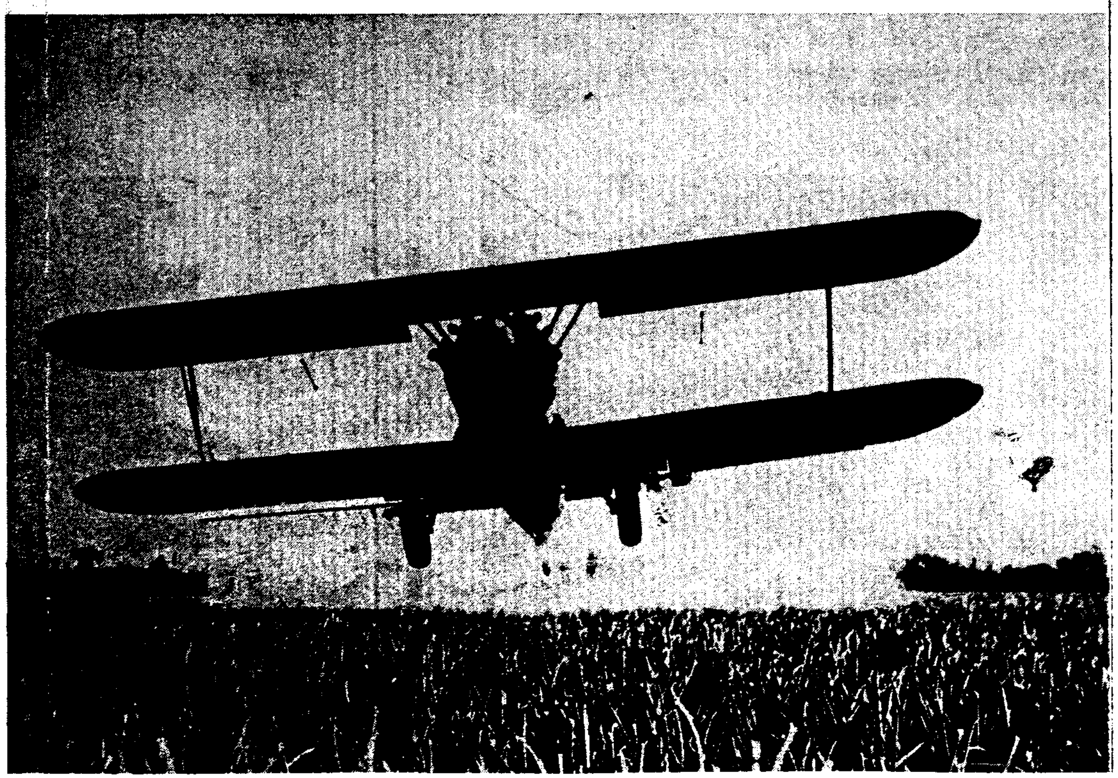
JOURNAL

OF THE

RIO GRANDE VALLEY HORTICULTURAL SOCIETY

Volume 15, 1961



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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 15 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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Given for meritorious service in behalf of horticulture in the Lower Rio Grande Valley. Recipients of this award include:

Arthur T. Potts	(1955)
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Lon C. Hill	(1961)

Lon C. Hill

Lon C. Hill
Recipient of the Arthur T. Potts Award
January 24, 1961

The Valley Horticultural Society recognized the contributions of Lon C. Hill, Jr. of Corpus Christi and Bayview to Valley agriculture over several decades by presenting him with the Arthur T. Potts Award for 1961 at the Valley Horticultural Institute at Weslaco on Jan. 24.

Mr. Hill was not able to be present and the plaque was accepted on his behalf by R. A. Ewing of San Benito.

Widely-known throughout South Texas as the area's outstanding civic leader, Lon C. Hill directed the operations of Central Power and Light Company as president during CPL's largest period of expansion.

Mr. Hill is now honorary chairman of the company's board of directors.

As president of CPL from 1939 to 1954, he saw the company greatly expand and increase its operations. He served as chairman of the company's board of directors from 1954 to October, 1959, when he was named honorary chairman.

Known as "Mr. South Texas," Lon C. Hill has led the fight in recent years to secure a dependable supply of water for industrial growth and agriculture throughout the area. He has been appointed by two different governors to serve on committees to study water conservation on the Rio Grande and Nueces Rivers.

A native of Manor, Texas, Mr. Hill spent his boyhood in Beeville and the Lower Rio Grande Valley. He attended the University of Texas and served during World War I in the Army Air Corps.

Mr. Hill was engaged in farming, land development, land management and investment banking before becoming president of CPL.

As chairman of the Area Development Committee of the Corpus Christi Chamber of Commerce, Mr. Hill has played an active part in the orderly development of the Corpus Christi area.

The CPL honorary board chairman is also a trustee of the Texas Research Institute, a member of the Texas A. and M. College Advisory Committee, and president and board chairman of the First State Bank, Corpus Christi. Mr. Hill is a director of the Board of Trade, Port of Corpus Christi, and of Delhi-Taylor Oil Corporation. He is a past director of the Central and South West Corporation and of Texas A. and I. College of Kingsville.

In 1953, Mr. Hill was awarded the outstanding citizenship plaque at the annual Washington's Birthday Celebration in Laredo as "the man who has contributed most to the development of South Texas in the past 15 years."

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CITRUS SECTION

A Routine System For Spray Application Manually To Citrus[1]

L. A. Riehl
University of California Citrus Experiment Station, Riverside

The two words, "oil spray," are compact and too easily used in a manner which implies a single material; thereby leading to a tendency for users to over-simplify the considerations involved in the proper use of the material. Over-simplification favors careless thinking and it is more likely that this will bring troubles than good results. Success in the use of spray oils for pest control on citrus involves a number of factors and there are several I would like to bring to your attention for comment, 1) the insecticidal and acaricidal efficiency of the petroleum fraction *per se*, 2) formulation of the spray oil by adding emulsifiers, 3) requirements of the spray rig, 4) preparation of the aqueous mixture in the spray tank, 5) application coverage and 6) tree reaction. Let us consider the various factors individually now and the parties responsible for seeing that each of them is done properly.

There is a substantial fund of information in the literature on the relation of properties of petroleum fractions to pest control efficiency to serve as a guide in the choice of oil fractions for research trials involving new conditions or problems. This information expedites the evaluation and determination of the oil most suitable for the particular situation as your experiment station is doing currently in the Rio Grande Valley.

Recently, investigations of the pest control efficiency of spray oils have stated the relation of efficiency to amount of oil in terms of deposited oil per unit area of surface. These data gives us a target for formulation studies. In the past, experiments on formulation have shown that the performance is associated entirely with the particular ingredients used in the formulation and has to be determined empirically by trial. Currently there are many emulsifiers and wetting agents available which are not influenced by the hardness of the water. Also there are new equipment and techniques to make it possible to determine oil deposits rapidly and accurately. Thus, the performance of emulsifiers can be evaluated and formulations developed to give a specified rate of deposit. It is likely that many possibilities in the choice of formulation ingredients can be used. Generally the amounts of emulsifiers needed are small so it is fitting to leave it up to the manufacturer to supply a proprietary spray oil with a satisfactory formulation. Competition will be keen and will both govern the quality of spray oils and stimulate production of the best possible product.

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[1] A talk presented before the Annual Institute, Rio Grande Valley Horticultural Society, January 24, 1961.

Now I wish to take tree reaction out of the order given above and mention it here. Tree reaction may be short term such as leaf drop or long term such as effects on yield, juice quality or rind color development. Relatively high percentage unsulfonated residue (Cox, 1943) is a good means of avoiding short term or acute tree reactions. Alleviating long term responses of the tree is associated with the dissipation rate of the oil and will depend on a number of factors including the properties of the oil, deposit requirements for pest control, the climatic conditions and the variety of citrus; in general, do not use a spray oil higher in distillation or in deposit than needed for pest control. Given situations require specific information developed locally as your experiment station is doing now for the Rio Grande Valley.

Control of the effects of factors I have been talking about until now, namely, pest control efficiency of the oil, formulation and tree reaction, will be determined primarily by actions of the spray oil manufacturer. The product he offers should be supported by experimental data pertinent to the intended use. Information on the properties of the percent unsulfonated residue, the distillation range (preferably at 10 millimeters vacuum), the percentage of a paraffinic and naphthenic components and the deposit rate, is important to the choice of an oil for a given situation. There has always been a tendency to give the value for viscosity. However, since viscosity varies from structural composition, the value for viscosity alone can in fact be misleading because 2 oils with the same viscosity may have quite different distillation ranges and quite different rates of dissipation from the tree. Until reliable local data are available it is wise to put your trust in a spray oil supported by evidence from your area and to limit the use of a new spray oil to very small plots compared directly to an oil of known qualities for observation of effects on the tree as well as pest control.

On the other hand, the grower is solely responsible for the spray rig, preparation of the spray mixture and application coverage. Directions for the preparation of the spray mixture should be given in the label for the spray oil and should be followed to the letter to obtain the full potential of the product. Carelessness in this step will at least be wasteful if not more serious.

For the present purposes I propose to limit my remarks principally to a discussion of the procedures for hand spraying. I think the procedures for getting good application coverage by hand spraying lend themselves well to the matter of presenting and understanding the requirements of good coverage. Also, if a person knows how to cover a citrus tree thoroughly by hand application, he will know how to critically judge and evaluate the coverage produced by other methods of application. Some individuals and growers may find it easier to start with hand equipment and some hand application work will always be needed around houses, ranch buildings and borders of the orchard. Equipment for mechanical application is being developed (Carman, 1955; Lewis, Worthy and LaFollette, 1955; Ebeling, 1959) and several of the machines show good promise. Certainly good application by mechanical methods is a very desirable goal.

A modern power-driven spray rig equipped with a steel tubular adjustable telescoping hydraulic tower and preferably mounted on a truck is required for the hand spray application of oil spray to citrus trees. The agitator in the spray tank should have a speed of 150 to 200 R.P.M. and there should be a sufficient number of standard type paddles on the agitator to keep the oil from separating and floating out in the corners of the tank. For practical use the pump should be of the displacement, single-acting, reciprocating type with a capacity of 50 to 60 gallons per minute delivery and of maximum pressures of 800 to 1000 pounds per square inch. Illustrations and a more detailed description of spray rig equipment may be found in Ebeling (1959).

The spray stream directed against the outside of the tree should have enough force to turn and roll the foliage; this force is composed of the weight and momentum of the liquid of the spray stream. The weight of the liquid is regulated by the diameter of the orifice of the nozzle of the spray gun and the momentum is supplied by the pressure. In our experience in California we have found that 8/64 inch is the most satisfactory diameter for the orifice of the nozzle of the spray gun. If the diameter is smaller there is not enough weight in the spray stream but if the diameter is larger most spraymen will not be able to move the gun rapidly enough to keep from wasting material. Generally, it is practical to operate the spray rig with 2 guns from the ground and one in the tower. The hoses on the ground are usually 65 to 75 feet long and there is roughly a loss of one pound of pressure per lineal foot of hose with an inside diameter of half an inch. The pump then should have the capacity and the pressure to operate each of 3 hand guns with 8/64 inch aperture at a pressure of about 500 pounds per square inch at the gun.

