed in the Lower Rio Grande Valley (Godfrey 1950; Sleeth 1952) and probably infects all of the older groves as well as the young replanted groves. Better growth has been obtained when citrus replants were planted in soil that was fumigated with a nematocide prior to planting than in untreated soil (Martin 1952; Baines et al 1956; Sleeth 1952, 1958). To ascertain the effect of certain soil fumigants on the growth of citrus replants and on the nematode populations, a mixed citrus planting was established in 1952 at the Weslaco Station in which the soil was treated with ethylene dibromide prior to planting. A second field test was established in 1956 in which nemagon (1,2-dibromo-3-chloropropane) and D-D (1,3-dichloropropene and 1,3-dichloropropane) were used.

SOIL FUMIGATED WITH ETHYLENE DIBROMIDE

PROCEDURE

Ethylene dibromide, at 350 pounds per acre rate, was used to fumigate 6 alternate permanent borders 250 feet long in an area from which a 20-year-old citrus grove had been taken out 2 years earlier. The fumigant was applied, December 1951, with a pressure applicator at depth of 10 inches in bands 12 inches apart. A 14-foot wide center strip 250 feet long was treated in the 21 foot wide borders, or two-thirds of the total area was fumigated. Six untreated borders served as control.

Psorosis-free nursery trees were planted in June 1952 in the 6 fumigated and 6 non-fumigated borders. The order of planting within the border plots from west to east was as follows, pink grapefruit, red grapefruit, Valencia orange, Marrs orange, Washington navel orange and white grapefruit. Two trees of each variety were planted, the odd numbered trees were on Cleopatra mandarin rootstock and the even numbered ones on sour orange, except white grapefruit which was on sour orange only.

The usual grove cultural practices were followed in the care of the experimental planting. Weed growth was kept under control with a tractor drawn rotary weed cutter. Early tree growth was retarded in the

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[1] Plant Pathologist, Texas Agricultural Experiment Station, Weslaco.

first, second and third years by drought conditions, however, since 1954 the trees have grown well. The severe freeze of January 1962 caused extensive damage to the trunk and main branches rendering rehabilitation of questionable value. However, the grove is to be taken out because of highway rightway encroachment.

Tree growth was obtained by measuring the circumference of the tree trunk 4-6 inches above the bud union. From this measurement, the cross-sectional area of the trunk was calculated. Fruit yields were usually taken in January. Even though individual tree growth measurements and yields were taken, the results are expressed as response of grapefruit and oranges to fumigation and rootstock in Table 1.

RESULTS

The growth of citrus trees growing in fumigated soil was consistently greater than for trees in non-fumigated soil. The increase in growth was apparent in the second year and was maintained, or increased, as the trees grew older. At the end of 9 years, this increase in growth of trees on Cleopatra mandarin rootstock was 12 percent for oranges and 25 percent for pink-red grapefruit; on sour orange rootstock the increase was 7 percent for oranges, 13 per cent for white grapefruit and 31 percent for pink-red grapefruit. The average over all increase in growth resulting from the soil fumigation treatment for all varieties was 18 percent.

Table 1. Effect of soil fumigant, ethylene dibromide, on growth and yield of 9-year-old citrus replants.

			Tree age, average growth and yield for 3 years[1]			
			Average cross-sectional area of stem in square inches, 6 inches above union			*Total yield, in pounds for 3 years*
Citrus group	*Rootstock*	*Soil treatment*	*2 yrs.*	*6 yrs.*	*9 yrs.*	*7, 8, 9 yrs.*
Grapefruit;						
Pink and Red	Cleo. m.	None	3.4	12.3	27.9	480
	Cleo. m.	Fumigated	2.4	15.4	35.0	648
	Sour o.	None	3.4	9.8	20.5	594
	Sour o.	Fumigated	4.1	12.9	26.9	717
White	Sour o.	None	4.0	17.5	35.5	646
	Sour o.	Fumigated	4.8	20.9	41.0	657
Orange:						
Mars, Valencia						
& Washington n.	Cleo. m.	None	2.1	7.5	20.0	143
	Cleo. m.	Fumigated	2.6	8.6	22.4	150
	Sour o.	None	2.6	7.3	17.7	181
	Sour o.	Fumigated	2.8	8.3	19.0	219

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[1] Growth and yield of grapefruit based on average of 12 trees, orange 18 trees.

Rootstock affected both growth and yield (Table 1). The 9-year-old trees on Cleopatra mandarin were approximately 25 percent larger than those on sour orange; the increase growth of pink-red grapefruit trees was 33 percent and for oranges 15 percent. The yield of fruit on sour orange rootstock was higher by 20 percent than on Cleopatra mandarin, even though the trees were smaller. This increase in yield was 16 percent for pink-red grapefruit and 36 percent for oranges.

Soil fumigation increased fruit yield for the 3-year period, 1959-61, by about 20 percent. The increase resulting from fumigation with ethylene dibromide for pink-red grapefruit was 35 percent on Cleopatra mandarin rootstock and 20 per cent for sour orange. For the same period, the increase in yield of oranges was 5 percent on Cleopatra mandarin rootstock and 21 percent on sour orange. The total average yield was considerably less for the orange trees than for the grapefruit (Table 1).

NEMAGON AND D-D SOIL FUMIGATION

PROCEDURE

Soil fumigants, nemagon at 275 pounds per acre and D-D at 400, 800 and 1200 pounds per acre, were applied in November 1954 in an old grove site in which citrus trees 20 years and older had been removed about 12 months earlier. The fumigants were applied with a pressure applicator at a depth of 10 inches, 12 inches between injectors in a 24-foot wide strip in 27-foot wide permanent borders. The experimental layout consisted of 4 randomized blocks, 4 fumigation treatments and control and two subtreatments, red and white grapefruit on Cleopatra mandarin rootstock. A fumigated plot consisted of an entire border 378 feet long, which was split into 2 subplots of 7 red and 7 white grapefruit trees. The grove was planted on April 16, 1956 with a total of 280 trees.

The test grove was cared for in the usual manner. Irrigation water was applied as needed. Non-tillage cultural practices were followed. The weed growth was kept down by use of a tractor drawn rotary weed cutter. Nitrogen fertilizer was applied as needed. Good to excellent

Table 2. Effect of soil fumigants on growth of 5-year-old citrus replants.

	Average cross-ectional area of stem in square inches[1]							
	Red Grapefruit				*White Grapefruit*			
Treatments	*1-yr*	*3-yrs*	*4-yrs*	*5-yrs*	*1-yr*	*3-yrs*	*4-yrs*	*5-yrs*
Control	1.6	5.0	11.4	15.7	1.6	5.7	13.2	17.4
Nemagon 275 lbs./a.	1.4	5.2	12.2	16.5	1.7	5.9	13.1	19.9
D-D 400 lbs./a.	1.3	4.9	12.2	16.8	1.7	6.0	13.7	18.7
D-D 800 lbs./a.	1.3	5.4	12.7	18.0	1.7	5.5	14.5	18.8
D-D 1200 lbs./a.	1.4	5.1	12.1	16.6	1.9	7.1	15.2	19.8

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[1] Average tree growth based on 28 trees.

growth occurred throughout the grove. Periodic growth measurements of the trunk were taken and fruit harvested in January.

RESULTS

All soil fumigation treatments increased tree growth in both the red and white 5-year-old grapefruit over the control by 1961 (Table 2). This increase ranged from 7 percent for 400 lbs./a D-D to 14.6 percent for 800 lbs./a D-D for red grapefruit. The increase in growth, cross-sectional area of trunk for both red and white grapefruit was approximately the same, however, in some treatments the white grapefruit trees were larger than the red after 5 years' growth. As a group, 140 trees in each, the white grapefruit trees were 13 percent larger than the red grapefruit trees after 5 years' growth.

There was a slight but consistent increase in yield of fruit from the trees growing in fumigated soil over the controls (Table 3). The yields for the 3-year period 1959-61 are given in Table 3 and range from an increase of 5.6 percent for 1200 lbs./a D-D to 26.3 percent for 400 lbs./a D-D both in red grapefruit. However, the yield of white grapefruit for the same period was larger than for the red receiving the same treatments. The total yield of white grapefruit was 40 percent greater than for the red grapefruit.

Table 3. Effect of soil fumigant treatments on yield of young citrus replants for a three-year period.

	Age and average yield per tree in pounds[1]							
	Red Grapefruit				*White Grapefruit*			
Treatments	*3-yrs*	*4-yrs*	*5-yrs*	*Total*	*3-yrs*	*4-yrs*	*5-yrs*	*Total*
Control	26	79	74	179	31	110	111	252
Nemagon 275 lbs./a.	12	106	80	198	31	150	97	278
D-D 400 lbs./a.	15	103	107	226	29	124	116	269
D-D 800 lbs./a.	10	98	88	196	36	137	109	282
D-D 1200 lbs./a.	9	113	67	189	45	167	97	309

[1] Yield based on average of 28 trees.

DISCUSSION

The increased growth and yield of citrus replants obtained in the two soil fumigant tests are in agreement with the results reported for California (Baines 1956, 1959). This improvement in growth and yield tends to confirm the citrus growers observations that a citrus replant problem exists in the Lower Rio Grande Valley; that replants do not grow as well as first planted trees. Since commercial nematocides were used, their effectiveness is considered to have resulted from reducing the citrus nematode population. This would indicate that the citrus nematode is primarily responsible for the citrus replant problem. However, it is realized that other factors (Baines, 1959, 1960) may be important as other pathogenic soil organisms, accumulation of toxic materials, both organic and inorganic, as well as a nutritional deficiency.

The increased growth and yield from citrus replants that might be expected to result from soil fumigation undoubtedly depends upon more than one condition or factor. The citrus nematode population would be expected to vary with age of grove and manner of infection. The replant problem would be expected to be less serious following the removal of a young citrus grove, 10 years-old or under, than where a 30-year-old grove or older was removed, unless heavily infected nursery trees had been planted. Soil conditions, as texture and structure and permeability might be expected to be less favorable in an old grove site for growth of citrus replants than in an entirely new location.

The data in Tables 1, 2 and 3 do not cover a sufficient period of time to fully evaluate the economics of soil fumigation. Unfortunately these tests have had to be terminated or greatly curtailed because of the severe freeze of January 1962 and in case of the older grove because of highway improvements. Since treating the entire soil area requires large quantities of soil fumigant per acre and is comparatively expensive, less expensive methods have met with some success, as spot treatment or applying light dosages to living trees (Baines et al 1959, Baines et al 1960, Reynolds 1958).

The effectiveness of fumigating the planting site before replanting is considerably reduced if nursery infected trees are used. Since balled citrus trees are generally used in the Lower Rio Grande Valley, it is a comparatively easy matter to infest the new grove or reinfest a treated planting site if such trees come from a nursery infested with citrus nematodes. If nursery trees were grown in a nematode free site it would be most helpful in coping with the citrus replant problem.

SUMMARY

Both tree growth and fruit yield of citrus replants were increased by treating the soil with certain nematocides following the removal of 20 to 25-year-old citrus trees. In one test, 9-year-old citrus trees growing in soil, which had been treated with ethylene dibromide at 350 pounds per acre the growth of pink-red grapefruit trees was increased 27 percent and the yield of fruit 20 percent; growth of orange trees was increased 10 percent and yield of fruit 13 per cent. In a second test of replanted grapefruit trees after 5 years' growth, nemagon (1,2-dibromo-3-chloropropane) at 275 pounds per acre increased tree growth 10 percent and fruit yield 10 percent; D-D (1-3-dichloropropene and 1,3-dichloropropane) at 400 pounds per acre increased tree growth 7 percent and fruit yield 15 percent; D-D at 800 pounds per acre increased tree growth 11 percent and fruit yield 11 per cent; D-D at 1200 pounds per acre increased tree growth 10 percent and yield 15 per cent.

ACKNOWLEDGEMENT

The chemicals used in the soil fumigant tests were furnished through the courtesy of The Dow Chemical Company and the Shell Chemical Corporation. Their aid and assistance is gratefully acknowledged.

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Fertilizing Red Grapefruit and Valencia Oranges on Willacy Fine Sandy Loam

Amon D. Dacus and A. V. Shull[1]

INTRODUCTION

A large number of fertilizer studies with citrus have been initiated in the citrus growing areas of the Valley, and except for freezes which interrupted many of these tests, our background of information on the subject would be much more complete. Several formulas based either on production or age of the trees have been proposed for determining the rate of fertilization for a grove.

These studies were interrupted by the January 1962 freeze, and tree damage is such that the groves will not be suitable for continuation. It is hoped that the data obtained prior to the freeze and reported here will be helpful in formulating fertilizer recommendations for groves of comparable age or similar sites.

MATERIALS AND METHODS

Red Grapefruit: The grapefruit experimental area was located approximately one mile north of Delta Lake on soil classified as Willacy fine sandy loam. The trees were set in November, 1953 on 20 feet x 27 feet spacing.

Valencia Oranges: The orange test was also located about a mile north of Delta Lake on a similar soil, except that the site had been leveled just prior to setting the trees. The trees were set in March, 1955, on 15 feet x 27 feet spacing.

In each case, the randomized block experimental design was used. Five and four replications were supplied for the grapefruit and orange tests respectively.

The treatment materials were applied broadcast in February or March over the entire plot of six trees in the case of the grapefruit, and eight trees in the case of the oranges. The materials were disced into the soil in the process of maintaining clean cultivation. Flood type of irrigation was used. Yield data were obtained from two grapefruit trees and three orange trees. Border trees inside the plantings were shared except in the oranges where the treatment trees were separated by two trees in the rows having a tree spacing of 15 feet.

Yield were determined in 1959 and 1960 by determining the average weight of a box of fruit and computing the acre yield from the number of boxes of fruit produced. In 1961 and 1962, the fruit produced by each plot was weighed.

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[1] Head Research and Citrus Production Departments, respectively, Rio Farms, Inc., Edcouch, Texas.

RESULTS AND DISCUSSION

Both manure and nitrogen as ammonium nitrate increased yield of red grapefruit in 1961 and 1962 (Table 1). Yield differences were slight and not significant in the first two years of the test. The phosphate, potash, and minor elements of treatment 7 had no effect upon yield. No rate of nitrogen produced yields equal to that from manure, and yields decreased with increasing rates of nitrogen in 1962. This would seem to indicate that for trees of that age, even the one-pound-per-tree rate of nitrogen was excessive. This was the reverse of the trend in 1961 when yields increased with increasing nitrogen levels up to the one and one-half pounds per tree.

Table 1. Yield of red grapefruit (tons/acre).

	Yield of red grapefruit in tons/acre			
Treatment	*1959*	*1960*	*1961*	*1962*[*]
1. Check	7.8	9.3	14.1	8.1
2. Manure 5 T/A/Yr	8.6	9.9	17.1	14.6
3. Manure 10T/A/Yr	8.6	10.6	18.6	14.5
4. ½ Lb N/Tree/Yr	9.0	9.7	16.8	12.2
5. 1 Lb N/Tree/Yr	8.1	8.6	17.4	11.3
6. 1½ Lb N/Tree/Yr	9.2	8.6	18.0	9.8
7. 500 Lbs/A 5-10-10 with trace elements[**] plus N to equal No. "5"	7.7	9.1	17.4	11.9
Co-efficient of variation	25%	23%	9%	17%
L.S.D. (.05)	NS	NS	1.2	1.4

[*] In 1962 N levels were increased to 1, 2, and 3 Lbs/Tree on treatments 4, 5, and 6, respectively, and to 2 lbs/Tree on treatment "7".

[**] A commercially available mixed fertilizer containing small amounts of trace elements.

The yields of Valencia oranges show no significant difference due to fertilizer treatment. Both soil and tree variations probably tended to obscure any real difference due to treatment (Table 2). Acid and brix were determined on samples of fruit obtained four days following the January, 1962 freeze. These data seem to indicate that nitrogen resulted in fruit with higher acid and lower brix, whereas, manure applications resulted in similar acid levels, but lowered the brix quite a bit when compared with fruit from the check plots (Table 3).

Table 2. Yield of Valencia oranges (tons/acre).

	Yield of Valencia oranges in tons per acre		
Treatment	*1960*	*1961*	*1962*
1. Check	3.2	4.7	5.7
2. Manure 5T/A/Yr	3.3	6.6	5.1
3. Manure 10T/A/Yr	3.6	6.8	7.9
4. ½ Lb N/Tree/Yr	3.6	6.6	6.0
5. 1 Lb N/Tree/Yr	3.6	7.1	6.7
6. 1½ Lb N/Tree/Yr	3.5	6.6	5.8
7. 500 Lbs/ A5-10-10 with minor elements plus N to equal No. "5"	4.2	6.9	5.2

Table 3. Analysis of Valencia orange juice–1962.

Treatment	*Brix*	*Acid*	*B/A*
1.	11.3	.92	12.3
3.	10.8	.89	12.1
6.	10.9	1.17	9.3

Changes in Cost of Packing Grapefruit: 1950-51 Season Versus 1959-60 Season

H. B. SORENSON[1]

Changes occurring in a decade can be so gradual that they are hardly noticed or remembered. The Texas citrus industry had a number of changes reflected in packing costs during the fifties. Changes occurred in the size of the container from a 1 3/5 bruce box to a 1 2/5 bruce box and the hourly wage rate which increased from 75 cents to $1 per hour. Currently, this rate has increased to $1.15 per hour. There was a change in the method of payment for packing, from hourly to piece rate. The volume of fruit handled per firm varied but increased during the period. Also, the type of transportation and loading pattern changed.

The purposes of this study were to point up changes in the packing of grapefruit and determine their effects on the cost of packing citrus in Texas.

The operations performed at the citrus packing house by fresh grapefruit shippers include degreening, dumping, washing, drying, waxing, grading, sizing, packing and loading. In the degreening process, if needed, the fruit is placed in gas-tight coloring rooms upon arrival at the packing house and these rooms are filled with ethylene gas for several hours until the green pigment has been removed. The fruit is then moved to the washing and waxing operations. From this point the fruit is moved over grading belts where fruits having disqualifying characteristics of size, shape or blemishes are removed and the market grades are separated before the identifying stamp is placed on the grapefruit. The fruit is passed through the sizing machinery and onto conveyors that drop the fruit into the packing bins; the fruit is then hand-packed into the proper container.

Filled boxes normally move out of the packing area on a belt or roller conveyor to a point where the lid is fastened. From there, the fruit moves by hand or fork-lift truck to storage on the truck or rail car in which it is shipped.

DISTRIBUTION OF GRAPEFRUIT

Distribution of Use of All Citrus

The State's grapefruit production was reported at 7,500,000 boxes in 1950-51 and 5,800,000 boxes in 1959-60. The production dropped to 200,000 boxes for the 1951-52 season due to the freeze in January 1951, then gained steadily up to the 1959-60 season.

A considerably larger proportion of the 1959-60 season total citrus production was packed for fresh market than of the 1950-51 season production, Table 1. During the early fifties about 58 percent of the total citrus production was packed as fresh fruit and for the 1959-60 season about 76 percent of the fruit was packed for the fresh market. More of the total fruit was handled by the packing plants in the 1959-60 season when only 2 percent of the fruit was moved directly from the grove to the cannery. During the 1950-51 season 23 percent of the fruit was moved directly from the grove to the cannery. Thus, the fact that 98 percent of the 1959-60 season crop was handled by the packing plants would help to explain some of the increase in per unit cost of certain packing operations.

Containers

There was a significant change in the type of containers used to pack and ship fresh grapefruit from the Lower Rio Grande Valley during the fifties. During the 1950-51 season the predominant container was the 1 3/5 bruce box. However, use of this container was discontinued during this period, Table 2.

Table 1. Use of all citrus fruit harvested, 1950-51 and 1959-60 seasons.

Type of use	*Season*	
	1950-51	*1959-60*
	——— *Percent* ———	
Total packed fresh	58.0	75.7
House to cannery	19.0	22.0
Grove to cannery	23.0	2.3
Total	100.0	100.0

Table 2. Distribution of major containers for grapefruit, 1950-51 and 1959-60 seasons.

Type of container	*Season*	
	1950-51	*1959-60*
	——— *Percent* ———	
1 3/5 bruce box	82.2	
1 2/5 bruce box		1.5
4/5 bruce box	....[1]	5.3
5-pound bag	4.9	17.7
8-pound bag	7.0	1.0
20-pound bag	0.1	4.5
40-pound, ½-box container		62.6
Master container—bulk		6.4
Other containers	5.8[2]	1.0[3]
Total[4]	100.0	100.0

[1] .02 percent
[2] 8 other containers.
[3] 14 other containers.
[4] All containers converted to 1 3/5 bruce box size for 1950-51 season and 1 2/5 box size for 1959-60 season.

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[1] Marketing Specialist, Texas Agricultural Experiment Station, College Station.

The 1 2/5 bruce box replaced the larger 1 3/5 bruce box but comprised less than 2 percent of the 1959-60 shipments. The 40-pound, one-half box fiberboard container is currently the favorite with about 63 percent of the volume being packed in this container.

There has been significant increase in the proportion of the crop packed in the 5-pound bag. Eight other containers were used in the 1950-51 packing season, but together they represented less than 6 percent of the volume. A number of these containers were discontinued and were replaced by others; 14 additional containers were listed as being used in the 1959-60 packing season but represented only 1.0 percent of the volume packed.

Use of a large number of different containers, some of which are used sporadically, causes some confusion. Lack of uniformity in the unit of shipment and unit of billing especially increase the difficulty and cost of record keeping by members of the industry. Increases in record keeping costs affect both shippers and receivers. If fewer types of approved containers were used, fewer containers would need to be carried on the inventories.

GRAPEFRUIT PACKING COSTS

Costs and efficiency of handling citrus have become of increasing importance to the grower and shipper. Increases in total U. S. production of citrus has resulted in lower prices; however, costs have increased and materials and transportation have narrowed margins.

Cost information was obtained from packing houses operating in the Lower Rio Grande Valley. The 1950-51 costs were reported in the Texas Agricultural Experiment Station Progress Report 1485 and the 1959-60 costs were obtained from packing house operators during the marketing season, Figure 1. The packing costs are shown by major items of expense.

Items of Cost

Materials:	Crate material; bags; fruit wraps; nails; strips and straps; labels and paste; and end guards.
Labor:	(a) Piece rate operation for packing of fruit parable to wrap and pack for 1950-51 season. (b) Other labor—receive; truck and dump; crate making and labeling; foreman; grader and others; truck, check and load; and payroll taxes. Payroll taxes include both social security and compensation insurance.
Other Direct Costs:	The cost of power, lights and water; repair of buildings and equipment; miscellaneous supplies.
Other Operational Charges and Expenses:	Gas coloring and wax; precooling; and inspection.
Indirect Operating Expenses:	Insurance; taxes; licenses; and depreciation.
Administrative and Selling:	Management and office salaries; office supplies and expenses; auto and travel; telephone and telegraph; miscellaneous office expense; sales department cost or charge for selling. Selling cost does not include brokerage or any terminal market charges.

Labor Wage Rates

There was a tremendous change in the wage scale in the Texas citrus area during the fifties. Early in the decade, the hourly wage was generally less than 50 cents per hour. The federal wage hourly law, affecting agricultural products which were entirely interstate shipments, became effective in 1949. This contributed materially to increase labor costs in the packing of citrus fruit. This wage rate increased to $1 per hour in 1956. This also materially affected the cost of packing citrus during the 1959-60 season. Increase in the hourly wage rate is a big expense item. The federal rate per hour was raised to $1.15 in 1961 and will be $1.25 per hour by September 3, 1963.

During the 1950-51 season, the use of piece rate for packing fruit was not fully established. The hourly wage rate and capacity ratio for packing fruit was used for determining packing costs in some plants. By 1959-60, piece rate packing was used by the entire industry.

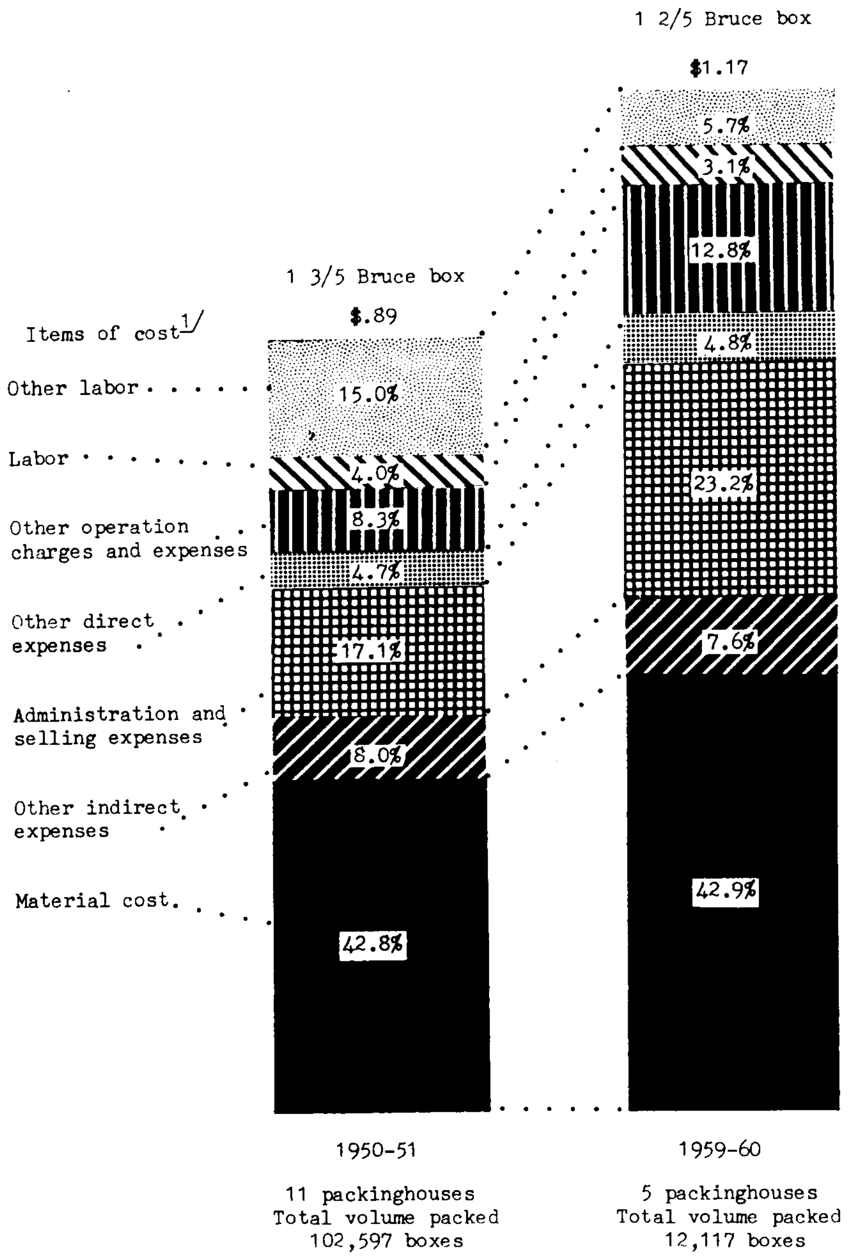
Packing Cost Comparisons

Both the volume of fruit handled and the number of packing houses varied for the two comparative seasons. This could account for some of the variation in cost of packing.