The definition of an insecticide as that which produces or will produce the destruction of insects covers an old, positive elementary method consisting of placing an insect between 2 stones pressed firmly together. The similarity between this method and oil spraying is not as far fetched as it may seem at first glance. The insecticidal action of spray oil is physical; death is caused by interference with respiration, or if you will, by suffocation. Scale and mite eggs do not move about so one must put the spray oil in contact with them. Now, in this light, oil spraying may be considered a convenient means of speeding up the use of 2 stones to destroy single individuals of the scale or mite pests on the tree. Therefore, when one is spraying, the tree should not be the target of his spray stream. His target should be the single scale with a diameter of less than 0.1 inch or the single mite egg with diameter of less than 0.01 inch existing out of sight at any place in the foliage of the tree. Failure to find these single individuals with the oil will be associated directly with the failure of the spray treatment to control the pest.

Adopting and following a good systematic procedure for spraying is the best way to get good application coverage. At this time I wish to describe a systematic routine for spraying a citrus tree which I think offers the maximum potentiality for getting complete coverage tree after tree.

For practical operations of spraying by hand, 2 rows of trees ,one on each side of the spray rig, will be sprayed as the rig moves through the orchard. For convenience in operation the spray is applied first to the top of the tree from above by the towerman stationed about 4 feet higher than the top of the tree. A "catwalk" platform about 14 feet long is mounted on the top of the steel tubular adjustable telescoping hydraulic mast with a pivot mechanism so the platform can be rotated in a horizontal plane through at least a 90 degree arc from a position in line with the chassis of the spray rig and back. With this arrangement the towerman can walk out 7 feet on either side of the center line of the spray rig and can adjust his height as needed to spray the tops of the trees. The towerman should move the spray stream from side to side of the visible part of the top of the tree starting at the farthest edge and progressing to the near edge. Usually it will not take the towerman as long to do both of the trees on either side of the spray rig as it will for the sprayer on the ground to do his tree; the tower gun should be shut off during intervals of waiting. Generally the towerman will work one tree ahead in the row of the sprayers on the ground.

As the sprayer on the ground approaches a tree he can think of it in terms of the quadrant positions 1) on the spray drive away from the spray rig, 2) off the spray drive away from the spray rig, 3) off the spray drive near the spray rig, and 4) on the spray drive near the spray rig, illustrated in figure 1.

Essentially, the foliage of citrus trees comprises a dome with inside and outside surfaces. Scale and mite eggs are present on the back sides of fruit and leaves and on the twigs, branches and even the trunk of the tree. To get complete coverage of all surfaces of the foliage the spray must be directed against the tree from the inside as well as the outside. To minimize contact of the sprayer with wet foliage, the inside of the tree is sprayed first. The set up for the progression pattern for the hose is based on spraying the inside of the tree by going in succession to each of the four tree quadrant positions listed above and then reversing the direction and spraying the outside of the tree by coming back through the four positions to the spray rig drive.

The sprayer will approach the tree in quadrant position number 1 (on the spray drive away from the rig). The spray gun should be adjusted to produce a cone pattern with reasonable driving force. Since the distances inside the tree are short, a wide open hard core spray stream might break leaves and fruit off. The sprayer should find a convenient opening to part the foliage so he can put his head, shoulders, arms and the spray gun inside the shell of foliage. In this position he should direct the spray stream to the inside surface opposite him. Special care should be given to spraying the inside of the top of the tree; then a pattern of horizontal strokes of the gun may be used working downward to the bottom with careful attention to the inside of the skirt until all of the area visible is wet including the branches and trunk. This routine should be repeated in succession at each of the other tree quadrant positions, numbers 2 through 4. As he moves to each of the positions the

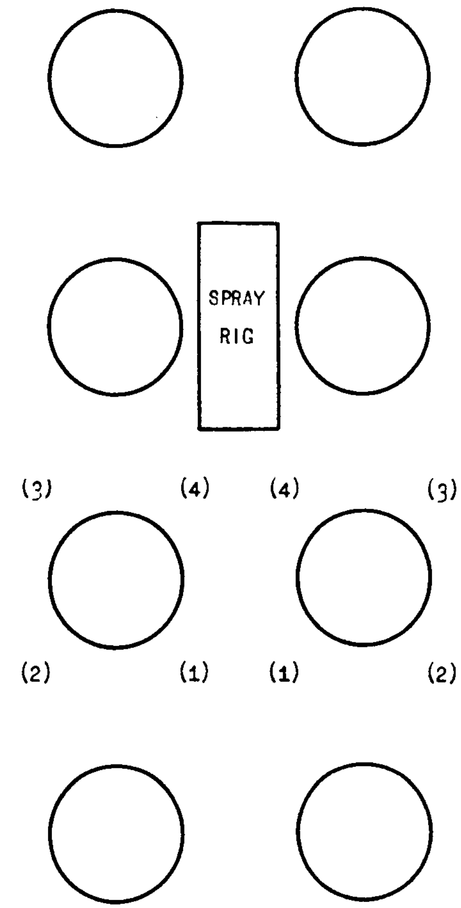

Figure 1. Diagram of tree quadrant positions for spray application by hand method to citrus trees to show quadrant positions (1) on the spray drive away from the spray rig, (2) off the spray drive away from the spray rig, (3) off the spray drive near the spray rig, and (4) on the spray drive near the spray rig.

spray stream can be directed against the skirt of the foliage.

At this point the sprayer is ready to begin the outside of the tree. Maximum coverage from the outside can be obtained best by directing the spray stream against the foliage from each of three angles, opposite the sprayer, ahead of and behind the direction he is moving. The sprayer should back several feet away from the tree and change the adjustment of the gun by opening it to produce a hard core spray stream. In spraying the outside of the tree the common type of spray gun is usually held in one hand with the handle resting against the outside of the arm above the elbow, with the barrel along and above the forearm so it is held between the thumb and index finger at the top of the hand placed inside the nozzle, and with the hose passing inside the elbow and downward across the front of the body. The hand which does not have the spray gun is used to hold the hose and aid in pulling it around the tree. As he moves back around the tree to quadrant position number 3, the sprayer should use vertical strokes from the top to the bottom of the tree and directed against the foliage left behind him starting at the farthest edge of the foliage on the spray drive side of the tree and progressing in the direction the sprayer is moving.

At the tree quadrant position number 3 the sprayer starts at the top of the tree with horizontal strokes from side to side of the full visible width of the foliage progressing downward to the bottom; this accomplishes direction of the spray stream to the surface opposite the sprayer. The sprayer then changes the pattern to vertical strokes full length from top to the bottom of the tree directed against the foliage ahead of him as he moves toward quadrant position number 2. Halfway to the next quadrant position the sprayer should stop moving forward but continue spraying the foliage ahead of him until the spray stream reaches the farthest visible edge of the foliage perimeter; then the sprayer should turn back to the distant edge of the foliage behind him, and spray the foliage behind with vertical strokes from top to bottom progressing in the direction he is moving until he reaches tree quadrant position number 2. Thus, in the routine of spraying the given tree quadrant the spray stream has been directed against the outer surface of the foliage from each of the three separate angles, opposite, ahead of and behind the path of the sprayer. The routine should then be repeated in succession for each of the other tree quadrant positions, in the order numbers 2, 1 and 4 since the outside of the tree was started at position number 3. At the finish of position 4 the sprayer should remember to use the vertical stroke to spray the foliage ahead of him to the outer edge in the direction of quadrant position number 3; this completes the tree. The hose is free and the sprayer is ready to start the next tree.

The routine described above may seem to be unnecessarily repetitive. Actually the gun is moved fast enough to whip the foliage and the routine can be accomplished with essentially no run-off waste of spray materials; what little there is will be more than justified by the enhanced potentiality for the complete coverage needed for good control and is inconsequential in terms of the amount of spray needed for a retreatment application.

The systematic routine should be followed without deviation but it should not be done mechanically. The sprayer should be constantly alert for the changes in the shape of the tree which will require a little extra attention and correction of the spray pattern to accomplish complete coverage.

All of the factors involved in oil spraying, efficiency of the petroleum fraction, formulation of the spray oil, a good spray rig, proper prepara-

tion of the spray mixture, complete application coverage and tree reaction, are like links in a chain. Like a chain, an oil spray treatment will not be better than its poorest component.

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Properties of Spray Oils for Grapefruit in the Rio Grande Valley of Texas for 1961[1]

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Various petroleum oil fractions have been under investigation during the past 2 years in an effort to identify the desired physical properties of citrus spray oils. The properties of oils for use on grapefruit are indicated below. Specifications of oils for use on oranges will be provided after sufficient data have been accumulated from experiments currently in progress.

The properties are as follows:

1. Unsulfonated residue (UR), minimum 92% (ASTM D-483).

2. Distillation at 10 millimeters pressure (ASTM D-1160, reduced pressure method).

   50% point 440° F. plus or minus 10° F.

   Maximum boiling range (10-90%), 85° F.

3. Neutralization number, maximum .03 (ASTM D-974).

Analytical procedures of the American Society for Testing Materials were used to determine the properties of the various experimental oils. These methods are commonly accepted throughout the petroleum industry.

Oils with higher unsulfonated residue percentages, 92% or higher, lessen the chance of plant toxicity when proper precautions for oil use are followed (Gray and de Ong 1926; Marshall 1932). Higher UR percentages are commercially feasible. Lighter oils, those with lower distillation temperatures than those indicated above, are not as efficient for pest control. Heavier oils, those with higher distillation temperatures than specified above, caused undesirable tree reactions in Valley experiments. Therefore, it is desirable to use an oil which produces the desired pest control efficiency with the least undesirable tree reactions. Neutralization number indicates the acidity of the oil. Increases in acidity may occur as a result of oxidation. Oils with high acidity have caused injury to plant foliage (Tucker 1936). The above neutralization number was selected as a reasonable maximum.

[1] Technical Contribution No. 3877, Texas Agricultural Experiment Station.

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False Spider Mites, A Potential Problem On Texas Citrus

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Insect problems many times develop following a change in control programs. Several Valley citrus growers have changed from a sulphur-dust program for rust mite control to a zineb spray without regard to the possible control of certain other pests by sulphur not obtained by zineb. This problem has been of concern since the use of zineb was begun. A possible problem with false spider mites became evident following the 1958 season.

The failure of zineb to control false spider mites, *Brevipalpus spp.*, and the Texas citrus spider mite, *Eutetranychus banksi* McG., became evident early in these investigations. Populations of the Texas citrus mite were much higher earlier in the spring following post-bloom zineb than where sulphur dust or spray was applied. Sulphur has been used as a controlling agent for the Texas citrus mite for many years. Control has been very poor in many instances but fair to good control has been found as compared to little or no control from zineb. False spider mites have been of little concern to Valley citrus growers. Control programs in which zineb is used without the addition of a controlling agent for false spider mites might result in abnormally high populations of the mite.

False spider mites evolve the possibility of a problem with a disease called "leprosis." According to Knorr *et al.* (1957), the principal symptoms of the disease in Florida are the characteristic lesions that occur on various tree parts. The chestnut-brown spots on fruit vary in size from pinpoint specks to platelets ¼ inch in diameter. Leaf spots are similar to those on fruit and occur on both upper and lower surfaces. The yellow-brown to red-brown spots on the twigs increase in size with the growth of the twigs and later give rise to circular persistent cankers. Leprosis cankers may develop on the trunk of the tree as well. Other names given to the disease are Florida scaly bark and nailhead rust. Knorrs *et al.* also reported the presence of leprosis in South America. Mexico, the Philippines, Java, Japan, China, India, Egypt, and South Africa. Knorr and Ducharme (1950) reported South American "lepra explosiva" to be synonymous with "leprosis."