The over-all increase in the cost of packing a 1 2/5 bruce box in 1959-60 compared to the 1 3/5 bruce box in 1950-51 was approximately 16 per cent, 89 cents to $1.17. Material costs increased about 12 cents per box, or about 23.5 percent, while the proportion of the total costs remained about the same.

Administrative and selling expenses increased from 17.1 percent to 23.2 percent of the proportion of the total cost of packing. This increase amounts to about 12 cents per box or a 43.8 percent increase for the operation. Increased administrative and selling expenses reflect an increased need for office help to keep books and records required for tax records, wage and hour regulations, inspection and numerous other records.

Total labor costs per unit were the only expense that showed a marked decrease. With an increase in wages, operations were closely watched and labor-saving devices were installed. Some labor-saving



[1] Refer to explanation in text.

Figure 1. Comparative cost of packing Texas grapefruit, 1950-51 vs. 1959-60 seasons

devices installed by some plants included bulk handling; use of fork-lift trucks to haul palleted boxes; using large 1,000-2,000 pound field boxes; using telescoped cartons; packing on orders; and loading trucks for shipment that day.

Transportation

Truck shipments in the 1959-60 season represented about 97 percent of the total movement of citrus. Packing on orders gave the opportunity for more efficient use of labor and equipment by utilizing a more continuous running operation and reducing the amount of long overtime hours. This phase of the operation partly eliminated the necessity of having to repack some of the fruit that had been packed previously.

SUMMARY

To have completely valid cost comparisons, a number of factors would need to be the same such as number of packing houses, volume of fruit packed and same size of container. All these were not the same, but some ideas as to changes may be obtained.

Approximately 75 percent of the fruit in 1959-60 was suitable for packing for the fresh market. During the fifties, the industry changed the size of the standard size container from 1 3/5 bruce box to 1 2/5 bruce box but did not accept it as the container. The most popular container is the 40-pound, one-half box fiberboard container. The 1 2/5 bruce box represented less than 2 percent of the 1959-60 shipments.

The over-all increase in the cost of packing a 1 3/5 bruce box in 1950-51 as compared to the 1 2/5 bruce box in 1959-60 was approximately 16 per cent. Some of the cost items are a) materials increased 23.5 percent; b) administrative and selling expenses increased 43.8 percent; and c) total labor costs per unit were the only expenses that showed a marked decrease.

Changes in Production and Marketing of Texas Citrus[1]

E. E. "GENE" WINN[2]

Citrus in the Rio Grande Valley has been increasing in value as a Valley industry since its early days in 1919-20. The USDA reported the value of the 1960-61 crop at over $16,000,000.

During this period, 1919-1961, there have been many heartaches and reverses as well as profitable and encouraging years.

Through trial and error there have been many changes and improvements in different phases of the industry.

There have been changes in rootstocks and varieties in an effort to find those that are most compatible with our soil, water and climate. This change is still going on and improved varieties are being developed by the Experiment Station and nurserymen in our Valley.

Cultural practices are different now than in the early days of the industry. Changes have been made in cultivation methods; fertilizer requirements are based on more scientific studies, and much experimental work has been done to determine the best tree spacing. Volume production per acre becomes more important as land values and cultural costs increase.

Many improvements have been made in equipment for citrus farming. New soil-tillage implements are being developed and also many changes have been made in methods of applying pest-control materials.

Production of citrus in the Valley during the 1920's increased from 10,000 boxes to over 1,800,000 boxes for the 1929-30 season. In the early 30's production increased with the exception of the year of the hurricane. Beginning with the 1936-37 season there was a gradual increase in production until it reached a volume of over 28,000,000 boxes during the three seasons of 1945-46, 1946-47 and 1947-48.

The freeze during the winter of 1948-49 drastically reduced the production of fruit for two seasons and then the disastrous freeze of 1951 almost completely destroyed both the crop and the trees. Very few trees survived the severe cold of 1951.

During the 30-year period from 1920 to 1950 many farmers had seen the great potential and possibilities of citrus production in the Valley and began immediately to rebuild the industry. Citrus nurseries made plans to meet the increased demand for trees. During the years between 1951 and 1962 many new groves were planted and production increased gradually, reaching the 10,000,000 box mark in the 1960-61 season. An average of 400,000 trees per year were planted during the seasons of 1959-1960 and 1961.

One important feature in the history of our industry has been the changing trends in the variety of fruit grown. For many years, in fact, until the late 40's, the predominant varieties were the Duncan and Marsh Seedless varieties of grapefruit with the White Marsh as the leading variety.

A new grapefruit was discovered about 1930 and its popularity grew to the extent that 90% of new plantings during the early 50's were of this variety. This new variety was our Ruby Red grapefruit. The eating quality of the fruit is unsurpassed by any grapefruit grown in the United States.

Heavy production of this one variety in recent years created a marketing problem. Without a planned and controlled marketing program it became evident that a more diversified planting of citrus was necessary. A definite trend to a higher percentage of orange plantings began in the late 50's, by 1959 plantings were equally divided between oranges and grapefruit and in 1960 and 1961 orange plantings outnumbered grapefruit.

Another factor brought about some of these changes in citrus plantings. This was the increased demand for canned citrus juices, especially frozen orange juice. For many years a high percentage of the orange production in the Valley was sold in fresh form. The early varieties of oranges were popular to fill this demand. When consumers became more conscious of quality, and trends changed to canned juices, it became necessary to change varieties of orange production to meet these new demands. The late orange (Valencia) began to be planted in increasing numbers. At present the orange planting is about equally divided between early and late varieties.

While these changes in citrus production were taking place there were also changes being made in handling and processing fruit. Many improvements have been introduced in the packing and shipping of fresh fruit. Oranges and grapefruit can be handled more efficiently between grower and consumer than in previous years, thereby assuring the buying public of a fresher and finer fruit.

Facilities for handling citrus not shipped in fresh form have been inadequate in the Valley. The Texas canners have done a fine job and have been invaluable to the industry but we needed new outlets and new products. This need was partially met during the past season when three new processing facilities were installed for making concentrated juice. These together with the one already operating would have been sufficient to handle our citrus volume for many years. The freeze of 1962, however, will curtail capacity operations of these plants for several years.

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[1] A portion of a talk given April 26, 1962 before monthly meeting of the Rio Grande Horticultural Society.

[2] Manager, Texas Citrus Mutual, Weslaco.

Citrus growers and shippers have seen the need for other organizations to help stabilize our industry and make it more profitable. The shippers formed Texa-Sweet Citrus Incorporated and started an advertising program along with other activities. Growers are now cooperating in this promotional effort and the 1961-62 season was to launch a quarter million dollar advertising plan that would aid in a profitable distribution of our citrus.

The growers and shippers together have a marketing agreement to regulate sizes and grades of fruit shipped in fresh channels. Other duties of this organization are to standardize shipping containers and furnish statistical information that will guide growers and shippers in moving the entire crop in an orderly fashion.

Another organization was chartered in 1958 for the purpose of serving the industry and especially the grower. Many are the duties of this group, the Texas Citrus Mutual. Information pertaining to the growing, harvesting and selling of citrus can be relayed to the grower through this organization. Research, legislation, both federal and state, labor problems, experimental work, export and import regulations; all those fall within the scope of Mutual's activities. Two of the most important phases of our industry are now being considered by Texas Citrus Mutual. These are an improved advertising program and a marketing agency to stabilize prices.

Citrus fruit has been handled basically by three types of organizations: cash buyers, independent handlers on consignment and cooperatives. There is a need for all three types of operations to satisfy grower demands. All harvesting, packing, and selling is done by these groups at present. These three types of shippers should now be cooperating in an effort to sell the fruit at prices that will return a fair profit to those with investments in the industry. In recent years each shipper has maintained a sales force and operated independently of any other shipper or group. As a result of the freeze in January, production will be small for two or three years and marketing should not be a particular problem. However, now is the time to put into operation those agencies that will be needed when a volume is produced in our Magic Valley. Agencies now in existence should be maintained so that only quality fruit will be shipped. Establishing a reputation for quality should be started now, not after production becomes a problem.

Through the efforts of several agencies in the Valley we now have improved weather service for our growers. This will benefit all farming, not just our citrus.

Many of our Valley organizations are working together to control our ever-increasing pest problem. Research work is being done on materials and methods of application. Also new parasites are being introduced to help keep certain pests under control.

In many areas of the Valley our citrus groves are recovering rapidly from the serious freeze of January. Pruning operations are continuing on a large scale. Nurserymen are working to produce trees to meet the great demand and will have some trees available in November and December of this year. Thousands more will be ready to plant by spring of 1963 and there should be ample supplies of all varieties by fall of 1963.

Although these new plantings will not be in production for several years we can expect a fast recovery of the older trees and a steady increase in volume of fruit from the five million trees that are being pruned. Estimates of production for the next year or two vary considerably and accurate figures will not be available for several months. The general opinion is that we will reach a 10-million-box crop again in possibly six years.

During these intervening years it behooves everyone in our industry to cooperate and make citrus one of the most important crops in the Valley.

By comparison with other producing areas of the United States, we are in an enviable position. Our land values are much lower than available citrus land in other states. Cost of production in the Rio Grande Valley is less than in our competitive states. The quality of most of our fruit is comparable to any produced and some varieties grown here are superior to any other in any area. With these favorable conditions it remaines for all facets of our industry to work for improved marketing and distribution of our citrus.

Strict quality control of fruit shipped from our Valley during the recovery period will give our growers the returns that will justify an expanding industry.

Seasonal Variation in Texas Hamlin and Marrs Orange Juice, 1961-62

Bruce J. Lime and Donald M. Tucker[1]

Interest in the processing characteristics of oranges grown in the citrus-producing area of Texas has increased during the past several years. Citrus replantings immediately after the 1951 freeze were approximately 80% grapefruit and 20% oranges. Each year more oranges have been planted and a survey of nursery stock last year (Anonymous, 1961) indicated more orange than grapefruit trees in the nurseries. This increase in orange plantings is partly responsible for the installation this season of three concentrate plants for the production of frozen citrus concentrates. To meet the anticipated requirements of shippers of fresh fruit and processors of single strength and frozen citrus concentrates, industry leaders have recommended that growers should plan for a balanced citrus industry by planting one-third grapefruit trees, one-third Valencia orange trees, and not more than one-third early orange trees.

Texas produced approximately 3.5 million boxes of oranges during the 1960-61 season, one-half of which were fruit from early varieties. When utilized in processed products, the juice from the early varieties is best suited for blending operations in the manufacture of frozen concentrate and other orange juice products. The juice from the early varieties is lighter in color and lower in sugar and acid content than the late season Valencia orange. The Valencia orange is generally accepted as having the most desirable processing characteristics. In a previous publication, Lime and Tucker (1961) have reported on effects of seasonal variation on the maturity of Texas Valencia oranges for the 1960-61 season. The amount of juice that can be used in the blending operations depends upon the processing characteristics of the oranges. This report lists the variation in juice yield, acid, Brix, visual color and solids content of Hamlin and Marrs early oranges for approximately a three-month period during the 1961-62 Texas season.

METHODS

Hamlin and Marrs oranges were harvested at weekly intervals from two locations. A grove near Mission[2], Texas, was the source of one series of fruit samples for both varieties, and another near Monte Alto[2], Texas, was the source of the other samples for both varieties. Trees in these groves were planted since the freeze of 1951 (were approximately 7 years old) and are representative of the bearing trees of the areas in which they are planted. Six trees in each grove were set aside for this study. Each sample consisted of 5 fruit from each of the 6 trees. The fruit were picked from inside and outside locations at eye level around the perimeter of the trees. The samples were brought to the laboratory and held at 40° F. until analyzed. The fruit was never held longer than 48 hours before analysis. The fruit composited in each sample were weighed, halved and the juice extracted by hand reaming with a Sunkist Juice Extractor[3]. Large pulp and pieces of rag were removed from the juice by gently working the juice through a 16-mesh stainless steel screen. The juice was weighed and the percent yield calculated, using the original weight of the fruit.

The acid content was determined by titration with standard sodium hydroxide and reported as anhydrous citric. The Brix was determined by direct reading with an "Abbe 56" refractometer[3]. Color notations were made by comparing the juice samples with color tubes of U. S. Department of Agriculture Color Standards for Orange Juice[4]. The tubes were numbered from 1 to 4, with No. 1 having the deepest orange color. The solids per 90-pound box and solids per ton were calculated from the juice yield and Brix reading of the juice. Vitamin C content of freeze damaged fruit was determined by the colorimetric method reported by Schmall, Pifer and Wollish (1953).

RESULTS AND DISCUSSION

Table 1 lists the results obtained from the Hamlin orange samples. The juice yield showed little variation throughout the season until the January 12 freeze. After the freeze the juice yield dropped sharply. The Brix values increased as the season progressed. Fruit from Pride O'Texas grove had higher Brix and acid values than Rio Farm fruit. The percent acid of the juice decreased during the season, with a sharp decrease noted after the freeze. The Brix to acid ratio increased during the season. The visual color rating never reached tube No. 4 until after the January 12 freeze. The calculated solids per box and ton increased as the Brix values increased.

Table 2 lists the results obtained from the Marrs samples. The juice yield varied little throughout the season but dropped after the January 12 freeze. The Brix increased during the season and the acid content slowly decreased until the freeze and then dropped sharply. The Brix to acid ratio increased as the Brix values increased and the acid values decreased. The visual color rating increased as the season progressed and was rated as tube No. 4 or better after November 14. The solids per box and ton increased as the Brix values increased.

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[1] Chemists, U. S. Fruit and Vegetable Products Laboratory, Southern Utilization Research and Development Division, Agricultural Research Service, United States Department of Agriculture, Weslaco, Texas.

[2] Fruit samples for this study were furnished by Pride O'Texas Citrus Association, Mission, Texas, and Rio Farms, Monte Alto, Texas.

[3] The mention of firm names or trade products does not imply that they are endorsed or recommended by the Department of Agriculture over other firms or smiliar products not mentioned.

[4] The U. S. Department of Agriculture Color Standards, Orange Juice, were furnished by the Fruit and Vegetable Division, Processed Products Inspection Branch, Agricultural Marketing Service, USDA.

Although the severe freeze of January 12 was unusual, the effect on fruit composition is of interest because of the large quantity of fruit which was salvaged by canning or concentration of juice. Temperatures dropped to 10-12° F. and both oranges and grapefruit were frozen solid. Results of analysis presented in Tables 1 and 2 show a sharp drop in juice yield and citric acid content after the freeze. Additional data on freeze damage fruit shows a decrease in vitamin C content of 34% in 7 days (1/12 to 1/19) for Marrs and a decrease of 40% in 11 days (1/12 to 1/23) for Hamlin. Valencia oranges were also analyzed after the freeze and during the same 11 day period decreased in juice yield from 58 to 44%, citric acid from 1.25 to 1.11% and vitamin C from 56 to 41 mg. percent, or approximately 27% decrease in vitamin C content.

Table 1. Seasonal Data on Juice of Hamlin Oranges, 1961-62.

Sampling Date	*Location*[a]	*Juice Yield %*	*Brix°*	*Acid %*	*B/A*	*Visual Color*[b]	*Solids per 90 lb. box*	*Solids per ton*
10/17	M.	54.1	9.0	0.82	11.0	4	4.38	97.4
10/24	M.	57.0	9.8	0.84	11.7	4	5.03	111.7
10/31	M.	55.7	10.0	0.68	14.7	4	5.01	111.4
11/7	M.	55.5	10.7	0.71	15.1	4	5.34	118.8
11/14	M.	55.4	10.2	0.67	15.2	4	5.09	113.0
11/21	M.	57.0	10.5	0.63	16.7	4	5.39	119.7
11/28	M.	56.0	10.3	0.68	15.1	4	5.19	115.4
12/6	M.	55.5	11.3	0.64	17.7	4	5.64	125.4
12/13	M.	56.3	10.9	0.64	17.0	4	5.53	122.8
12/19	M.	54.1	11.0	0.64	17.2	4	5.36	119.0
12/26	M.	55.6	11.7	0.63	18.6	4	5.85	130.1
1/2	M.	52.2	11.8	0.64	18.4	4	5.54	123.2
1/9	M.	53.9	11.8	0.63	18.7	4	5.72	127.2
10/17	M.A.	57.5	9.4	0.78	12.1	4	4.86	108.1
10/24	M.A.	56.0	9.3	0.77	12.1	4	4.69	104.2
10/31	M.A.	56.4	9.5	0.70	13.6	4	4.82	107.2
11/7	M.A.	56.2	9.7	0.72	13.5	4	4.90	109.0
11/14	M.A.	58.4	10.0	0.59	16.9	4	5.26	116.8
11/21	M.A.	57.9	9.5	0.56	17.0	4	4.95	110.0
11/28	M.A.	58.7	9.8	0.64	15.3	4	5.18	115.1
12/6	M.A.	50.8	10.3	0.50	20.6	4	4.71	104.6
12/13	M.A.	57.9	9.9	0.66	15.0	4	5.16	114.6
12/19	M.A.	56.8	10.2	0.56	18.2	4	5.21	115.9
12/26	M.A.	55.2	10.2	0.55	18.5	4	5.07	112.6
1/2	M.A.	58.8	10.2	0.61	16.7	4	5.40	120.0
1/9	M.A.	54.9	10.6	0.59	18.0	4	5.24	116.4
1/16*	M.A.	41.3	10.6	0.52	20.4	3-4	3.94	87.6
1/19	M.A.	41.1	10.2	0.50	20.4	4	3.77	83.8
1/23	M.A.	41.4	10.3	0.43	24.0	4	3.84	85.3

[a] Location: M., Pride O'Texas orchard, Mission, Texas.
M.A., Rio Farms orchards, Monte Alto, Texas.

[b] Visual Color: Number of tube matching sample. Color tubes were furnished by the Processed Products Inspection Branch, A.M.S., U.S.D.A.

* Samples after 1/12 were from fruit frozen on that date.

Table 2. Seasonal Data on Juice of Marrs Oranges, 1961-62.

Sampling Date	*Location*[a]	*Juice Yield %*	*Brix°*	*Acid %*	*B/A*	*Visual Color*[b]	*Solids per 90 lb. box*	*Solids per ton*
10/17	M.	55.8	10.0	0.72	13.9	4	5.02	111.6
10/24	M.	55.6	9.8	0.63	15.6	4	4.90	109.0
10/31	M.	58.2	10.0	0.66	15.2	4	5.24	116.4
11/7	M.	55.4	10.1	0.67	15.1	4	5.04	111.9
11/14	M.	57.3	10.6	0.62	17.1	4	5.47	121.5
11/21	M.	57.5	10.5	0.62	16.9	3-4	5.43	120.8
11/28	M.	58.6	10.5	0.65	16.2	3-4	5.55	123.3
12/6	M.	57.3	10.9	0.60	18.2	2-3	5.62	124.9
12/13	M.	58.5	10.9	0.63	17.3	2-3	5.63	125.2
12/19	M.	57.9	11.8	0.59	20.0	2-3	6.15	136.6
12/26	M.	56.6	11.8	0.60	19.7	2-3	6.01	133.6
1/2	M.	58.9	12.1	0.59	20.5	2-3	6.41	142.5
1/9	M.	56.1	12.4	0.64	19.4	2-3	6.26	139.1
10/17	M.A.	54.7	10.0	0.72	13.9	4	4.92	109.4
10/24	M.A.	56.5	10.2	0.65	15.7	4	5.19	115.3
10/31	M.A.	55.1	10.7	0.65	16.5	4	5.31	117.9
11/7	M.A.	53.8	11.5	0.61	18.9	4	5.57	123.7
11/14	M.A.	55.4	11.3	0.62	18.2	4	5.63	125.2
11/21	M.A.	55.5	11.0	0.65	16.9	3-4	5.49	122.1
11/28	M.A.	56.5	11.5	0.64	18.0	3-4	5.85	130.0
12/6	M.A.	54.8	11.5	0.58	19.8	2-3	5.67	126.0
12/13	M.A.	55.8	11.8	0.58	20.3	2-3	5.92	131.6
12/19	M.A.	52.7	11.6	0.55	21.1	2-3	5.50	122.3
12/26	M.A.	53.1	12.4	0.56	22.1	2-3	5.93	131.7
1/2	M.A.	50.7	12.0	0.60	20.0	2-3	5.48	121.7
1/9	M.A.	52.3	12.4	0.57	21.8	2-3	5.84	129.7
1/16*	M.A.	55.0	12.6	0.41	30.7	2-3	6.24	138.6
1/19	M.A.	40.7	11.1	0.36	30.8	2-3	4.07	90.4

[a] Location: M., Pride O'Texas orchard, Mission, Texas.
M.A., Rio Farms orchards, Monte Alto, Texas.

[b] Visual Color: Number of tube matching sample. Color tubes were furnished by the Processed Products Inspection Branch, A.M.S., U.S.D.A.

* Samples after 1/12 were from fruit frozen on that date.

SUMMARY AND CONCLUSIONS

The variation in juice quality of Texas grown Hamlin and Marrs oranges is reported. The low acid, Brix and color values noted for juice from Hamlin oranges indicates that a high quality juice product could be prepared from this variety only by blending a large quantity of juice from another variety such as Valencia. Although the data obtained from the juice from Marrs oranges shows higher Brix and color values, the low acid values would indicate that this variety should also be blended with a variety such as Valencia.

The juice yield, citric acid content, and ascorbic acid content of the oranges decreased rapidly after the January 12 freeze. Hamlin and Marrs, the more mature varieties on this date, showed the greatest loss, while Valencia, a later maturing variety, had the smallest percent of decrease.

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Cold Hardiness of Avocados During the January 1962 Freeze

Norman P. Maxwell[1]

During the freeze of January 9-12, 1962, 34 strains were growing in the avocado test nurseries at the Texas Agricultural Experiment Station near Weslaco, Texas. These strains were composed of three avocado races and their hybrids. Part of the avocado strains were named varieties from California and Florida, and part were selections made in Texas and Mexico. All of the strains were being tested for their adaptability to the Valley.

Table 1 shows the number of hours the temperature was at or below 32° on the Texas Agricultural Experiment Station. Since the avocado test plot is within two hundred yards of the weather station, the avocado trees were subjected to about the same temperatures.

Table 1. Duration of freezing temperatures at the Texas Agricultural Experiment Station weather station near Weslaco, January 9-12, 1962.

Temperature	*No. of hours below indicated temperature*
32°	65.0
31°	57.0
30°	54.5
29°	51.0
28°	40.0
27°	30.0
26°	22.0
25°	16.0
24°	8.5
23°	8.2
22°	8.0
21°	7.0
20°	7.0
19°	4.0
18°	4.0
17°	0.7
16°	0.5

A record was made on degree of freeze injury of each strain in the plot and on the status of growth at the time of the freeze. Table 2 gives the freeze injury information on the various strains represented in the test plot.

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[1] Associate Horticulturist, Texas Agricultural Experiment Station 15, Weslaco.

Table 2. Cold injury to avocado trees in Experiment Station test plot four months after freeze of January 9-12, 1962.

Strain	*Avocado race*	*Age of tree in years*	*Growth status at time of freeze*	*Amount of cold injury*[1]
Zutano	Mex. x Guat.	3	Blooming	5
Chapeno	Mex.	6	Blooming	3
14/8	Mex.	9	Blooming	4
Hart Seedling	W.I.	2	Dormant	5
Santa Engracia	W.I. x Mex.	12	Blooming	3
McRill	W.I.	12	Dormant	5
Hannam	Mex.	12	Blooming	1
Haven	Mex.	12	Blooming	1
Lula	W.I. x Guat.	12	Dormant	5
Booth 7	Guat.	12	Dormant	5
7/2	Mex.	11	Blooming	2
Prior Seedling	Mex.	7	Blooming	1
14382	Mex.	12	Blooming	2
Austin	Mex.	4	Blooming	5
J-12	Mex.	1	Dormant	5
14369	Guat.	12	Dormant	5
1/18	Mex. x W.I.	11	Blooming	1
Hass	Guat.	4	Growing—no bloom	5
Castro 2	Mex.	11	Blooming	2
R #1	Mex.	11	Dormant	2
Amidon	Mex.	8	Blooming	3
Alanis 3	Mex.	11	Blooming	2
W #1	Mex.	11	Blooming	1
Paz #4	Mex.	8	Blooming	2
29/9	Mex. x W.I.	9	Blooming	4
10/2	Mex.	9	Blooming	2
Paz #3	Mex.	8	Blooming	3
Pancho	Mex.	6	Blooming	2
5/2	Mex.	8	Blooming	4
San Juaneno	Mex.	4	Blooming	5
Chamano	Mex.	6	Blooming	3
Gonzales	Mex.	6	Blooming	4
Molina	Mex.	6	Blooming	4
Garza	Mex.	6	Blooming	4

[1] Legend
1. Secondary wood frozen, main framework limbs alive.
2. Main framework limbs dead halfway to crotch of the tree.
3. Main framework limbs dead to just above crotch of tree.
4. Top completely dead, tree alive just below crotch of the tree.
5. Tree dead to the soil bank or ground if unbanked.

All strains of West Indian, Guatemalan, and hybrids between the two races were killed to the soil banks. Trees of the Mexican race and some of the Mexican hybrids showed a wide range of cold tolerance; some showed only secondary wood damage, others were frozen back to the soil bank. Within the Mexican race, trees up to six years of age were less cold tolerant than trees over six years of age. At the time of the freeze, most of the Mexican-race trees were in bloom, which should have caused the trees to be fairly cold tender. This indicates that the degree of dormancy has less effect upon the hardiness of avocados than with many other plants.

An examination of the avocado test plot in May showed that all of the strains except two were alive above the bud union. Most of the trees have made three feet or more growth since the freeze and probably will produce fruit in 1963.

VEGETABLE AND ORNAMENTAL SECTION

Chemical Weed Control in Vegetables Grown in the Lower Rio Grande Valley of Texas[1]

ROBERT M. MENGES[2]

Losses from weeds on United States farms are estimated at 4 billion dollars annually. They equal the combined losses from insects and diseases and are overshadowed only by losses from soil erosion. Losses caused by weeds are assessed on the basis of (1) the cost of control, (2) the loss of crop yield and quality due directly to weed competition and indirectly to the harboring of insects and diseases, (3) harvesting difficulties, and (4) damage to soil structure and other properties by repeated cultivation.