False spider mites were found associated with leprosis. Knorr (1950) reported symptoms of the disease to develop on sweet orange seedlings when *Brevipalpus sp.* was cultured on the seedlings. Knorr and Thompson (1954) associated the sudden decline of the disease in Florida during the late 1920's to the greatly increased use of sulphur for the control of citrus rust mites. *Brevipalpus australis* (Tucker) was the species of false spider mite associated with the disease and a species known to

be controlled by sulphur. Counts of leprosis lesions on the fruit showed a high degree of association between the presence of the mite and the amount of fruit spotted.

Two species of false spider mites, *B. australis* and *B. phoenicis* (Geijskes), have been recorded on citrus in the Lower Rio Grande Valley of Texas. *B. australis* is probably the most common species.

MATERIALS AND METHODS

Experiment 1.—An experiment including four different dust treatments was started in April of 1959 in a Pride O' Texas grove northwest of Mission. Treatments consisted of three experimental dusts and the standard treatment, sulphur. In April and October, experimental dusts of 5% zineb, 4% zineb and 4% zineb-50% sulphur were used. May and July applications had 3% kelthane added to the 4% and 5% zineb dusts. Treatments were applied with the same type duster and were blown in from the north and south sides of the tree.

False spider mites continued to increase in the 4% and 5% zineb treatments of the April application. Treatments during May kept the populations at a low level until the July application. Populations remained small in the kelthane treatments, but started to increase 2 months after July application in the sulphur plots. After the October application, populations were reduced in the sulphur plots. In the 4% and 5% zineb plots, populations increased slowly. By February, 1960, population differences were small in all plots. The number of mites on 120 leaves are recorded in table 1.

Experiment 2.—At a Rio Farms grove just west of Monte Alto, four different oils were compared with a non-oil treatment. The oils used were designated A (a light-medium naphthenic), B (a light-medium paraffinic), C (a heavy paraffinic), and D (a light-medium naphthenic commonly used in California). Each of the oils was used at 1.6% actual oil plus 1 lb. of zineb per 100 gallons. The non-oil treatment consisted of 1 lb. zineb plus 1 qt. kelthane plus 2 oz. spreader-sticker (B-1956) per 100 gallons. These treatments were applied during July.

Trees were sprayed with a conventional ground rig using single guns with a number 6 orifice. Pressure was held between 550-600 pounds at the tank. Spraying was done in quadrant positions, making sure all of the tree was thoroughly covered.

The non-oil treatment resulted in better residual control than the four oils, as shown in table 2. Oil sprays did keep the population level small for over 3 months. The paraffinic oils produced better residual control of the mites than the naphthenic oils. This trend followed in both 1959 and 1960.

False spider mite populations were not affected when all plots in this experiment were sprayed with 1 lb. of zineb per 100 gallons in November 1959. Populations decreased and remained small after the April

1960 spraying with 1 lb. zineb plus 1 pt. kelthane per 100 gallons. After summer spraying the populations continued to remain small for about 3 months in the oil plots but remained small for over 6 months in the non-oil plots.

Experiment 3.—Oils applied at different times during the July-September period were investigated for the control of false spider mites at a Crockett grove west of Harlingen. Applications were made on July 1, July 15, August 1, and September 1. A non-oil treatment was applied on September 1. Oil sprays contained 1.6% actual oil of a heavy paraffinic oil plus 1 lb. of zineb per 100 gallons. The non-oil treatment contained 1 lb. zineb plus 1 qt. kelthane plus 2 oz. spreader-sticker (B-1956) per 100 gallons. Treatments were applied with the same equipment and in the same manner as described in the Rio Farm experiment.

All plots in this experiment were sprayed with 1 lb. zineb plus 1 lb. tedion plus ¾ lb. copper per 100 gallons at post-bloom. Populations were

Table 1. Dust treatments applied in the Pride O' Texas grove and their effect on false spider mites and false spider mite eggs during 1959.

	A		B		C		D	
Date	*FSM*[1]	*FSME*[2]	*FSM*	*FSME*	*FSM*	*FSME*	*FSM*	*FSME*
April 2	0	0	2	0	4	4	2	4
April 15	5% zineb		4% zineb		4% zineb— 50% sulphur		sulphur	
April 22	2	18	10	26	2	2	2	2
May 12	2	16	6	2	12	10	4	10
May 14	5% zineb— 3% kelthane		4% zineb— 3% kelthane		4% zineb— 50% sulphur		sulphur	
June 3	0	0	0	2	0	0	0	0
June 23	4	2	0	0	6	0	2	0
July 7	0	0	0	0	0	0	0	0
July 17	5% zineb— 3% kelthane		4% zineb 3% kelthane		4% zineb 50% sulphur		sulphur	
July 30	0	0	4	0	0	2	0	0
Aug. 27	2	2	0	0	2	0	2	14
Sept. 21	2	0	0	4	8	18	16	6
Oct. 7	10	6	0	0	16	8	50	16
Oct. 10	5% zineb		4% zineb—		4% zineb— 50% sulphur		sulphur	
Nov. 9	2	6	8	0	2	0	6	0
Dec. 15	10	0	10	0	6	6	2	2
Jan. 12, 1960	12	2	8	6	10	2	6	2
Feb. 11, 1960	16	6	26	6	14	16	16	6

[1] False spider mites on 120 leaves.
[2] False spider mite eggs on 120 leaves.

slightly decreased one month after spraying but then continued to increase until summer spraying.

Data presented in table 3 show the oil gave control of these mites over three months after all applications. Populations remained small even after six months in the oil treatments. The non-oil treatment remained effective over five months. Even with heavy populations, both the oil and non-oil treatments lowered the population of the mites to small levels and kept the population in check through the winter months.

Experiment 4.—A spray and dust experiment in a Pride O' Texas grove northwest of Mission was started in March 1960. Post-bloom treatments consisted of 1 lb. zineb plus 1 lb. of tedion plus 2 oz. spreader-sticker (B-1956) per 100 gallons, 1 lb. zineb plus 2 oz. spreader-sticker (B-1956) per 100 gallons and sulphur dust. The zineb treatment included

Table 2. Spray treatments applied at Rio Farms and their effect on false spider mites and false spider mite eggs during 1959-60.

	Oil A		Oil B		Oil C		Oil D		Non-oil	
Date	*FSM*[1]	*FSME*[2]	*FSM*	*FSME*	*FSM*	*FSME*	*FSM*	*FSME*	*FSM*	*FSME*
May 26	8	2	14	8	2	6	0	4	2	0
June 18	120	58	102	38	64	24	96	28	80	22
July 1, 2	Sprayed[3]		Sprayed[3]		Sprayed[3]		Sprayed[3]		Sprayed[4]	
Aug. 3	2	2	0	0	0	2	10	14	0	0
Sept. 1	10	12	2	0	0	2	30	6	0	0
Sept. 23	16	0	8	20	4	8	12	22	4	2
Oct. 21	50	40	20	12	34	12	86	26	2	6
Nov. 4, 5	Sprayed with 1 lb. zineb / 100 gal.									
Nov. 18	74	46	52	10	10	8	36	34	0	2
Dec. 28	82	34	30	20	24	14	40	28	2	6
Jan. 20, '60	76	72	74	36	32	18	36	48	0	0
Feb. 15	72	22	24	26	26	10	28	8	2	2
Mar. 17	38	26	30	30	26	6	62	40	0	4
Apr. 7, 8	Sprayed with 1 lb. zineb + 1 pt. kelthane / 100 gal.									
May 10	0	0	0	0	0	0	2	0	0	0
May 31	0	0	0	0	0	0	2	0	0	0
June 27	0	0	0	0	0	0	0	0	0	0
July 5, 6	Sprayed[3]		Sprayed[3]		Sprayed[3]		Sprayed[3]		Sprayed[4]	
Aug. 10	0	8	0	0	4	2	2	0	4	2
Sept. 14	10	0	6	0	2	0	22	0	0	0
Oct. 11	56	28	32	10	10	4	38	18	4	4
Dec. 15	72	24	58	12	36	12	42	22	12	2
Jan. 23, '61	26	50	18	10	12	12	18	30	0	0

[1] False spider mites on 120 leaves.
[2] False spider mite eggs on 120 leaves.
[3] Sprayed with 1.6% actual oil + 1 lb. zineb per 100 gallons.
[4] Sprayed with 1 qt. kelthane + 1 lb. zineb per 100 gallons.

a pound of 25% wettable powder chlorobenzilate per 100 gallons in the second application. Kelthane was used with zineb instead of tedion in the second application, in the other spray treatment.

Populations continued to increase in the spray treatments until the July application. The sulphur dust treatment held the population at a much lower level. After the July spray application the mites were reduced to small levels and remained small up to time last count was made (7 months after spraying). Populations remained smaller in the kelthane plots than in either of the other two treatments as shown in table 4.

DISCUSSION

False spider mites have not been considered a major economic pest of citrus in the Valley during past years. These mites have been of major economic importance in Florida due to their association with the disease "leprosis." As potential carriers of virus diseases and as plant feeders, excessive buildups of the mites should be controlled.

Plots treated with kelthane had smaller populations for a longer period after application than other experimental plots which were compared. Properly timed, thorough applications of sulphur dust maintained very small populations of these mites. Populations after oil spraying were reduced and stayed at small levels for over 5 months. Paraffinic oils did give a longer residual control of the mites than the naphthenic oils. Populations were smaller following applications of chlorobenzilate and remained small for several months. Zineb and tedion did not affect the false spider mite populations in these experiments.

Table 3. Effect of timing oil spraying on false spider mites and false spider mite eggs in test grove at Crocketts during 1960.

	A		B		C		D		E	
Date	*FSM*[1]	*FSME*[2]	*FSM*	*FSME*	*FSM*	*FSME*	*FSM*	*FSME*	*FSM*	*FSME*
Jan. 27	14	12	8	0	6	8	0	0	*	*
Mar. 3	4	10	4	0	0	0	4	0	*	*
Mar. 31	26	10	36	20	20	6	34	10	*	*
Apr. 4	Sprayed with 1 lb. Z-78 + 1 lb. tedion + ¾ lb. copper/100 gal.									
May 5	20	0	4	2	4	0	12	0	*	*
June 7	144	96	102	56	166	58	78	86	*	*
June 28	110	68	90	60	66	56	110	72	*	*
July 1	--------		--------		Sprayed[3]		--------		--------	
July 15	Sprayed[3]		--------		--------		--------		--------	
Aug. 1	--------		Sprayed[3]		--------		--------		--------	
Aug. 18	0	0	0	0	0	0	230	132	372	128
Sept. 1	--------		--------		--------		Sprayed[3]		Sprayed[4]	
Sept. 23	0	0	0	0	0	0	0	0	0	0
Oct. 20	4	0	0	0	6	12	0	0	0	0
Nov. 18	2	0	6	0	0	0	0	0	0	0
Dec. 19	20	8	8	2	20	10	4	0	0	0
Jan. 31, '61	0	0	0	0	10	2	0	0	0	0

[1] False spider mites on 160 leaves.
[2] False spider mite eggs on 160 leaves.
[3] Sprayed with 1.6% actual oil + 1 lb. zineb/100 gals.
[4] Sprayed with 1 qt. kelthane + 1 lb. zineb + 2 oz. B-1956/100 gal.
*No mite counts made until Aug. 18.