Improvement in tillage equipment was probably the first significant development in weed control that offered some relief from hand-weeding. Motor-powered equipment decreased weed problems by allowing rapid cultivation of fields in optimum weather. The use of quality seed, proper fertilization, crop rotation, and pre-planting irrigation are management practices which should supplement tillage and chemicals for weed control. In spite of improved tillage and management practices, weeds in the row areas of cultivated crops still require attention. The use of herbicides, or chemical weed-killers, has netted significant return in these row areas.

The use of chemicals to control weeds dates to the late 1800's. Herbicides then included copper and iron sulfate, sodium chloride, sulfuric acid, phenol, formaldehyde, and sodium arsenate. These and other contact herbicides including calcium and potassium cyanates, pentachlorophenol, and various petroleum fractions were used almost exclusively before discovery of the herbicide 2,4-dichlorophenoxyacetic acid [2,4-D] during World War II.

The obvious objective in weed control within cultivated crops is selectivity or weed control without injury to the crop. Since contact herbicides kill plant tissues close to the point of application, they must be well distributed on the foliage of weeds so that they will kill the growing points. To be selective, herbicide contact with the growing points of crop foliage must be prevented; this may be provided by spraying the weeds only in a pre-planting or pre-emergence treatment or by directing the contact spray to the weeds in a post-emergence treatment. Selectivity in post-emergence treatments may also depend on crop dormancy or differences in leaf surfaces, leaf arrangement, and location of the growing points of the weed and crop plant. The main advantage of the contact herbicide spray is that it is inexpensive. Dis-

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[1] Paper presented before the Sixteenth Annual Institute of the Rio Grande Valley Horticultural Society, January 23, 1962.

[2] Research Horticulturist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Weslaco, Texas.

advantages, however, are that it provides a relatively short period of weed control and perfect timing of the application is essential.

Most field recommendations for weed control utilize the newer, organic chemicals, many of which can remain active in the soil for extended periods and kill germinating weed seeds; such chemical treatments are termed "residual." A number of residual, pre-emergence treatments of herbicides successful in the North and East have repeatedly failed here in the Southwest because of vastly different soil environments. In the Southwest, high sunlight intensity, high soil temperatures, and high microorganism activity tend to decompose soil-applied herbicides rapidly. High winds sometimes carry off the surface layers of soil containing herbicides. Rainfall or overhead irrigation moves the surface-applied herbicide down to the zone of germinating weed seeds, but furrow irrigation does not. Consequently, most furrow-irrigated, pre-emergence treatments with herbicides have been unsatisfactory in the Southwest.

The performance of certain residual herbicides has been strikingly improved when soil surface applications are incorporated with the surface layers of soil before furrow irrigation. Although several herbicides perform well when incorporated with the surface 2 in. of soil, experiments are being conducted to determine the most efficient depth of incorporation for the control of specific weed species.

The estimated cost of weeds to the growers of vegetable crops in the United States is 240 million dollars yearly, or about 17% of the gross value. Several chemical families are being tested for pre- and post-emergence weed control in the vegetable crops, but the carbamate family has been especially fruitful. Included in this group are isopropyl *N*-(3-chlorophenyl)carbamate [CIPC], ethyl di-*n*-propylthiolcarbamate [EPTC], and 2-chloroallyl diethyldithiocarbamate [CDEC]. These herbicides are residual and are most effective when applied to the soil before weed emergence. They are volatile and the deposits are sometimes rapidly lost from the hot soils characteristic of Texas. Controlled volatility is desirable, however, since herbicide residues which might affect succeeding crops are greatly reduced. This inherent characteristic of volatility requires that Texas growers use higher rates of herbicides for weed control than used in the North.

For pre-emergence weed control in cabbage, lettuce, and spinach, 3 to 6 lb/A of CDEC can be applied in 40 gpa of water just after seeding and just before overhead or furrow irrigation. The higher rates should be used when temperatures are high, on heavier soils, or with furrow irrigation. CDEC will control a number of annual broadleaved weeds with furrow irrigation but will often fail to control annual grassy weeds which germinate deeper in soil.

For pre-emergence weed control in cantaloupe, cucumber, and watermelon, 4 to 6 lb/A of *N*-1-naphthylphthalamic acid [NPA, sodium salt] can be applied in 40 gpa of water just after seeding and just before irrigation. Weed control is superior when overhead irrigation is used.

CDEC at 3 to 6 lb/A is also effective in pre-emergence applications.

For pre- or post-emergence weed control in carrot and parsley, undiluted special light aromatic oils can be applied at 40 to 100 gpa to small weeds either before the crop plants emerge or after 2 true leaves form. Application should not be made later than 6 weeks before harvest to avoid off flavors in the marketable product. The aromatic oils are best applied in the evening when air movement is downward and relative humidity is high. Studies are being conducted to find residual herbicides which will selectively control such oil-tolerant weeds as common ragweed *(Ambrosia artemisiifolia L.)* and sunflower *(Helianthus annuus L.)*.

For pre-emergence weed control in onion, special light aromatic oils or 3 to 5% sulfuric acid can be applied to small weeds at 40 to 100 gpa, depending on the weed density. Post-emergence applications of 2 to 3% sulfuric acid can be made when the first true leaf of onion is more than 2 in. long; later applications of 3 to 4% sulfuric acid should be directed so as to avoid hitting the tops of onion plants.

We have controlled annual broadleaved and grassy weeds selectively in cantaloupe, onion, cabbage, and spinach when soil surface applications of certain herbicides were incorporated with soil in pre-planting treatments. The time lapse between the dates of treatment and planting is being studied, since most vegetable seedlings are injured when herbicides are incorporated with soil just before planting. Although these pre-planting, soil-incorporated treatments look quite promising for weed control in furrow-irrigated vegetables, recommendations on their use will not be made until our results are verified by additional experimentation.

Lettuce Mosaic

Robert C. Lambe[1]

Mosaic, a virus disease of lettuce, has not been recognized as a serious problem in Texas. However, in California, it has been reported as a serious threat to lettuce production. The disease has been suspected in the Lower Rio Grande Valley and was visually identified in the field by Dr. R. G. Grogan from California in December 1961 while visiting in the area.

In a field near Weslaco, a high incidence of mosaic was observed. Field diagnosis was confirmed in the greenhouse by testing suspected plants which gave typical symptoms on indicator plants.

Symptoms of mosaic are not always striking. Plants infected early are usually stunted. Irregular sizes in young plants may indicate virus infection. Symptoms expression differs in young and old plants.

In young plants of the Great Lakes type, leaves have slight inward rolling along the axis; new growth is often irregular in shape, slightly lobed, and may be accompanied by light-green to yellow mottling. As plants grow older, the mottling usually disappears or becomes indistinct. Half-grown to mature plants are often severely stunted and show discoloration that varies from dull green to slight yellow. Tips of outer leaves roll downward and infected plants may appear wilted.

As lettuce plants flower, mosaic is easily recognized as a yellow-green mottle in young leaves; seed form these plants will be infected with the virus and is the principal way in which the mosaic is introduced into lettuce fields. The virus can also be transmitted from these seed-infected plants by aphids. Certain weeds are host of lettuce mosaic, but the importance of these carriers in the Valley area are unknown.

Because symptoms of the virus are relatively indistinct in lettuce, certain other plants are used as indicator or test plants. *Chenopodium amaranticolor*, *Gomphrena globosa* and *Lactuca sativa* variety Eiffel Tower Cos lettuce exhibit definite symptoms when inoculated with the lettuce mosaic virus. Juice from suspected lettuce plants taken from the field near Weslaco in 1961 was rubbed on leaves of indicator plants of the 3 kinds mentioned above. Typical symptoms of lettuce mosaic appeared in 7 to 10 days indicating the presence of the virus.

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[1] Area Plant Pathologist, Texas Agricultural Extension Service, Weslaco.

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Systemic Insecticide Effects on Irish Potato Yields During 1962

James A. Harding[1]

Systemic insecticides applied at planting time to Irish potatoes were evaluated during 3 growing seasons in the Winter Garden area of Texas (Harding, 1962). Aphid and flea beetle control was effective for 77 days and some effectiveness extended to 96 days. Tuber yields from these tests were consistently increased.

The tests with ifnsecticides reported herein were continuations of the previously reported study. However, during 1962, leafhoppers were the only insects of consequence and insect-transmitted diseases were virtually non-existent.

MATERIAL AND METHODS

All tests were designed as completely randomized blocks having each treatment replicated 4 times. Plots in the experiments shown in Tables 1 and 3 were 35 feet long; those summarized in Tables 2 and 4 were 20 feet long and all plots were one row wide with a guard row between each plot. Three-foot alleyways separated the replicates.

Granular insecticides were applied as indicated in the tables with a Planet Jr. push planter, calibrated to deliver the desired amounts. Sprays were applied with a compressed-air sprayer using 2 nozzles per row calibrated to deliver 10 gallons of liquid per acre.

On January 29, 1962 Red Pontiac seedpieces were spaced 9 inches apart in rows with 36-inch centers. The soil was then bedded over the row to cover the seedpieces approximately 3 inches deep. The systemic insecticide treatments were mainly applied in the planting furrow below the seedpieces before planting with the exception of the placement test. In this test some plots were treated in the furrow while other plots had the granules applied on top of the bed after the seedpieces were covered.

Insects and disease symptoms were checked and data recorded each week if available. Yields were taken on May 9 and 10, 1962 and only show U. S. No. 1 A size potatoes.

Data were analyzed for sources of variance by applying the F test. Duncan's New Multiple-Range test at the 5% level of probability was used to evaluate differences between treatment means.

RESULTS

Insect infestations early in the season were very light. On March 7, 4 aphids per 5 leaves were found in the check plots; 1 to 2 aphids per 5 leaves occurred on plants in the treated plots. Only 5.7 beetle-feeding scars per leaf were recorded on March 7 in the check plots. On the same date, there was less than 1 scar in the Phorate plots, but an average of 3 scars in the DiSyston plots. The insect infestations remained very small until April 16 when leafhoppers became numerous. On April 26 foliar differences in leafhopper damage among the plots was easily discernable. This condition remained apparent until harvest. No records were made on the severity of the hopper damage since this could be evaluated by the effect on yields.

Tuber yields were affected by the application of systemic, granular insecticides placed below the seedpiece in the area of the fertilizer at planting. Plots treated with 2 pounds of Phorate or DiSyston produced significantly higher yields than the check or dimethoate treated plots, but did not differ from the other treatments (Table 1).

Table 1. Effect of granulated systemic insecticides placed under the seedpiece at planting time on Irish potato yields, 1962.

Material	*Active Ingredient (Lb./Acre)*	*Yield (Lb./Acre)*	*Analysis*[a]
DiSyston	2	16,751	│
Phorate	2	15,922	│
Phorate	3	15,351	│ │
Demeton	3	14,729	│ │
DiSyton	3	13,744	│ │
Check		11,877	│
Dimethoate	3	11,721	│

[a] Means not paralleled by the same line are significantly different.

Results of a second test (Table 2) compared yields under conditions of different placements of the systemic insecticides that were used.

Table 2. Effect of granulated phorate placement on Irish potato yields, 1962.

Treatment	*Yield (Lb./Acre)*	*Analysis*[a]
Middle of planting furrow	13,431	│
Both sides of planting furrow	13,340	│
Top middle of planting bed	12,161	│
Check	10,709	│
Top both sides of planting bed	10,164	│

[a] Means not paralleled by the same line are significantly different.

The results did not indicate any significant differences in yield due to the placement of the insecticides.

The test summarized in Table 3 compares soil application of Phorate with spraying and a combination of Phorate plus spray. The sprayed plots

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[1] Entomologist, Texas Agricultural Experiment Station, Crystal City.

Table 3. Effect of phorate, sprays, and combinations on Irish potato yields, 1962.

Treatment	Yield (Lb./Acre)	Analysis[a]	
Phorate alone	16,124	│	
Check	14,573	│	│
Phorate + part sprayed	13,691	│	│
Phorate + sprayed	13,381	│	│
Sprayed	13,381	│	│
Part sprayed	12,706		│

[a] Means not paralleled by the same line are significantly different.

received 1 pound of heptachlor and ½ pound of parathion per acre on each of three applications. Sprays were applied on March 2, April 11, and April 30. The part-sprayed plots received only the two April sprays, thereby allowing the small aphid and flea beetle infestation to continue their activity during March. Although the yields obtained in the phorate plots treated at planting was considerably higher than all the other treatments, it was significantly different only from the plots designated as part-sprayed.

Systemic furrow treatment combined with various spray scheduling were also compared. Early, mid, and late sprays were applied on March 2, April 11, and April 30, respectively. The spray materials were the same as used in the test shown in Table 3. Analysis indicated that significantly higher yields were obtained from plots treated with Phorate, sprayed, late spray, and mid and late spray plots than from the early sprayed plots, but these plots did not differ significantly from the check plots (Table 4).

Table 4. Effect of various spray treatments compared to phorate at planting on Irish potato yields, 1962.

Treatment	Yield (Lb./Acre)	Analysis[a]	
Phorate	15,840	│	
Sprayed	13,159	│	
Late spray	12,433	│	
Mid + Late spray	11,888	│	
Early + Mid spray	11,253	│	│
Mid spray	11,162	│	│
Early + Late spray	11,072	│	│
Check	10,709	│	│
Early spray	6,625		│

[a] Means not paralleled by the same line are significantly different.

Some phytotoxicity apparently resulted from the spray treatments even though no foliar symptoms were observed.

Insect control from systemic insecticides applied at planting, remained in evidence until harvest. The treatments gave consistant yield increases in these tests as in those reported previously, even though, the present tests were exposed to lighter insect infestations, except for the leafhopper infestation, and no disease. Systemic planting treatments apparently resulted in better yields than sprays applied after the insects were observed.

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Virus Diseases of *Hibiscus rosa-sinensis* in the Lower Rio Grande Valley

D. M. McLean[1]

Literature pertaining to virus diseases of *Hibiscus rosa-sinensis* L. in the United States is scant. Stoner, 1953, reported a mechanically transmissible, non-persistent virus from Kenaf (*Hibiscus cannabinus* L.) in Florida that infected several varieties of ornamental hibiscus. One variety, Brilliantissima (single scarlet), was a symptomless carrier. Symptoms indicated that the virus may be particularly harmful to rootstock varieties and therefore of significance to nurserymen. Stoner postulated that the presence of the virus in hibiscus species indicated a reservoir large and widespread enough to account for the spread of the virus in commercial plantings of kenaf, although an insect vector was not reported.

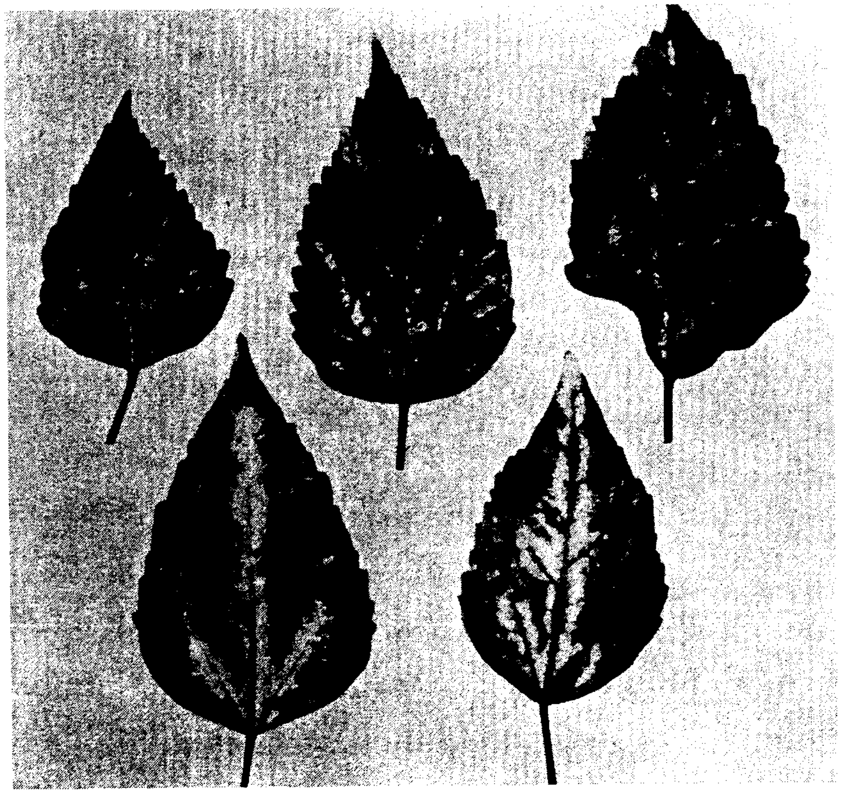

Figure 1. Symptoms of mosaic mottle on Hibiscus var. 'Coral Beauty'. Note dark-green to chlorotic veinbanding.

Experimental plantings of kenaf at Weslaco, Texas, have shown chlorotic-mottle, virus-like symptoms.[2] In recent studies (McLean, 1962) described symptoms in kenaf after inoculating with tobacco ringspot virus. These observations led the writer to examine several virus-like symptoms in ornamental hibiscus in the Lower Rio Grande Valley. Specimens were selected from nurseries and observed for several years in the USDA glasshouse. Results observed are presented.

SYMPTOMS

Mosaic mottle

Symptoms of mosaic mottle were observed commonly on the variety Coral Beauty and were characterized by a pattern of dark-green irregular blotches in the interveinal leaf tissues. Often irregular dark-green or chlorotic bands extended along the veins (veinbanding) (Figure 1). Mild chlorosis might be mistaken for nutritional disorders. Symptoms were more pronounced in new growth and became indistinct during certain periods. The causal virus was readily transmitted to the variety

Figure 2. Symptoms of yellow-vein on Hibiscus var. 'Fiji'. Note yellow-netting of leaf veins.

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[1] Plant Pathologist, U. S. Department of Agriculture and Texas Agricultural Experiment Station, Weslaco.

[2] Reported in conversation by Texas Experiment Station workers.

Agnus Classa by grafting scions from diseased plants.

Yellow-vein

Symptoms of yellow-vein were studied in the variety Fiji, but the virus was readily transmitted by grafting to the variety Rosabel. Symptoms are best described as a yellow-netting appearance of the chlorotic veins (Figure 2). Symptoms were more pronounced during rapid growth. Yellow-vein symptoms seemed distinct from those of mosaic mottle, but they might be confused in different varieties. It is not certain whether the different symptoms are produced by one virus. Infected plants did not appear to be stunted and the virus otherwise was innocuous.

Chlorosis-stem canker

This disorder was first called to our attention on landscape hibiscus plants at the Entomology Research Center, Brownsville, Texas, in 1959. Similar symptoms were subsequently observed on potted specimens of Coral Beauty in a nursery. Infected plants showed extreme chlorosis which was pronounced in new shoot growth. In older plants black necrotic stem cankers were conspicuous (Figure 3). These necrotic lesions were approximately ⅛ in. in size and extended through the bark. Infected plants were unsightly. Only the chlorotic phase was transmitted by grafting to the variety Mary Morgan. Symptoms, however, were indistinct after the plants were fertilized. Thus, it is not certain whether this disorder is caused by a transmissible virus or results from unfavorable nutrition.

Figure 3. Symptoms of chlorosis-stem canker on Hibiscus var. 'Coral Beauty'. Note severe chlorosis on leaves and prominent stem cankers.

Attempts to improve the condition of the Brownsville plants by pruning and fertilization failed; the affected plants ultimately died. Several enquiries have been made by home-owners who described symptoms of chlorosis stem-canker and the death of affected plants.

TRANSMISSION STUDIES

Preliminary attempts to graft scions from infected hibiscus to Turk's Cap (*Malvaviscus drummondii* Torr. & Gray) and Okra (*Hibiscus esculentus* L.) were unsuccessful. No symptoms developed after mechanical inoculations from hibiscus to seedling *Hibiscus sp.*, Okra, Kenaf, Hollyhock (*Althaea rosea* (L.) Cav.), Cotton (*Gossypium hirsutum* L.), and Cowpea (*Vigna sinensis* (Tor.) Savi.).

No attempt was made to identify the viruses or to relate them to virus diseases of crops plants in the Rio Grande Valley.

DISCUSSION

Hibiscus usually is propagated by air-layering (marcottage) or by rooting cuttings in the Rio Grande Valley. From an economic standpoint viruses may be very important to nurserymen, particularly when they are present in propagating stocks.

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MISCELLANEOUS

Distribution of Soluble Salts in a Typical Salt Spot of the Lower Rio Grande Valley[1]

Carl D. Fanning[2]

INTRODUCTION

The presence of saline spots throughout the older soils of the Lower Rio Grande Valley is not new (Beck and Hendrickson, 1928; Hawker, et al, 1929; Hawker and Simmons, 1926). Usually salt-affected areas are small and irregularly shaped. Often their distribution is such that several occur in the same field so that a relatively high percentage of the field is affected. Many acres of brushland originally cleared for high-value truck and vegetable crops have been retired to lower value crops because of saline conditions. Increased production costs and lowered crop returns now make farming operations a marginal endeavor on much of the land affected by salinity.

Many farmers have attempted reclamation practices to bring salt-affected areas back into production. Some of the attempts have been sound and based on good judgment, but too often decisions were made to initiate reclamation programs with little basic knowledge of the problem to be solved. Such programs are costly and have often failed. In fact, in some instances these practices have made salinity conditions more severe. A summation of the characteristics common to saline soils of the Lower Rio Grande Valley would be helpful for establishing management guide lines. This study was initiated to determine some of the physical and chemical characteristics of a salt spot considered typical of the dry-land area of the Lower Rio Grande flood plain.

PROCEDURE

A saline soil considered typical of the nonirrigated area in Willacy County east of Raymondville, Texas, was selected and a transect made at right angles to the natural direction of the affected area. The site was approximately rectangular, about 200 feet wide, and extended across a 20-acre tract of land. Samples for analysis were taken at 25-foot intervals along the transect at depth increments of 0-6, 6-12, 12-24, 24-36, 36-48, 48-60 and 60-72 inches.

Samples were analyzed for particle-size distribution, CEC (cation exchange capacity), ESP (exchangeable sodium percentage), pH, saturation-extract-soluble sodium, calcium, magnesium, potassium, bicarbonate, chloride, sulfate and the ECe (electrical conductivity of the saturation extract). Bulk density and the moisture retained at ⅓ and 15 atmospheres of pressure were measured on samples from the midpoint of the

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[1] Contribution from the Soil and Water Conservation Research Division, Agricultural Research Service, USDA, Weslaco, Texas, in cooperation with the Texas Agricultural Experiment Station.

[2] Research Soil Scientist.

transect. The methods of analyses were those of the U. S. Salinity Laboratory Staff (1954).

Near the center of the transect a pit was opened and the soil profile examined for features that might have value for interpretation of the salinity problem. The ground surface is slightly convex across the width of the affected site with the center about 0.2 foot higher than either edge. A brief description of the profile is as follows:

Raymondville Clay Loam[3]

0-6 inches	A_{1p}	Very dark brown sandy clay loam with weak, very fine to fine granular structure. This horizon, the plow layer, contained a few very fine roots and remnants of vegetative material.
6-14 inches	A_{12}	Very dark brown sandy clay loam with moderately strong, fine subangular blocky structure. This horizon, contained a few worm casts, root cavities and very fine roots.
14-21 inches	AC	Very dark brown sandy clay with strong, medium subangular blocky structure. A few worm casts, root channels, very fine roots and partially decayed snail-shell fragments were present.
21-47 inches	C_{ca_1}	Dark brown clay with strong, medium subangular blocky structure. Approximately 5% of the soil by volume is composed of soft calcium carbonate concretions ¼ inch in diameter. A few fine roots were also present.
47-60 inches	C_{ca_1}	Yellowish-brown clay with strong medium subangular blocky structure. An occasional soft concretion, thread of $CaCO_3$ and a few very fine roots were present.
60-72 inches	C_{sa}	Brown clay with strong, medium subangular blocky structure. No roots were present. Crystalline salt accumulations partially fill vertical cracks and coat faces of peds. A few segregated masses of gypsum crystals 2-5 mm wide were present. Accumulations were more pronounced in the lower portions of the described horizon.

A seasonally fluctuating water table which is of a regional nature is prevalent in the area. At the sampling site, fluctuations from 30 inches to below 7 feet beneath the ground surface have been observed in a single season. At the time the pit was opened the water table level was at a depth of 58 inches.

RESULTS AND DISCUSSION

ECe varied with sampling depth and with distance from the center of the salt spot as illustrated in Figure 1. The feature of most agronomic importance in Figure 1 is the very high ECe values. Soils with an ECe of 4 mmhos/cm are about at maximum tolerable salt level for many field and vegetable crops. At an ECe of 8 mmhos/cm only the more salt tolerant crops produce profitable yields. Above an ECe of 12 mmhos/cm very few crops yield profitably. Common crops grown in the area such as grain sorghum, sweet corn, field beans, onions, cabbage, carrots, tomatoes, lettuce and cucumbers will show reduced yields above an electrical conductivity of 4 mmhos/cm (U. S. Salinity Laboratory Staff, 1954). The very high value of 38 x 10^3 shown in the soil surface at the center of the salt spot points out the extreme severity of the condition.

The transition from unaffected to highly saline soils along the transect was very abrupt. Although salts in the surface samples (Figure 1) are concentrated within a relatively short interval across the center

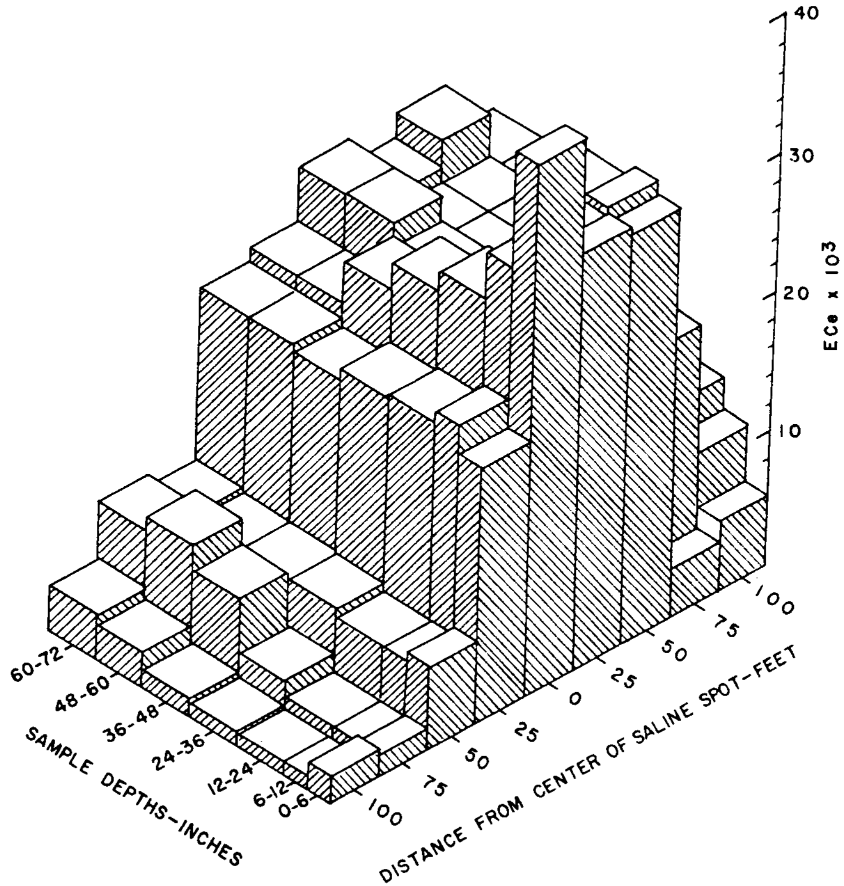

Figure 1. The salt distribution in a typical saline spot.