SUMMARY

False spider mites should be considered a potential economic pest on citrus in the Lower Rio Grande Valley. Most Valley citrus growers have not had a major problem with false spider mites due to the materials used to control other pests. Kelthane, oil, chlorobenzilate and sulphur, properly applied, have shown to give adequate control of these

Table 4. Spray and dust treatments applied in a Pride O' Texas grove and their effect on false spider mites and false spider mite eggs during 1960.

	A		B		C	
Date	*FSM*[1]	*FSME*[2]	*FSM*	*FSME*	*FSM*	*FSME*
Mar. 24	62	16	52	24	40	20
Apr. 5	Sprayed[3]		Sprayed[4]		--------	
Apr. 19	--------		--------		Dusted[7]	
May 3	38	12	42	18	10	6
June 1	109	24	154	112	22	10
June 3	--------		--------		Dusted[7]	
June 22	250	246	444	146	14	10
July 12	1104	780	984	728	60	17
July 19	Sprayed[5]		Sprayed[6]		--------	
Aug. 10	2	4	10	6	108	76
Aug. 31	2	0	6	0	176	182
Sept. 20	0	0	2	0	58	38
Oct. 18	4	0	2	2	84	54
Nov. 1	--------		--------		Dusted[7]	
Nov. 8	0	0	12	8	18	32
Dec. 7	0	0	10	6	74	44
Dec. 20	0	0	12	6	88	46
Feb. 16, 1961	0	0	6	4	16	40

[1] False spider mites on 160 leaves.
[2] False spider mite eggs on 160 leaves.
[3] Sprayed with 1 lb. zineb + 1 lb. tedion + 8 oz. B-1956 per 100 gallons.
[4] Sprayed with 1 lb. zineb + 2 oz. B-1956 per 100 gallons.
[5] Sprayed with 1 lb. zineb + 1 qt. kelthane + 2 oz. B-1956 per 100 gallons.
[6] Sprayed with 1 lb. zineb + 1 lb. chlorobenzilate + 2oz.B-1956 per 100 gallons.
[7] Dusted with sulphur.

mites. Growers that use only a rust-mite-controlling agent, such as zineb, may expect abnormally large buildups of the false spider mites unless a controlling agent is used.

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Release of Texas Virus-Indexed Citrus Budwood

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In recent years Texas citrus growers have become aware of the importance of planting virus-free trees, or trees that are free of recognizable virus diseases. Such trees are more vigorous and productive, less susceptible to cold injury and longer lived than virus-infected trees of the same varieties. Symptoms of virus infection are not always readily detected because scion-rootstock combinations, age and even cultural practices greatly influences the development of a diseased condition. In some instances, certain rootstock-scion combinations are tolerant, sufficiently so, of one or more viruses as to be considered symptomless carriers. Since the four known serious citrus virus diseases, psorosis, tristeza, exocortis and xyloporosis, are readily transmitted through buds, it is important that virus-free budwood be used in the propagation of nursery trees.

VIRUS-INDEXING PROGRAM

An effective psorosis-free budwood-source program was initiated in 1948 through the combined cooperative efforts of the Rio Grande Valley Nurserymen Association, the Texas Department of Agriculture and the Texas Agricultural Experiment Station. A short time after this program was underway, it was discovered that there were other virus diseases that were even more serious than psorosis if certain susceptible rootstocks were used. In an effort to find and maintain virus-free budwood sources of citrus varieties for commercial and research purposes, a cooperative citrus-virus-indexing program was developed by the Crops Research Division of the United States Department of Agriculture and the Texas Agricultural Experiment Station at Weslaco, Texas.

More than 95 per cent of the commercial grapefruit trees in Texas are infected with one or more viruses; orange trees are less frequently infected. It is necessary to test many individual trees of an old-line or commercial variety to find one or two trees that are virus-free. These individual trees, or their progeny in the test plots, become the parent tree of a virus-free clone and the basic budwood source for the propagation of nursery trees. (Clone is used to designate the asexual propagated progeny of a single individual tree. Such a clone might be called a strain or selection of a given variety).

RELEASE PROCEDURE

Citrus budwood from virus-indexed clones found to be free of psorosis, tristeza, exocortis and xyloporosis may be released for commercial propagation in accordance with procedures established jointly by the Texas Agricultural Experiment Station and the United States Department of Agriculture. These regulations are necessary because of the limited amount of budwood available of virus-indexed clones and the necessity of maintaining the disease-free condition of type trees. The procedure by which virus-indexed clones, which are under the control of USDA and TAES agencies, may be released is stated in a policy formulated and adopted in February, 1960. Copies of this statement may be obtained from the Superintendent, Texas Agricultural Experiment Station, Substation 15, Weslaco. A brief outline of the manner in which citrus material may be released is given below: Steps involved in release of virus-indexed clones:

1. Citrus budwood proposed for release must be free of psorosis, tristeza, exocortis and xyloporosis viruses.

2. Citrus budwood proposed for release must be recommended by the citrus research personnel of both the Federal and State agencies, or a designated committee representing the two agencies at Weslaco.

3. All citrus budwood releases must be approved by the Director of the Texas Agricultural Experiment Station and by the Director of the Crops Research Division, ARS, USDA.

4. Following approval by the Directors, a release notice stating the approximate amount of budwood available will be sent to Texas licensed citrus nurserymen, the Nursery Inspector of the Texas Department of Agriculture and the presidents of the Texas Citrus Mutual and Texa-Sweet, Inc.

5. The available budwood to be released will be prorated, not to exceed 50 buds, to licensed citrus nurserymen, except where provision is made by the Nurserymen Association to contract propagation of pooled stocks with an individual nurseryman.

6. Trees of released budwood will be maintained by the Texas Agricultural Experiment Station in a foundation planting to provide a source of virus-free material and type trees for future reference. Budwood released from such trees shall not exceed 25 buds per clone to a citrus nurseryman or grower.

7. In case of private ownership of virus-indexed clones, which qualify for release, prior written approval of the owner must be obtained before official release of budwood is made.

8. In the case of introductions, hybrids and new varieties, which are only a few years old from seed, release may be made only after fruit quality, fruit yield and other horticultural characteristics have been evaluated.

VIRUS-INDEXED CLONES; BUDWOOD RELEASED 1961

From the cooperative disease-indexing program of the Texas Agricultural Experiment Station and the United States Department of Agri-

culture, budwood of virus-indexed clones of 19 citrus varieties is being released to nurserymen. These are described varieties; several have been in commercial production for many years. However, a number of the clones have been propagated from seed in recent years. Since these particular varieties are polyembryonic most of the seed are nucellar. Only those seed-propagated trees bearing fruit that resembled the old-line variety were selected and they are considered to be from nucellar seed, identical to the parent tree and true to the varietal type.

The year in which a parental-line tree was seed-propagated is given, or the approximate date of its introduction into Texas is indicated. To preserve the identity of the released material, the varietal name is followed by the Texas Release serial number.

VIRUS-INDEXED OLD LINE COMMERCIAL VARIETIES

The varieties represented by the released virus-indexed clones of old-line commercial varieties have a good production history and are considered to be free of psorosis, tristeza, exocortis and xyloporosis viruses. These clones should be more productive and longer lived than trees that may be infected with one or more viruses. They should be propagated in preference to non-indexed clones.

VALENCIA ORANGE, TR. 1. Parent tree from California set out in grove in Hidalgo County in 1933. Fruit typical Valencia.

MARRS EARLY ORANGE, TR. 3. Parent tree grown in Marrs Nursery, Texas, set out in grove in Hidalgo County in 1945.

WASHINGTON NAVEL ORANGE, TR. 4. Parent tree on sour orange rootstock planted in grove in Hidalgo County in 1933.

HAMLIN ORANGE, TR. 5. Parent tree on sour orange, planted in grove in Hidalgo County in 1932.

MEYER LEMON, TR. 6. Parent tree planted in test plot in 1955. Budwood traces back to Rickett's introduction of commercial trees from Florida about 1930. This selection is tristeza-free; many Meyer lemon trees are not.

MARSH (GARNER) WHITE GRAPEFRUIT, TR. 10. Parent tree planted in test plot in 1953. Budwood traces back through TAES Substation 19, Crystal City, to a fruiting seedling observed at Laredo in 1934.

ORLANDO TANGELO, TR. 14. Parent tree planted in test plot in 1953. Budwood traces back through TAES Substation 15, Weslaco, to introduction by USDA in 1930's. Variety originated as a hybrid of grapefruit pollinated with Dancy tangerine. Fruit is of shape and size of a large tangerine, but resembles a highly colored orange. Season – November through January. Fruit is exceptionally good to eat. Recommended for planting in backyards and in small commercial acreages.

FALSE HYBRID SATSUMA, TR. 12. Parent tree planted in test plot in 1953. Budwood traces back through TAES Substation 19, Crystal

City, to introduction by USDA in 1930's. Selection is probably a seedling of Owari satsuma. This selection is tristeza-free; many satsumas are not. This selection grows well on sour orange and trifoliate orange rootstocks. Since satsumas are more cold hardy than other mandarins, they are planted in backyards along the Gulf Coast from Louisiana to Corpus Christi; few are planted in the Lower Rio Grande Valley where better mandarins can be grown.

VIRUS-FREE CLONES OF VARIETIES RECENTLY PROPAGATED FROM SEED

Virus-free young-line clones include trees that have fruited for 3 or more years, but data on production and fruit quality characteristics are incomplete. These selections are considered free of psorosis, tristeza, xyloporosis and exocortis viruses. These are generally more vigorous, more thorny, and slower to come into bearing than clones 20 years or older from seed. Selections in this group have not been adequately evaluated and are therefore *not* recommended for large scale commercial propagation at this time. These selections have been released to permit nurserymen to develop scion groves in event these selections prove to be superior to the old-line selections of the same varieties.

VALENCIA, TR. 2. Parent tree planted in test plot in 1953. Budwood traces back to a seedling planted about 1940 and which was propagated on sour orange rootstock and planted in 1942 at TAES Substation 15, Weslaco.

RED BLUSH GRAPEFRUIT, TR. 7. Parent tree from seedling, grown from seed, planted in Texas about 1950.

RUBY GRAPEFRUIT, TR. 8. Parent tree from seedling, grown from seed, planted in Texas about 1948.

CALIFORNIA 56 RED GRAPEFRUIT, TR. 9. Parent tree planted in test plot in 1956. Budwood traces back through USDA budwood introduction into Texas in 1956 to Red Blush seedling trees planted about 1940 at Citrus Experiment Station, Riverside, California. This selection is less thorny than the nucellar Red Blush and nucellar Ruby red grapefruit of Texas origin. It has been propagated commercially in California; it seems at present the most promising of the young-line red grapefruit available in Texas.

DANCY TANGERINE, TR. 13. Budwood traces back to seedling, grown from seed planted about 1948. A productive, highly colored, easy-peeling tangerine, later than Clementine. Since all old-line Dancy trees were infected with psorosis virus, nurserymen ceased to propagate them. With virus-free buds, this variety can be again planted in backyards and small commercial plantings.

PEARL TANGELO, TR. 15. Parent tree a seedling from seed planted about 1951. This selection has good flavor, solid fruit, season—October to December; it is earlier than the Orlando tangelo. Its weaknesses are its yellow peel and numerous big seeds. Variety described in California

about 1940; originated from pollination of grapefruit by Willowleaf mandarin.

WEKIWA TANGELO, Tr. 16. Parent tree a seedling from seed planted in 1948. Fruit is small, yellow peel, sweet, seedy, low acid, has a pink tinge to flesh, and has a special perfume. Season—November to January. Variety is ¾ grapefruit and ¼ tangerine. Recommended for backyard culture.

MURCOTT, TR. 17. Parent tree a seedling from seed planted about 1951. Fruit is seedy, thin peel, orange colored, sweet, firm flesh, orange peel. Variety is of interest because the fruit is good in March and April when most other tangerines are gone. Fruit does not get puffy. Chief weakness of variety is that the fruit sunburns easily, and a high proportion of exposed fruit show 1 or more dry sections. This variety is popular in Florida where it originated before 1920.

MINNEOLA TANGELO, TR. 18. Parent tree a seedling from seed planted about 1951. Variety is of the same parentage as the Orlando tangelo. Fruit deep red-orange in color, especially in the Winter Garden area. Season is January-March; fruit is seedly, necked, very good flavor. It usually bears less than Orlando tangelo.

KARA MANDARIN, TR. 19. Parent tree from a seedling tree, seed planted 1948. Fruit has an orange peel, orange flesh, season – March to April, good flavor, melting flesh, good size, and it is seedy. Variety originated in California as satsuma seed pollinated by King orange. Variety looks good in Winter Garden area; adaptability in Lower Rio Grande Valley is uncertain.

EUSTIS LIMEQUAT, TR. 11. Parent tree planted in test plot about 1955. Budwood traces back to a tree of seedling origin at TAES Substation 19, Crystal City; it was propagated on Uvalde citrange rootstock about 1950. Fruit has yellow peel, greenish flesh, tender, juicy, acid, season in fall and more or less throughout year. Variety originated as Mexican lime seed pollinated by kumquat. The variety has lime-like fruit, but is more cold-hardy than Mexican lime. Variety cannot be propagated on sour orange; it can be propagated on *Poncirus trifoliata,* Calamondin, or Cleopatra mandarin.

CARE OF VIRUS-FREE CITRUS

It is important that care be exercised to prevent virus-infection of virus-free scion budwood groves and budded nursery stock subject to certification. To minimize the infection hazard scion groves should be isolated by at least 35 feet or more to prevent the possibility of infection through root grafts.

There should be close supervision of the cutting and labeling of budwood, the budding operation and correct marking of budded rows and plots to assure accurate identification of nursery stock for certification. Nursery stock should not be double budded with buds from any source other than the original clone. In general double budding should be discouraged. Mixed budding in a nursery row should not be permitted. Good cultural practices should be followed in both the scion grove and nursery to promote the development of vigorous and healthy trees.

Scion groves should be inspected periodically for unhealthy appearing trees. All such trees should be checked immediately for the possibility of virus infection by insect vectors. Obviously diseased trees should be removed. Scion groves should be in a continuing virus-indexing program to be certain that the trees continue to be a source of virus-free budwood for many, many years.

Harvesting Practices For Marrs Early Orange

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Marrs Early Orange has been planted extensively in the Rio Grande Valley since the 1951 freeze. It is a very heavy bearer of large fruits which pass the Texas maturity standards while the peel is still green. Because rind-oil spot causes considerable loss each year to growers and shippers, some shippers are reluctant to handle the Marrs. Although the trouble is generally associated with ethylene degreening, studies over the past few seasons show moisture relations to be an underlying factor in the susceptibility of Marrs orange to spotting.

In 1916 Fawcett (1936) observed that moisture relations were factors in the susceptibility of lemons to rind-oil spot or oleocellosis. He found that minute quantities of citrus oil acting on the fruit surface for a very short time caused characteristic shrinking of the tissue between the oil glands in the rind and left the glands standing out prominently over the spotted area.

The spots may be circular or irregular in outline, and may vary in size up to ½ inch in diameter and at times involve a larger portion of the surface of the orange. The affected areas of the peel remain green in contrast to the yellow color of the normal peel after degreening with ethylene gas.

Several days are required before the spotting is apparent. This delay in development of the disorder has led to a generally accepted but erroneous idea that faulty operation of the degreening room is responsible. Another generally accepted idea, and one with some foundation, is that rain on the fruit during picking or hauling to the packinghouse causes the rind-oil spot.

Several seasons of work on this problem has been done by the staff of the Harlingen, Texas, station of the U.S.D.A. Agricultural Marketing Service.

STUDIES DURING THE 1957 AND 1958 SEASON

METHODS

The effects of different harvesting and handling practices on the susceptibility of Marrs orange to rind-oil spot have been compared. Exploratory studies in 1957 and 1958 included the following practices:

(a) Clipped fruit vs. pulled fruit

[1] U.S.D.A. Agricultural Marketing Service, Market Quality Research Division, Horticultural Crops Branch, Harlingen, Texas, August 9, 1960.

(b) Ethylene degreening vs. no ethylene

(c) Morning-picked fruit vs. afternoon-picked fruit

(d) Fiberboard-lined boxes vs. wooden field boxes

(e) Picked with gloves vs. picked without gloves

RESULTS

(a) The Marrs variety tends to bear fruit in clusters. It is difficult to clip one orange in a cluster without contacting adjacent fruits with the clippers. Under morning conditions (high relative humidity), rind-oil spot developed at these contact points and occurrence was greater on clipped fruit than on pulled fruit. However, under afternoon conditions (lower relative humidity), slightly less oil-spot developed on clipped fruit than on pulled fruit. The difference was so minor that further testing with clippers was discontinued.

(b) Degreening with ethylene did not appear to increase the occurrence or severity of rind-oil spot, when compared with non-gassed fruit. However, the contrast between the normal and affected peel areas is more pronounced in the gassed fruit because of the yellow color brought on by the gas treatment. Ethylene degreening of test fruit was continued because it made rind-oil spots easier to see.

(c) Fruit picked in the morning consistently showed more rind-oil spot than fruit from the same trees picked in the afternoon. Two exceptions occurred; (1) 24 hours after irrigation there was no reduction of oil spot in the afternoon-picked fruit, and (2) after a heavy noon shower more rind-oil spot developed in the afternoon-picked fruit than in the morning-picked fruit. These two exceptions led to more intensive study in the 1959 season.

(d and e). Fruit emptied from picking bags into fiberboard-lined field boxes had less rind-oil spot than fruit emptied into regular wooden field boxes. The use of cotton gloves by the picker reduced the occurrence of oil spot on fruit picked either in morning or afternoon. These two practices consistently reduced the incidence of rind-oil spot but in all tests on clear, sunny days morning-picked fruit had more rind-oil spot than afternoon-picked fruit.

STUDIES DURING THE 1959 SEASON

METHODS

In 1959, tests were continued with (c) morning-picked vs. afternoon-picked fruit. Also tests were begun to study the relationship between susceptibility to rind-oil spot and the factors which affect the turgor of the fruit, such as soil moisture, sunshine (insolation), and relative humidity of the atmosphere.

In September of 1959, experimental orchard plots each containing four Marrs orange trees were selected at Rio Farms north of Elsa, Texas.

The soil surface of one plot was covered with 6-mil polyethylene film sheeting, shortly after a regular orchard irrigation, so as to prevent any additional moisture from rains reaching the soil.

The second plot was banked with borders and tank-watered weekly at rates varying from 500 to 1,250 gallons per tree. The third plot was left as a control plot. This arrangement of plots followed the procedure described by Grierson and Koo (1958).

The first (film-covered) plot received no water during the test period except what could be obtained by the roots beyond the edges of the film sheeting extending at least 10 feet from the trunks. The second (wet) plot received natural rainfall and the weekly watering. The third (check) plot received only natural rainfall.

From September 25 through November 27, samples of oranges were picked from each test plot at 10 a.m. and 2 p.m. at intervals of 1 to 4 days. The picked fruit was degreened with ethylene gas for 4 days and then evaluated for rind-oil spot injury. At the same times, diameters of 12 growing fruits per plot were measured with a machinist micrometer.

RESULTS

Fruit picked at 2 p.m. was much less susceptible to rind-oil spotting than that picked at 10 a.m. on clear, sunny days. This difference was apparent in all plots. In contrast during periods of rain, drizzle, or cloudiness, the incidence of oil spotting was nearly the same in the morning-picked and afternoon-picked fruit.

During clear weather, fruit diameters were smaller in the afternoons than in the mornings, probably because of turgor differences. However, during periods of rain, drizzle, or cloudiness the morning and afternoon measurements were nearly the same.

CONCLUSION

Harvesting practices which reduce the occurrence of rind-oil spot on the Marrs Early orange, picked green, listed in order of importance, are as follows:

Pick fruit in afternoons of clear, sunny days.

Defer picking 2 or 3 days after rain or irrigation.

Use fiberboard-lined field boxes or padded trailers.

Pickers use cotton gloves.

If these practices are observed the incidence of the disorder can be reduced greatly. Relative humidity before and during picking was the most important factor in preventing rind-oil spot of Marrs Early orange and had more effect than all other factors combined.

Acknowledgement

The cooperation of Rio Farms in making these tests possible is gratefully acknowledged.

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Seasonal Variation of Texas Valencia Orange Juice

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Oranges are becoming increasingly more important to the Texas citrus industry. Although the citrus replantings for several years after the 1950-51 freezes consisted of 80% red grapefruit, the United States Department of Agriculture's estimated production figures for the 1960-61 season are 3.5 million boxes of oranges and 6.5 million boxes of grapefruit.

In the past two years the interest in orange production has increased to such a point that nursery stock plantings now show more orange trees than grapefruit trees (Anonymous, 1961). One factor which may be responsible for this interest in orange production is that further outlets are becoming available through new and expanded processing facilities for producing frozen concentrates and chilled juices.

The processor, as well as the grower, needs more information than is now available relating to the seasonal variation and the juice quality of the fruit. This presentation lists the variation in yield, Brix, acid, visual color and solids contents of Valencia orange juice for approximately 4 months of the 1961 Texas season.

METHODS

Valencia orange samples[2] were gathered at weekly intervals from two locations. One sample was from a grove of Pride O' Texas Citrus Association, Mission, Texas, and the other sample was from a grove of Rio Farms, Monte Alto, Texas. These groves consist of trees planted since the 1950-51 freeze and are representative of the area in which they are planted. Six trees in each grove were set aside for this study. The samples 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 30 fruit samples were brought to the laboratory and held at 40° F. until analyzed. The samples were never held longer than 48 hours before analysis. The samples were weighed, the fruit halved and the juice extracted by hand reaming with a Sunkist Juice Extractor.[3]

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[1] One of the laboratories of Southern Utilization Research and Development Division, Agricultural Research Service, United States Department of Agriculture.

[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 similar products not mentioned.

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.

Table 1. Seasonal Data on Juice of Valencia Oranges, 1961.