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[3] Soil profile correlated by Charles M. Thompson, USDA, Soil Conservation Service to be within the range of characteristics of Raymondville clay loam soils.

of the site, the preponderance of salts are in the subsoil. While the increase in the salinity level in the subsoil is abrupt along the transect on one side of the center of the saline spot, the increase in salinity on the other side is less rapid. Closely associated with the pronounced change in salt content along the transect is a change in subsoil texture. One hundred feet to the left of the center of the transect as shown in Figure 2 the subsoil at the 36-48 inch depth has an ECe of less than 4 mmhos/cm and contains 25 percent clay. At the center of the saline spot the subsoil contains 52 percent clay and a corresponding high ECe value. Surface soil textures did not change across the area.

The soils of the study area are alluvial in origin and as such are variable in textural composition. Although the site sampled is typical of the affected soils in the area, other transects may yield differing textural relationships.

The high clay content of the affected site coupled with the slightly convex ground surface reduces water intake so that during periods of high rainfall water runs off of the salt spots and infiltrates to the water table through adjacent more permeable soils. Soil drying moves water with its soluble salts back to the surface where the water evaporates, leaving the salts behind. In the Valley flood plain a regional water table exists that maintains a uniform water table level, which makes water equally available for upward flow in the affected site and in the adjacent unaffected area. However, capillary rise, one of the mechanisms responsible for upward flow from a water table, is greater under the salt-affected soil with its higher subsoil clay content. Consequently, the potential for salt accumulation is greater in this soil when compared with adjacent less clayey soils. This imbalance between the upward and downward movement of soluble salt perpetuates the saline condition. The high ECe values in the soil surface, Table 1, which diminish with depth, are typical of saline soils that develop as a result of upward salt movement from a water table (Reeve, et al, 1955).

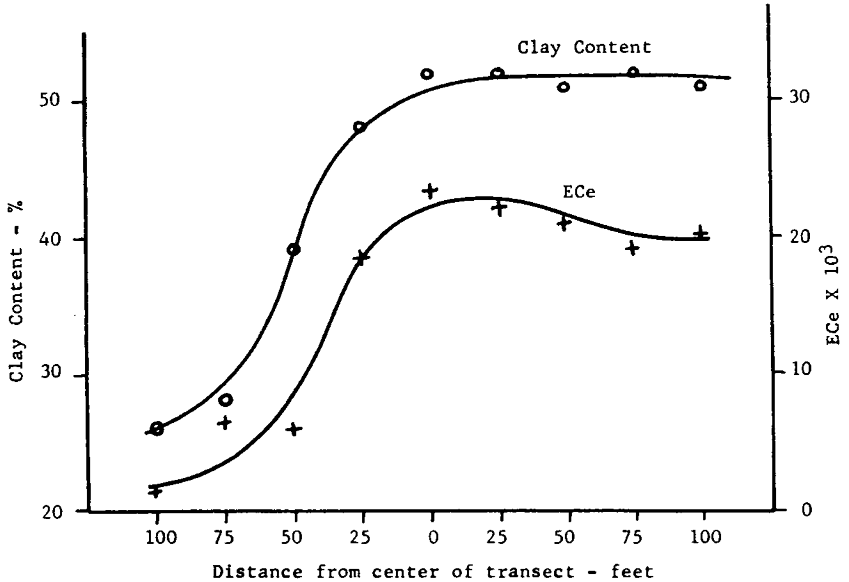

Figure 2. Relationship of clay content and ECe in the 36 to 48-inch depth with distance from center of transect.

Table 1. Salinity condition by depth increments at the center of a typical salt spot.

Depth	*pH*	*ECe*	*CEC*	*ESP*
Inches		*mmhos/cm*	*me/100 gm*	
0-6	7.2	38.5	17.4	17.3
6-12	7.3	30.5	22.2	23.4
12-24	7.6	26.5	21.8	21.6
24-36	7.8	25.0	21.8	26.6
36-48	7.6	23.0	25.0	16.9
48-60	7.8	20.0	23.0	14.0
60-72	7.8	20.0	20.8	25.0

The percent sodium saturation of the soil-exchange complex is an important criterion to be considered in the reclamation and management of any salt-affected soil. Other investigators (U. S. Salinity Laboratory Staff, 1954) have found that soils with ESP values above 15, after removal of excess soluble salts, are difficult to manage and require an amendment to replace sodium on the exchange complex. Excessive sodium causes structure deterioration in that it allows the soil to disperse readily when wetted, thus reducing water-intake rates. Upon drying these conditions cause severe surface crusting. The ESP values shown in Table 1 indicate that these considerations should not be overlooked when reviewing possible reclamation measures.

The clay content shown in Table 2 increases with depth to give a profile with a dense, slowly permeable substratum. The moisture retention capacity data show the soil to have an appreciable available moisture holding capacity. Plants with unrestricted root activity can effectively use this water. In a saline system, however, root activity is reduced and the amount of the water present that can actually be used by a plant is dependent on the plant's salt tolerance level (U. S. Salinity Laboratory Staff, 1954).

The composition of ions in the saturation extract, Table 3, represents ions that will be found in the soil solution when the soil is saturated with water. It is apparent that the salts are dominantly the chlorides of sodium and calcium with lesser amounts of magnesium chloride. The amount of sulfate in solution is small compared with the chlorides and is of minor significance. The quantity of calcium and magnesium ions present with respect to the sodium concentration is important because of their ultimate effect on the sodium saturation of the exchange complex with leaching. The amount of calcium plus magnesium present exceeds the sodium in the top 3 feet of soil, but increases in sodium below 3 feet reverse this order. At other locations along the transect the sodium content was higher in the surface and was more nearly equal to the calcium plus magnesium content.

The dominant salts present, calcium and sodium chloride, are readily soluble in water. Water moving through the soil can be expected to carry these salts with it. The reduction in chloride concentration from a very high level at the soil surface to a lower more constant level with depth indicates a net upward movement of this ion (Reeve, et al, 1955).

Something of the magnitude of total salt load in this affected spot can be seen in the calculated tons of salt present per acre in each depth increment of soil (Table 3). How much salt a reclamation measure must be capable of removing to make the soil productive depends on the tolerance of the proposed crop, but for any crop the amount will be sizeable. Once salts are removed by reclamation measures, careful management will be necessary to prevent these soils from reverting to their present status.

Table 2. Particle size distribution, moisture retention and bulk density by depth increments at the center of a typical salt spot.

Depth	*Size distribution*			*Moisture-holding capacities*			*Bulk density*
	Sand	*Silt*	*Clay*	*At field[1] capacity*	*At wilting[2] point*	*Water available to plants*	
Inches	%	%	%	*Inches of water/depth increment*			*gm/cm³*
0-6	59.8	12.2	28.0	2.0	1.4	.6	1.41
6-12	53.4	12.6	34.0	1.9	1.4	.5	1.38
12-24	49.8	14.2	36.0	4.8	3.9	.9	1.52
24-36	40.0	14.4	45.6	5.3	4.0	1.3	1.58
36-48	37.8	14.6	47.6	5.7	4.1	1.5	1.66
48-60	34.6	17.8	47.6	5.6	4.3	1.3	1.72
60-72	32.8	19.6	47.6	5.7	4.2	1.5	1.75

[1] Moisture retained at ⅓ atmosphere pressure.
[2] Moisture retained at 15 atmospheres pressure.

Table 3. Saturation-extract analysis at the center of a typical salt spot by depth intervals.

Depth	*Sodium*	*Calcium*	*Magnesium*	*Potassium*	*Chlorides*	*Sulfate*	*Bicarbonates*	*Total salts*
Inches	*meq./liter*							*Tons/acre*
0-6	167	274	21	5	442	27	1	6.0
6-12	94	140	37	3	288	19	1	5.2
12-24	87	109	26	1	222	11	2	10.0
24-36	85	89	21	1	188	30	1	10.2
36-48	132	64	23	1	160	27	2	9.2
48-60	158	48	20	1	168	38	4	8.1
60-72	132	39	14	1	158	24	3	8.3

SUMMARY

The soluble salt concentrations found in a typical salt spot of the Lower Rio Grande Valley change rapidly over short distances. Highest concentrations were found to be associated with dense, slowly permeable subsoils. The preponderance of salts are the chlorides of calcium and sodium. Crystalline salts were observed in the subsoil of an exposed profile.

There is evidence that these salt-affected soils are a result of surface evaporation from a high water table.

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Production of Pulp-Fortified Concentrate From Ruby Red Grapefruit — A Progress Report

DONALD M. TUCKER and BRUCE J. LIME[1]

INTRODUCTION

Since the killing freeze of January 1951, there has been a continuing rise in the ratio of red to white grapefruit produced in the Rio Grande Valley, due to the heavy red grapefruit plantings following the freeze. Prior to this freeze, the red variety accounted for only a small portion of the total grapefruit production, but during the 1960-61 season it accounted for more than 90 percent of the total grapefruit production. This is a complete reversal of pre-freeze conditions. This large amount, percentage-wise, of colored fruit has presented the industry with a major processing problem.

Until the fall of 1961, the Rio Grande Valley had not been involved extensively in the production of concentrate. There was only one evaporator in the Valley, and it was used largely for custom work. But between the fall of 1961 and the freeze of January 9-12, 1962, three additional evaporators with a combined capacity of some 40,000 pounds of water vapor per hour have been installed. Because red grapefruit represents a large portion of the total production (some 65 percent of the 1960-61 Valley citrus crop) and the installation of these evaporators, industry has shown considerable interest in methods of producing a high quality red grapefruit frozen concentrate.

Huffman et al (1953) suggested the use of suspended pulp for improvement of color in concentrate made from colored fruit, and the series of packs described in this report were prepared using this method of color improvement. These packs were designed to determine the degree of color improvement, the degree of heat treatment necessary for cloud stability, and taste acceptability of pulp fortified concentrate.

EXPERIMENTAL PROCEDURE

1960-61 Season. Beginning in January 1961, a series of experimental packs of pulp fortified red grapefruit juice concentrate were prepared, using both heat treated and non-heat treated feed juice. Fruit was harvested as needed from forty-five 20-year old Ruby Red grapefruit trees which survived the 1951 freeze. The fruit was washed on rotating brushes and reamed on a Brown Citrus Extractor[2]. The juice was immediately finished by passing it through a screw-type finisher and a paddle finisher in series. The screw finisher was set loose enough to prevent the cracking of seeds and the paddle finisher was equipped with brushes. Low pulp juice (5-7 percent suspended solids content) was obtained from the screw-type finisher, while high pulp juice (30-40 percent suspended solids content) was obtained from the paddle finisher. All juices were deaerated by being heated to 85-90° F. in a tubular heat exchanger and sprayed into a vacuum tank under a vacuum of 27-29 inches of mercury.

All concentrates were prepared in a Mojonnier Low Temperature Laboratory Evaporator[2]. The juices were heat treated in two stainless steel tubular heat exchangers connected in series. The first was used to heat the product in 8 seconds by hot water circulation and the second cooled the product to 40-45° F. in 16 seconds using iced recirculated brine. The product was fed into the heat exchangers by a metering pump to assure a constant flow. Treated juices were held at 40° F. until used in the process. The concentrate was prepared by concentrating the low pulp juice to approximately 50° Brix, dividing the concentrate into 6 portions and cutting back to 42° Brix with untreated low and high pulp cutback and portions of high pulp cutback treated at 170° F., 175° F., 180° F., and 185° F. Feed juice was also treated at these temperatures. One control pack in each series was prepared from concentrate which was not heated until after concentration and addition of cutback. Two series were prepared, one mid season (January and February), and one late season (March), in which either low or high pulp cutback was added to the 50° Brix concentrate before heat treatment. The concentrate was canned in 6 ounce plain tin cans, blast frozen, and stored at –10° F. until evaluated.