Sampling Date	*Location*[a]	*Juice Yield %*	*Brix °*	*Acid %*	*B/A*	*Visual Color*[b]	*Solids per 90 lb. box*	*Solids per ton*
2/22	P.T.	58	11.4	1.16	9.8	1-2	5.95	132.2
2/22	R.F.	60	11.2	1.08	10.4	1-2	6.05	134.4
3/2	P.T.	59	11.6	1.03	11.3	1	6.16	136.9
3/2	R.F.	62	11.2	1.02	11.0	1	6.25	138.9
3/9	P.T.	58	11.8	1.07	11.8	+1	6.16	136.9
3/9	R.F.	58	11.2	1.00	11.2	+1	5.85	129.9
3/17	P.T.	59	12.1	1.00	12.1	+1	6.43	142.8
3/17	R.F.	60	12.2	.97	12.6	+1	6.59	146.4
3/24	P.T.	60	12.9	1.00	12.9	+1	6.97	154.8
3/24	R.F.	59	13.0	.97	13.4	+1	6.90	153.4
3/31	P.T.	60	13.3	.96	13.9	+1	7.18	159.6
3/31	R.F.	62	13.0	.90	14.4	+1	7.25	161.2
4/7	P.T.	61	13.3	.95	14.0	+1	7.30	162.3
4/7	R.F.	60	13.5	.91	14.8	+1	7.29	162.0
4/14	P.T.	60	13.2	.93	14.3	+1	7.13	158.4
4/14	R.F.	60	13.0	.95	13.7	+1	7.02	156.0
4/21	P.T.	59	13.6	.88	16.5	+1	7.22	160.5
4/21	R.F.	61	13.2	.81	16.1	+1	7.25	161.0
4/27	P.T.	61	12.9	.86	15.0	+1	7.08	157.4
4/27	R.F.	62	13.0	.85	15.3	+1	7.25	161.2
5/4	P.T.	60	13.4	.77	17.4	+1	7.24	160.8
5/4	R.F.	62	13.3	.76	17.5	+1	7.42	164.9
5/12	P.T.	62	12.9	.65	19.9	+1	7.20	160.0
5/12	R.F.	62	13.2	.68	19.4	+1	7.37	163.7
5/18	P.T.	60	13.5	.65	20.8	+1	7.29	162.0
5/18	R.F.	62	13.4	.69	19.4	+1	7.48	166.2
5/26	P.T.	58	13.7	.65	21.1	+1	7.15	158.9
5/26	R.F.	61	13.8	.68	20.3	+1	7.59	168.4
6/2	P.T.	61	13.0	.62	21.0	+1	7.14	158.6
6/2	R.F.	63	13.3	.70	19.0	+1	7.54	167.6
6/9	P.T.	61	13.0	.64	20.3	+1	7.14	158.6
6/9	R.F.	59	13.3	.71	18.7	+1	7.06	156.9
6/16	P.T.	57	13.2	.61	21.6	+1	6.72	149.3

[a] Location: P.T., Pride O' Texas orchard, Mission, Texas.
R.F., Rio Farms orchards, Monte Alto, Texas.

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

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 "Abbe56" refractometer. Color notations were made by comparing the juice sample with color tubes of U.S.D.A. Color Standards for Orange Juice. 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.

RESULTS AND DISCUSSION

Table 1 lists the results of this study. The juice yield showed little variation during the testing period. The oranges were hand reamed and special care taken to obtain all the juice so that the yield values reported here are the highest that should be expected under ideal extraction.

The acid and Brix values have approximately the same seasonal variation as reported for Florida oranges (Harding, et al, 1940). The acid values declined during the testing period. The Brix values increased sharply during the early part of the season, leveled off during the mid season, and remained at the same level for the last half of the testing period. The Brix to acid ratio increased during the testing period, primarily due to the steady decrease in acid values. The solids per box and solids per ton values have the same trend of variation as the Brix values since the juice yield values are fairly constant. Little variation in juice quality and yield was noted between the two groves tested.

The color of all samples was good. After the second sample date the color was rated as better than Tube No. 1 for all samples.

SUMMARY

The seasonal variation of the juice quality of Valencia oranges grown in Texas is reported. The same general trends due to seasonal variation were noted as reported from Florida Valencia oranges. Although this study covers only one season and fruit from two groves, the seasonal variation of juice quality should be applicable in predicting the variation that can be expected in other seasons from normal groves.

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Some Factors In Appraisal Of Citrus Groves

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PURPOSE

The purpose of this study is to point up some of the related factors that should be considered in the appraisal of a citrus orchard. No attempt will be made to give a price per acre or a complete appraisal but to show how the physical and economic factors and the cost of production can be used in appraisal work. A problem of evaluation of an orchard is to determine its value at any point in time. During the first stage of growth, an orchard increases in value because it is receiving additional inputs of labor and material although it has no income. Then, an orchard has a period when it yields an income, although the annual expenses exceed the annual receipts. The third and most important stage is that during which the orchard's net income is increasing and exceeds expenses. The fourth stage is that in which the orchard's net income is decreasing. Inputs must be studied carefully to maintain reasonable net returns from the enterprise.

Valuation is particularly important for durable assets. Some land improvements are as durable as land itself and buildings and orchards are highly durable. A durable asset derives its value from the "stream" of income that flows from it over the years. The market value of farm real estate therefore represents a certain level of expectations.

Condemnation appraisals require strict adherence to legal procedure and correctness because they may become the center of a court battle. The major objective is a value that compensates the owner for the property being taken. If a farm is condemned for an airstrip or a highway, the compensation value should be what it would cost the owner to buy an equivalent farm. When only a part of the farm is taken, compensation should include damages that represent the difference between the value of the farm and its value after the portion is taken. These damages should include the loss the owner might incur having had his farm reduced from the size most profitable for him to operate.

PHYSICAL FACTORS

There are a number of physical factors that should be considered in appraising an orchard. Climate, soil, drainage, topography, water resources, proximity to hard surfaced roads and accessability to processing plants and packingsheds are important in orchard management.

Soil

An ideal citrus soil is one that is deep and well drained, a sandy loam soil. It should have a subsoil free from tight clay layers. Soils like

this contain enough sand to keep them from being heavy when wet and allow rapid absorption of water.

The nutrient absorption zone for citrus trees is usually confined to the first two feet below the surface in which 80 per cent of the roots will be found. About another 15 per cent of roots is in the 2 to 3 foot level. Where soil moisture is maintained properly, the remaining small percentage of roots may be found at the 3 to 4 foot level. Those deeper roots help supply moisture during prolonged drouth.

The free water table should be more than 4 feet below the surface of the ground. A water table that fluctuates to a point about 2 feet from the surface is more harmful than a steady level at the 3 foot level.

Citrus trees should not be planted in low places. Surface, subsurface and air drainage are poor in such areas. Cold air is heavier than warm air and settles in the low spots to form frost pockets. Ridges and gentle slopes are better for orchards because the cold air drainage forms more readily and decreases frost hazards. Practically all of the citrus land in the Valley requires some mechanical treatment, especially before the land can be irrigated properly.

ECONOMIC FACTORS

Tree Spacing

Tree spacing has become an important factor with an objective of producing as much tonnage of good quality fruit of marketable size per acre as possible. Close spacing will provide a greater tonnage early in the grove life. Close spacing will cause crowding in the grove in about 10-15 years. The general trend today is to plant more trees per acre than were planted before the freeze in 1951, at which time 58 to 65 trees per acre was the normal number of trees per acre. At the present time, the general spacing trend is about 75 to 87 trees per acre. The 25' x 15' spacing, 116 trees per acre with eventual thinning to 25'x30' with 58 trees, is popular. Some orchards are now planted with spacing of 20' x 25' for 87 trees per acre, while spacing of 15' x 20' gives 145 trees per acre which is considered too close. There are several reasons for close spacing: (1) It provides maximum land utilization; (2) It minimizes productive expense per unit produced. Therefore, the number of trees per acre becomes important in appraisal work.

Yields

Yields are affected by many factors. Both the number of trees per acre and the number of boxes per tree contribute to the economic returns from an orchard. During the period 1940-50, the average grapefruit and orange yields for all fruit ranged from less than 4 to almost 7 boxes for grapefruit trees and from less than 3 to about 5 boxes for orange trees. Yield per acre is one of the most important factors in figuring values; each orchard appraisal has a potential yield of X number of tons depending upon the condition of the orchard being appraised. Some good orchards of grapefruit may go as high as 30 tons per acre.

The estimated average production for grapefruit is 15 tons per acre and orange production is estimated at 11 tons per acre. A citrus tree does not start producing immediately; a rule of thumb for grapefruit is: 3-5 years to start commercial production, 10-15 years to reach peak of production and 20-25 years or more of production. The production for Texas grapefruit is estimated in Table 1.

The time of picking during the season has some effect on the yields produced. Size increases throughout the season for all citrus. For example, grapefruit will increase at least one size, from 96's to size 80's or larger between November and late February.

Prices

Appraisers generally use average price over a period of 5 to 10 years or longer. Table 2 indicates the production, price and value the farmer received for Texas grapefruit and oranges for 1954-55 to 1958-59 seasons. This period was considered the most representative "normal" period with current data. The period from 1950-51 to 1953-54 would not be representative because it was affected by the freeze of 1951. The average price paid to growers for grapefruit for the past 5 years was $1.25 per 80-lb. box. At the same time the average orange price paid to growers was $1.49 for a 90-lb. box.

Table 1. Estimated production of grapefruit trees by various ages.

Age of tree	*Production per tree in boxes*[1]
4 yrs.	¾
5 yrs.	1½
6 yrs.	2½
7 yrs.	4
8-10 yrs.	5½
11-16 yrs.	6

[1] Grapefruit, 80 lbs. per field box.
Source: Various members of the Texas Citrus Industry.

Table 2. Production, price and value of Texas grapefruit and oranges to growers, 1954-55 to 1958-59.

	GRAPEFRUIT			*ORANGES*		
Crop Season	*Production*[1] *1,000 boxes*	*Price Dollars*	*Value*[2] *1,000 Dollars*	*Production*[1] *1,000 boxes*	*Price Dollars*	*Value*[2] *1,000 Dollars*
1954-55	2,500	1.27	3,175	1,500	1.61	2,415
1955-56	2,200	1.24	2,728	1,600	1.79	2,864
1956-57	2,800	1.03	2,884	1,600	1.57	2,512
1957-58	3,500	1.24	4,340	2,000	1.71	3,420
1958-59	4,200	1.41	5,922	2,300	2.54	5,842

[1] Grapefruit 80 lbs. per box; Oranges 90 lbs. per box.
[2] Equivalent packing house door returns for all methods of sale.
Released from Texas Crop & Livestock Reporting Service Market News Service on Fruits & Vegetables, AMS, USDA, Marketing Texas Citrus, Lower Rio Grande Valley, Summary of 1959-60 Season, by R. E. Winfrey, Weslaco, Texas, October 1960.

The price paid to growers varies by season, by varieties and by the end-product, canned or fresh. During the past couple of years, orange prices have been a little higher due mainly to the purchases of oranges for chilled juices and concentrate processing. Current information on Texas packingshed prices paid to growers by varieties for packed fruit is shown in Table 3. The information for this table was obtained from a

Table 3. Average price per ton paid by Texas packingsheds for grapefruit and oranges packed and distribution of volume by percentage, 1958-59 and 1959-60 season.

GRAPEFRUIT[1]	*Per Cent* Season 1958-59	*Per Cent* Season 1959-60	*Average Price/Ton* Season 1958-59	*Average Price/Ton* Season 1959-60
Red	61.4	61.3	$39.88	$32.29
Marsh Pink	23.5	17.5	27.82	27.89
Foster Pink	0.5	0.4	24.08	20.94
Marsh White	14.5	20.7	29.06	27.78
Duncan	0.1	0.1	19.11	18.98

[1] Number of boxes in sample in 1958-59 was 1,893,672; 1959-60 was 1,218,755.

ORANGES[2]	*Per Cent* Season 1958-59	*Per Cent* Season 1959-60	*Average Price/Ton* Season 1958-59	*Average Price/Ton* Season 1959-60
Early Oranges	58.8	39.0		
Navel			$83.98	$57.89
Marrs			79.99	36.32
Hamlin			59.09	36.22
Pineapple			54.93	32.48
Mid-Season	0.4	8.7		
Jaffa			54.23	36.53
Temple			73.94	42.82
Late Varieties	40.5	51.8		
Valencia			62.20	34.83
Other Citrus	0.3	0.5		
Tangerines			73.07	78.87
Tangelos			42.99	38.81
Lemons			....	....

[2] Number of boxes in sample in 1958-59 was 1,319,359; 1959-60 was 522,495.

majority of the Valley shippers and represents over a million field boxes of grapefruit for each season, 1958-59 and 1959-60. The data on oranges for the same period represents over a million boxes one year and over 500,000 boxes the other. The prices paid to growers by processors are considerably less; for example, today the canners price for red grapefruit is less per ton than the price paid for white grapefruit.

This year the Florida Citrus Industry is buying oranges for processing on price per pound of solids. This is a relationship between pound of solids and number of 6-ounce cans of frozen orange concentrate produced per 90-lb. box of oranges. This may become a new pricing system in the future.

Varieties

Texas citrus may be divided into three major groups for commercial purposes. They are grapefruit, oranges and mandarins. Varieties of oranges may be placed into three general classes: early, mid-season and late varieties. The leading early varieties are Hamlin, Pineapple, Navel and Marrs; mid-season varieties are Jaffa, Joppa and Temple; the late variety is Valencia.

Grapefruit are generally classified by color of flesh, such as white, pink and red. More specifically, the important named varieties are Marsh White, Marsh Pink, Foster Pink, Ruby Red, and Duncan, a white seedy variety.

The proportion of production by varieties in per cent of volume purchased by packinghouses in Texas during the 1958-59 and 1959-60 seasons is shown in Table 3. Grapefruit represented 57.3 per cent of the tonnage handled, with red the predominant variety. Valencia, a late orange, represented almost half of the orange tonnage.

COST OF PRODUCTION

The planting of trees and their protection involves heavy costs the first year; thereafter, the costs are relatively low for a few years then rise rapidly until the trees are in good bearing condition. At this level the cost remains stable until the trees are removed. The cost of planting may vary. Some reports show high costs the first 3 years and lower costs thereafter due to increased machine operations and less hand labor.

The value of the orchard, measured by the discounted future net earnings, rises steadily and sharply to a maximum when the trees are about 10-15 years of age. An orchard is not at its most valuable age when its net income is the highest, but it is most valuable at the age when it enters into the period of relatively high net earnings. Because there are several profitable years ahead, this should be considered before buying or selling. By the time the peak annual earnings have been reached, the value is one of decline because the largest incomes have already been received. There are very few citrus orchards that might fall in this class.

Costs for grove care, be it either self-operations or commercial grove

care, will vary throughout the area. This variation may be attributed to the rate and applications of fertilizer, water and insect and disease controls applied, method of irrigation, type of orchard management and the amount of taxes.

Grove care costs are increasing just as are other costs. Table 4 shows the variation in grove care cost per acre by age of trees. In Table 4 the initial period represents the cost of trees and planting plus grove care costs the first year. After the first year, only the grove care costs are shown. As the trees become older and larger, they require more time and care for each operation. Thus, it should be noted that these yearly costs will vary and increase with the age of the orchard.

In constructing accumulative cost of production and income per acre for grapefruit and oranges, certain factors were used. The cost per acre of orchard used was the one with initial costs of $150.00 per acre for planting, Operation A in Table 4. Production by age of trees was determined from Table 1. Two tree spacings were used, 65 trees per acre and 87 trees per acre, to indicate the difference in yield obtained

Table 4. Variations in planting costs and care of Texas citrus orchards.

		OPERATORS A	OPERATORS B	OPERATORS C
	No. trees per acre	86	80 (approx)[1]	70
Years	*Type of Cost*	*Cost per acre Dollars*		
	Trees and planting	$150	$102	$100[2]
1st	Care	100	88	70
	Total 1st year	250	190	170
2nd	Care	100	88	70
3rd	Care	100	88	70
4th	Care	110	88	90
5th	Care	115	88	110
6th	Care	120	106[3]	125
7th	Care	125	124[3]	135
8th	Care	130	143[3]	140
9th	Care	130	143[3]	140
10th	Care	130	143[3]	140
11th	Care	130	143[3]	140
12th	Care	130	143	150
13th	Care	130	143	150
14th	Care	130	143	150
15th	Care	130	143	150

[1] Estimated number of trees.
[2] Estimated cost of trees and planting $100 per acre.
[3] Estimated cost per acre.
Source: Hidalgo County Agent and reliable citrus orchard operators.

by the number of trees. The average price per box of fruit for a 5-year period was determined from the information in Table 2. The average price paid to growers for grapefruit for the last 5 years was $1.25 per box and for oranges it was $1.49 per box.

The projected accumulative costs and income for grapefruit and oranges are shown in Charts 1 and 2. This includes all costs, including taxes but no land investment costs.

It is evident that the number of trees per acre and the price per box or ton will have a considerable effect on the income per acre and the time required to realize returned investment.

Considerable care and judgment should be used when determining the basic value of orchard trees. In appraisal work several methods are

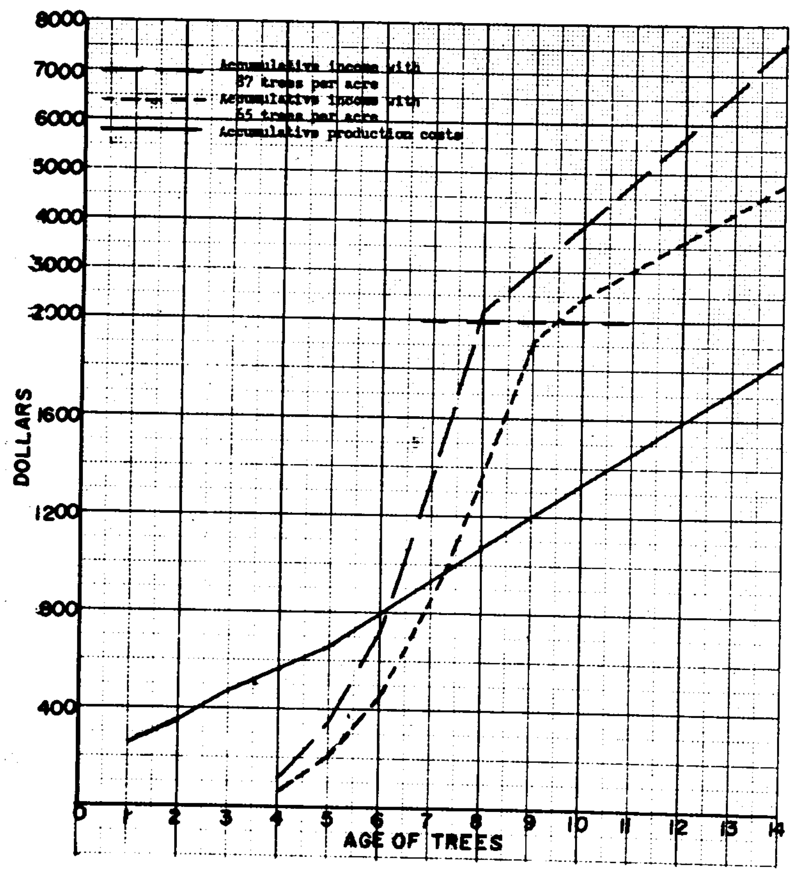

Chart 1. Accumulative cost of production and income for grapefruit per acre.

used for determining this basic value: (1) The tree value may be figured on the basis of future returns, as has been described previously; (2) The tree value may be figured on the cost of producing the trees; and (3) A combination of methods (1) and (2) may be used.

SUMMARY

A complete appraisal study would include a number of points.

1. The land value should depend upon such factors as soil type, location, topography, available water, water rights, drainage tile, irrigation pumps and installations. Less valuable but just as important should be consideration of salt spots, cold spots and other localized trouble areas.

2. The tree value should include factors as varieties, age of tree,

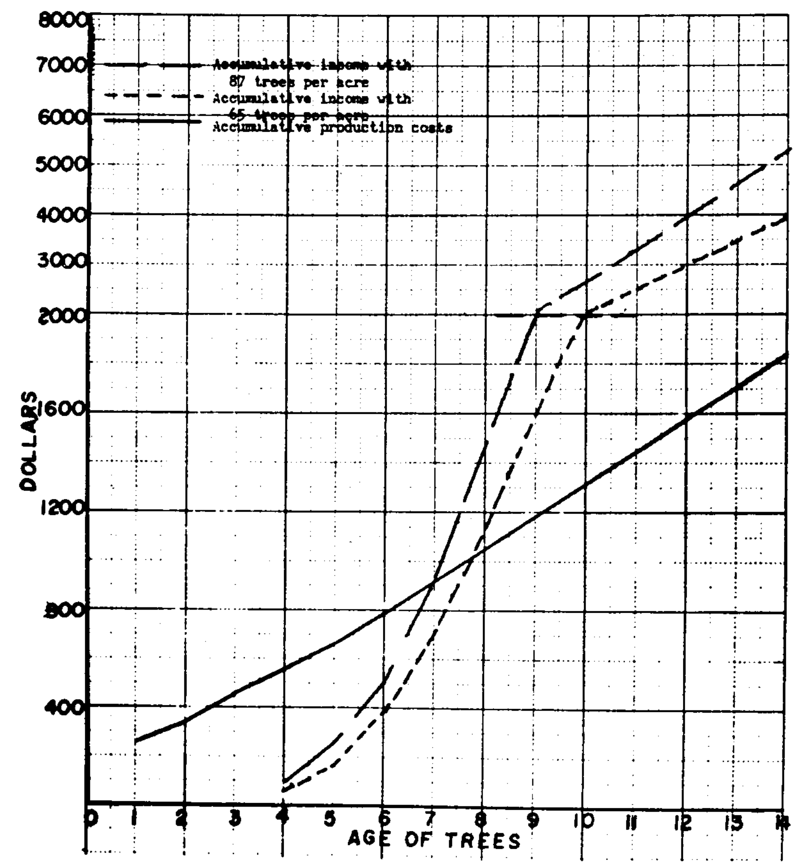

Chart 2. Accumulative cost of production and income for oranges per acre.

number of trees per acre, relative fruitfulness, condition of tree, amount, if any, of psorosis disease, incidence of frost damage, type of rootstock and life expectancy.

3. The future income of the orchard should be considered by prices paid for fruit, cost of production and interest on investment.

4. Compensation adjustments for hard to measure situations should be considered. For example, care of remainder of orchard sometimes becomes more difficult after a portion is sold. Sometimes the value of a grove increases when a good highway adjoins the orchard; such an orchard can be picked more easily after wet weather since trucks can get to the orchard.

Production of Red Grapefruit Trees Through Nine Years of Age in the Lower Rio Grande Valley

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Growers and prospective citrus growers have requested information about grapefruit yields for the first ten years after planting. This information has value in estimating when grove returns will exceed grove-care expenses.