For evaluation, cans of frozen concentrate were removed from the freezer, thawed on rotating brushes under running tap water and reconstituted to 12° Brix with distilled water, and analyzed for acid, degrees Brix, cloud, flavanone content, and suspended solids by standard procedures. Acid content was determined by titration to pH 8.0 (pH meter) with standard sodium hydroxide, and is reported as total titratable anhydrous citric acid. Degrees Brix was recorded as read at 20° C. from a Zeiss Abbe refractometer[2]. No correction for acid content was made. Cloud was read with a Lumetron colorimeter[2] as percent transmittance at 650 mu of the supernatant liquor after centrifuging for ten minutes at 1400 r.p.m. in a size 1 International centrifuge[2] (radius of the centrifuge head was 8 inches from center of the shaft to the far tip of the tube carrier when extended horizontally) (Loeffler, 1941). Suspended solids content was read from the same centrifuge tubes, and is reported as percent on a volume-volume basis. Flavanone content was determined by the Davis test (Davis, 1947) and was calculated as percent naringin. Reflected color was calculated as the a/b ratio from reflectance readings obtained using the Gardner Automatic Color Difference Meter[2] (Lime et al, 1956). Gel ratings were determined by thawing the canned sample in running tap water while on rotating brushes, followed by storage at 80° F. for 18 hours. Degree of gelation is reported as described

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[1] Chemists, U. S. Fruit and Vegetable Products Laboratory, Southern Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture, Weslaco, Texas.

[2] The mention of firm names or trade products does not imply that they are endorsed or recommended by the Department of Agriculture over other firms or similar products not mentioned.

by Olsen et at (1951), 0 indicating no gelation, 1 indicating questionable gelation, and 2 indicating the presence of definite gel particles. Accelerated cloud determinations were made after thawing the sample in the above manner and storing the sample at 68° F. for 18 hours. These stored samples were reconstituted with distilled water and cloud was determined as above. Cloud loss is reported as the increase in percent transmittance after 18 hours at 68° F. Samples with an increase of less than 10 percent transmittance were considered stable, while those with an increase of more than 10 percent transmittance were classed as unstable.

Taste tests were performed using a panel of 6 laboratory staff members. Flavor scores of all samples were determined by comparison with frozen control samples (no heat treatment of either feed or cutback juice) which were thawed and reconstituted to 12° Brix just prior to testing and were assigned to flavor score of 6.0 (fairly good). Each series of samples tasted also included a treated control sample in which both the evaporator feed juice and cutback juice were heat treated at 185° F. This treated control was not identified and was tasted along with the other samples. Samples were presented for tasting at 50-60° F. and panel members were asked to rate each sample against the untreated control mentioned above from 0 to 10, 0 being obviously deteriorated, 5 acceptable, and 10 ideal (Culver and Cain, 1952). Results are reported as the mean score.

1961-62 Season. Fruit was obtained from seventy 5 to 6 year old Ruby Red grapefruit trees and was harvested as needed. The procedures of the 1960-61 season were repeated, except that only an early season pack (December) was prepared. The January 9-12, 1962, freeze prevented the preparation of mid and late season packs.

Table 1. Reflected color (a/b ratio) of mid (1960-61), late (1960-61), and early (1961-62) season red grapefruit concentrate.

		a/b Ratio		
		Time of season		
Feed juice temperature	*Pulp content of cutback*	*Mid 1960-61*	*Late 1960-61*	*Early 1961-62*
0	Low	–0.108	–0.197	+1.000
	High	0.000	–0.114	+1.079
170	Low	–0.056	–0.222	+1.000
	High	+0.030	–0.112	+1.158
175	Low	–0.156	–0.189	+1.053
	High	–0.034	–0.110	+1.154
180	Low	–0.177	–0.195	+1.053
	High	–0.050	–0.106	+1.179
185	Low	–0.109	–0.227	+1.051
	High	–0.074	–0.158	+1.146

RESULTS AND DISCUSSION

There was no significant change in degrees Brix, or acid, or flavanone content of the concentrate samples during storage or evaluation.

The controlled addition of pulp by way of the cutback juice definitely improved the color of the reconstituted concentrate, as compared with that cut back with low pulp juice. Since a more positive (higher) a/b ratio indicates more red color, the data in Table 1 show that this

Table 2. Cloud loss and gelation in mid season (1960-61) red grapefruit concentrate.

Feed juice temperature	*Cutback juice temperature*	*Cloud loss (Gain in % T.)*	*Degree of gelation*
0	0 – L[a]	18.0	0
	0 – H[b]	59.0	2
	170 – H	54.0	1
	175 – H	50.0	1
	180 – H	53.0	0
	185 – H	52.0	0
170	0 – L	4.0	0
	0 – H	42.0	0
	170 – H	12.0	0
	175 – H	30.0	0
	180 – H	15.0	0
	185 – H	6.0	0
175	0 – L	1.0	0
	0 – H	51.0	1
	170 – H	3.0	0
	175 – H	4.0	0
	180 – H	4.0	0
	185 – H	2.0	0
180	0 – L	0	0
	0 – H	16.0	1
	170 – H	1.0	0
	175 – H	0	0
	180 – H	0	0
	185 – H	0	0
185	0 – L	1.0	0
	0 – H	3.0	1
	170 – H	9.0	0
	175 – H	0	0
	180 – H	0	0
	185 – H	0	0

[a] L – Low pulp content
[b] H – High pulp content

color improvement was accomplished in every case. The two values shown for each feed juice treatment temperature represent the reflected color of each of the samples (low and high pulp cutback juices) in each series.

From the data in Table 2 it appears that for the mid season packs, heat treatment of the evaporator feed juice at 185° F. was necessary for cloud stabilization when unheated high pulp cutback was used, while if the high pulp cutback juice was treated at 170° F., cloud stabilization could be attained by heating the feed juice to only 175° F. It should also be noted that there was no gelation, though there was definite cloud loss, when the evaporator feed juice was treated at 170° F. and high pulp cutback juice was untreated, while at a feed juice temperature of 180° F. gelation and cloud loss occurred when untreated high pulp cutback was added. Conversely, when the feed juice was treated at 185° F. and the high pulp cutback was not treated, there was gelation but no cloud loss. This indicates that there is not always a direct correlation between cloud loss and gelation.

Table 3. Cloud loss and gelation in late season (1960-61) red grapefruit concentrate.

Feed juice temperature	*Cutback juice temperature*	*Cloud loss (Gain in % T.)*	*Degree of gelation*
0	0 – L[a]	41.0	0
	0 – H[b]	28.0	2
	170 – H	42.0	1
	175 – H	41.0	1
	180 – H	46.0	1
	185 – H	45.0	1
170	0 – L	28.0	0
	0 – H	52.0	0
	170 – H	49.0	0
	175 – H	48.0	0
	180 – H	50.0	0
	185 – H	48.0	0
175	0 – L	32.0	0
	0 – H	41.0	1
	170 – H	38.0	0
	175 – H	38.0	0
	180 – H	38.0	0
	185 – H	39.0	0
180	0 – L	5.0	0
	0 – H	23.0	0
	170 – H	11.0	0
	175 – H	10.0	0
	180 – H	10.0	0
	185 – H	14.0	0
185	0 – L	2.0	0
	0 – H	36.0	0
	170 – H	3.0	0
	175 – H	3.0	0
	180 – H	3.0	0
	185 – H	1.0	0

[a] L – Low pulp content
[b] H – High pulp content

Table 4. Cloud loss and gelation in early season (1961-62) red grapefruit concentrate.

Feed juice temperature	*Cutback juice temperature*	*Cloud loss (Gain in % T.)*	*Degree of gelation*
0	0 – L[a]	18.0	0
	0 – H[b]	54.0	1
	170 – H	50.0	0
	175 – H	50.0	0
	180 – H	52.0	0
	185 – H	53.0	0
170	0 – L	7.0	0
	0 – H	54.0	1
	170 – H	52.0	0
	175 – H	50.0	0
	180 – H	53.0	0
	185 – H	54.0	0
175	0 – L	11.0	0
	0 – H	56.0	1
	170 – H	45.0	0
	175 – H	48.0	0
	180 – H	45.0	0
	185 – H	42.0	0
180	0 – L	5.0	0
	0 – H	54.0	1
	170 – H	44.0	0
	175 – H	42.0	0
	180 – H	46.0	0
	185 – H	45.0	1
185	0 – L	4.0	0
	0 – H	43.0	1
	170 – H	5.0	0
	175 – H	6.0	0
	180 – H	1.0	0
	185 – H	10.0	1

[a] L – Low pulp content
[b] H – High pulp content

Table 5. Flavor scores of mid (1960-61), late (1960-61), and early (1961-62) season red grapefruit concentrate.

Feed juice temperature	Cutback juice temperature	Flavor score Time of season Mid 1960-61	Late 1960-61	Early 1961-62
185	185 H[a]	5.7	6.1	5.0
0	0 L[b]	6.7	6.4	6.6
0	0 H[c]	6.8	6.2	6.6
0	170 H	6.7	6.3	6.8
0	175 H	6.5	6.2	6.8
0	180 H	6.6	6.5	6.8
0	185 H	6.6	6.3	7.0
185	185 H[a]	5.8	6.7	5.8
170	0 L	6.9	7.1	6.8
170	0 H	6.5	6.9	6.5
170	170 H	6.9	7.1	6.5
170	175 H	6.2	7.0	6.5
170	180 H	6.9	7.0	7.0
170	185 H	6.4	6.7	6.3
185	185 H[a]	6.9	7.1	6.3
175	0 L	7.0	7.1	6.7
175	0 H	6.7	6.8	6.3
175	170 H	7.0	6.9	6.5
175	175 H	6.8	6.4	6.5
175	180 H	6.8	6.7	6.7
175	185 H	6.4	6.7	6.8
185	185 H[a]	6.2	7.1	6.3
180	0 L	7.0	7.0	6.8
180	0 H	7.2	7.3	6.5
180	170 H	7.1	7.6	6.7
180	175 H	6.6	7.1	6.0
180	180 H	6.9	7.1	6.5
180	185 H	6.7	7.1	5.5
185	185 H[a]	6.4	6.8	5.6
185	0 L	6.9	7.3	6.6
185	0 H	6.6	7.2	6.2
185	170 H	6.7	6.7	7.0
185	175 H	6.7	7.1	6.6
185	180 H	6.5	6.9	6.8
185	185 H	6.8	7.1	6.8

[a] Control sample tasted "blind" with each series.
[b] Low pulp content.
[c] High pulp content.

As shown in Table 3, in late season packs it was necessary to heat both the evaporator feed juice and the high pulp cutback juice at 185° F. in order to attain cloud stability in the reconstituted concentrate. As noted in the discussion of Table 2, there was definite cloud loss, but no gelation, when the feed juice was treated at 170° F. and untreated high pulp cutback was used, again illustrating that it is not always possible to predict degree of gelation from cloud loss, and conversely. When there was no treatment of either the feed juice or high pulp cutback the sample showed an unusually low cloud loss. This was due to the fact that it had already lost approximately one-third of its cloud in storage prior to the accelerated cloud test.

The data in Table 4 show that it was necessary to treat the evaporator feed juice at 185° F. and the high pulp cutback at 170° F. in order to obtain cloud stability in the early season packs. Slight gelation occurred in every case when the high pulp cutback was not treated, and both gelation and cloud loss occurred after treatment of both the feed juice and high pulp cutback juice at 185° F. (Table 4). A comparison of the data in Tables 2, 3 and 4 shows that the gelation which occurred in the mid and late season packs during the 1960-61 season (Tables 2 and 3) was more severe than the early season pack in the 1961-62 season (Table 4), as shown by the fact that a gelation rating of "2" (definite gel particles) was found in both packs in the 1960-61 season when untreated high pulp cutback juice was used with untreated low pulp feed juice, but the greatest amount of gelation found in the 1961-62 season was "1" (slight evidence of gelation) when untreated high pulp cutback juice was used with untreated low pulp feed juice.

There appears to be no greatly adverse effect on taste due to the heat treatment necessary to stabilize the cloud of the reconstituted concentrate, as shown in Table 5, but one point bears special mention. In almost every case, the panel was able to pick out the control sample in which both the feed juice and high pulp cutback juice were treated at 185° F. which was tasted "blind" with the other samples. The panel was able to distinguish this treated control sample in every case in the early season pack, while in both the mid and late season packs the panel was unable to distinguish this control when it was tasted along with the pack in which the feed juice was treated at 175° F. At higher feed juice treatment temperatures the panel had more difficulty in distinguishing this "blind" control as the season progressed.

The discrepancies noted above may possibly be explained by the fact that the mid and late season packs were prepared using fruit from old trees which have borne fruit over a long period, while the early season pack was prepared using fruit from young trees which were just coming into commercial bearing, but it is apparent that before any definite conclusions can be drawn it will be necessary to prepare at least one series of packs (early, mid and late season) during a single season, using fruit from the same group of trees. This would tend to establish any seasonal trends (such as fading of color, etc.) and eliminate discrepancies that may be due to weather, age of trees, soil type, and the like. Because of the non-availability of fruit following the January 1962 freeze, further work on this problem is being postponed until high quality red grapefruit again becomes available.

SUMMARY AND CONCLUSIONS

Mid season and late season packs (1960-61) and an early season pack (1961-62) of pulp fortified red grapefruit juice concentrates were prepared, stored, and evaluated for color, cloud retention and taste. The improvement of the color of the reconstituted concentrate by the use of high pulp cutback juice in the preparation of the concentrate was repeatedly demonstrated. The addition of this pulp had an adverse effect on cloud retention which could be overcome by heat treatment of either the low pulp evaporator feed juice (mid season) or the heat treatment of both the low pulp evaporator feed juice and the high pulp cutback juice (early and late season). The addition of this pulp also caused gelation which could be overcome by heat treatment of either the low pulp evaporator feed juice or the high pulp cutback juice, or both. There was no apparent detrimental effect on taste due to the heat treatment necessary to offset the adverse effect on cloud and gelation of addition of high pulp cutback juice. Due to the freeze of January 9-12, 1962, which prevented a full season's work, these observations should be rechecked through another season under carefully controlled conditions, when normal fruit becomes available.

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