Information on fruit production by different-aged trees is also of value to state and federal personnel doing citrus research. The information aids planning the duration of citrus experiments and shows the variability of productiveness among trees of the same variety within the same year and variability between trees from year to year.

METHODS

A red grapefruit strain test was planted on the Experiment Station in April 1951. The trees were registered trees on sour orange and Cleopatra mandarin rootstocks. The plots consisted of four replications of two tree blocks of each strain. Data in Table 1 was taken from the results of the strain test over a nine-year period.

Yield data from a similar-aged red grapefruit grove at Rio Farms is presented in Table 2; this citrus experiment has been in progress for five years. These trees were planted in 1947 but were frozen to the soil banks in the 1949 and 1951 freezes; the tops are the same age as those in the Station grove.

Both plantings have received similar fertilizer treatment; three pounds of nitrogen per tree per year applied in three applications. The Station planting is managed as a permanent-border planting with weeds

Table 1. Production of Webb Red Grapefruit on Sour Orange Rootstock, Experiment Station Grove 1953 to 1960 Inc.

	Tons of Red Grapefruit Per Acre by Year of Age of Trees								
Replication	3	4	5	6	7	8	9	*Total*	*Mean*
1	2.0	2.1	6.6	8.6	17.1	19.2	35.4	91.0	13.0
2	1.4	5.8	6.6	10.3	15.6	11.1	16.8	67.6	9.6
3	2.2	3.1	3.8	9.2	13.5	12.9	18.5	63.2	9.0
4	4.4	3.6	10.4	11.4	16.3	18.0	19.7	83.8	11.9
Mean	2.5	3.6	6.8	10.0	15.6	15.3	22.6	76.4	10.9

and grass being cut with a cotton-stalk shredder and vine and weed control under the trees maintained by a shallow-cutting soil rotovator. The planting at Rio Farms is managed under a semi-clean system of cultivation with sprinkler irrigation.

RESULTS AND DISCUSSION

In the Station grove (Table 1) fruit production started when the trees were three years old and has steadily increased to an average of 22 tons per acre in the ninth year. There is up to 100 per cent variation occurring between plots in many years. However, the trees producing low or high yields are not necessarily the ones that will produce low or high yields the next season. Also, over the 7-year production period, the difference between the highest-producing 2-tree plot and the lowest-producing 2-tree plot is only 31 per cent. This would indicate that the wide variation between trees on a yearly basis is probably due to climatic factors rather than differences in the productive properties of the tree. Over a period of years, the yield differences between trees will decrease to 25 to 30 per cent.

Because of climatic factors such as cold dry winds causing mesophyll collapse, freezes, extremes of heat and drouth, Valley citrus groves probably seldom produce the crop that the trees are capable of producing under optimum climate conditions. The data in Table 2 for the sixth and seventh years illustrates the forementioned fact. In the fall of the fifth year, mesophyll collapse damaged the foliage and small wood so that the next season's crop was reduced; in the winter of the sixth year a light freeze killed enough wood to reduce the crop for the seventh year.

The data shows that research production tests in the Valley should be conducted for at least five years in order for the treatments to show true differences in their effects on yield. Probably, greater accuracy will be obtained if experiments are continued for a longer time.

Table 2. Production of Webb Red Grapefruit on Sour Orange Rootstock, Rio Farms Grove, 1956 to 1960 Inc.

	Tons of Red Grapefruit Per Acre by Year of Age of Trees						
Replication	5	6*	7**	8	9	*Total*	*Mean*
1	6.7	3.1	4.4	15.4	13.1	42.7	8.5
2	8.3	5.1	8.1	14.1	13.8	49.4	9.8
3	7.8	5.0	6.7	19.7	16.9	56.1	11.2
4	5.0	5.5	6.4	18.1	15.7	50.7	10.1
Mean	6.9	4.7	6.4	16.8	14.9	49.7	9.9

* Yield reduced by mesophyll collapse
** Yield reduced by freeze damage

The practice of taking yield records on trees for one or two years before starting an experiment is of questionable value in the Valley, since the trees producing high yields one season may not be equally high-yielding trees the next season.

The data presented herein is not intended to show what all groves will produce. It is intended only as a guide to production through nine years of age. Yields will vary in each grove due to tree spacing, soil, location, climatic factors and management. Many well-managed grapefruit groves in the Valley will not produce as much as these two and some will yield more fruit per year.

Earliness of Flowering and Fruiting of Citrus Trees Propagated From Top and Basal Shoots Of Young Fruiting Seedlings

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Young citrus seedlings pass through a juvenile growth phase before they form normal flowers and bear fruit.[1] The transition from the juvenile to the adult phase is gradual, and apparently not all parts of the tree attain the adult condition in which flowering occurs at the same time (Furr, Cooper, and Reece, 1947). It is common knowledge that the first flowers citrus seedlings produce are usually borne in the top of the trees or at the extremities of long branches; that is, flowering usually occurs first on shoots that have grown from buds far removed from the base of the tree trunk, the first formed and, presumably, the most juvenile stem tissue in the tree. Some citrus seedlings, particularly certain limes and lemons, may fruit first on what at first sight appear to be low lateral branches that arose from the trunk near the ground. Upon close examination all such branches observed by the writer have proved to be the central axis of the young tree that was crowded to one side and greatly overgrown by one or more vigorous shoots that arose at the base of the original seedling trunk. Apparently the original "top" of the seedling reached sexual maturity before the much taller stems that arose from the base of the original trunk.

Frost (1943) reported extensive observations on the relation between the juvenile growth stage and thorniness in citrus. He stated also that his observations suggest that as seedling thorniness declines, the tendency to flowering increases. In one test he found that budwood selected from a thornless shoot borne on a high branch of a young-line nucellar Kara mandarin tree produced nearly thornless trees that bore many flowers, whereas budwood from an extremely thorny shoot borne on a low branch near the trunk of the same tree produced very thorny trees with few flowers.

In work on the relation of juvenility in apple stems to ease of rooting, Stoutemyer (1937) found that cuttings made from shoots that arose from adventitious buds on roots or from latent buds on the trunk would root readily, whereas cuttings from shoots from the tops of fully mature trees would not root. Cervenko (1960) stated that apple trees propagated from shoots that grew from root cuttings started to flower later than trees

[1] Sometimes citrus seedlings, especially grapefruit or shaddock, only a few months old bear single, terminal flowers, which are usually abnormal and rarely produce fruit. Seedlings that flower at several months to 1 year of age do not flower again until they reach the period of transition from the juvenile to the adult phase of growth.

propagated from shoots from the tree top.

With such evidence as that cited of the persistence of the juvenile condition in the basal region of seedling or young line trees, it has seemed advisable in taking budwood for the propagation of such trees to select it from the extremities of the longest or topmost branches in the hope of thereby promoting early fruiting. When selecting buds from young seedlings or young-line budded trees, many citrus propagators now select relatively thornless budwood from shoots at the extremities of the tree top. There seems to be, however, little experimental evidence that trees budded from shoots borne on topmost branches will fruit appreciably sooner than those budded from basal shoots that arose low branches near the trunk or from the trunk itself, and it is often more difficult to obtain good budwood from the topmost branches of seedling or young-line trees than from shoots lower down.

This paper reports results of observations on the time of flowering and fruiting of citrus trees propagated from topmost shoots of seedlings that had not long been in bearing as compared with those propagated from basal shoots from the same tree.

MATERIALS AND METHODS

Except for a grapefruit seedling that had been in bearing about 10 years, seedlings selected as sources of budwood to be used in the comparison of earliness of flowering and fruiting of trees grown from top and basal buds had come into bearing the season before buds were taken. One criterion in the selection of bud-source trees was that they have shoots of the previous season's growth that had arisen from latent buds on the trunks near the ground. Shoots from the base of the trunks and from the extremities of branches that had fruited would, presumably, represent the greatest extremes in sexual maturity of the bud tissue taken for propagation. In most instances the trees selected as bud sources had been used in a ringing experiment in 1955. Bark rings had been briefly taken from the trunks and replaced. This resulted in little injury but stimulated the growth of shoots from latent buds below the rings.

In March 1956 trees were propagated in pairs. One tree of each pair was grown from a bud taken from a shoot that arose on a fruiting branch at the extreme top of lateral extension of the tree top (top bud), and the other member of the pair was propagated from a shoot that arose from the trunk near the ground (basal bud). Six pairs of trees were propagated from each of the following seedling sources: seedy grapefruit; Rangpur limes 1, 2, and 3; Iran lemons 6 and 15; Weslaco tangerine. Only 5 pairs of trees from a Murcott tangerine seedling were included.

Half the trees from each bud source were propagated on Shekwasha mandarin rootstocks. The budlings were grown one season in the nursery and were transplanted in February 1957 to temporary rows between rows of permanent trees one or two years older. Test trees were planted in pairs, those from basal buds alternating with those from top buds. They were planted 5 feet apart in the rows, and the rows were in adjacent middles between permanent rows of a variety collection of citrus trees spaced 15 feet apart in rows 22 feet apart. The space available allowed for only about 4 years of growth of the test trees without serious crowding.

RESULTS

In 1958, a year after the trees were transplanted to the field, many of the Rangpur lime trees and a few of the Iran lemon trees produced a few flowers (Table 1). On the two stocks combined 18 Rangpur trees were grown from basal buds and 18 from top buds. Of these, 9 trees from basal buds flowered and 13 from top buds flowered. On the two stocks combined there were 12 Iran trees from basal buds and 12 from top buds; of these, 2 trees from basal buds flowered and 6 from top buds flowered. The average number of flowers per tree on the 15 trees from basal buds and the 15 trees from top buds was, respectively, 7 and 19. Almost no fruit were matured from this first bloom.

All 18 of the Rangpur lime trees fruited in 1959 (Table 2). On Shekkasha rootstock the Rangpur trees from top buds produced more fruit (306) than those from basal buds (282), but on Carrizo stock the reverse was true; the trees from basal buds produced 210 fruit and those from top buds 188. The total numbers of fruit on Rangpur trees from basal and top buds were nearly the same, 492 and 494, respectively.

On Shekwasha stock the numbers of Iran lemon trees from basal and top buds that fruited in 1959 were, respectively, 3 and 5; and the numbers of fruit produced from basal and top buds were, respectively, 5 and 17. On Carrizo stock in 1959, all Iran lemon trees fruited; 74 fruit matured on the trees from basal buds and 82 fruit matured on trees from top buds. Thus, 9 Iran trees from basal buds fruited and produced 79 fruit, but 11 Iran trees from top buds fruited and produced 99 fruit.

Table 1. Number of Rangpur lime and Iran lemon trees from basal and top buds that flowered in 1958.

Kind of rootstock and bud source	*Pairs of trees (no.)*	*Basal buds*	*Top buds*
		Trees flowering (no.)	*Trees flowering (no.)*
Shekwasha stock:			
Rangpur 1	3	2	3
Rangpur 2	3	3	3
Rangpur 3	3	3	3
Iran 6	3	0	2
Iran 15	3	1	2
Carrizo stock:			
Rangpur 1	3	0	0
Rangpur 2	3	1	2
Rangpur 3	3	0	2
Iran 6	3	0	1
Iran 15	3	1	1

The Rangpur lime and Iran trees were removed in the winter of 1959-60.

In 1959 one of the 5 Murcott tangerine trees grown from basal buds produced a few flowers, but set no fruit. None of the Murcott trees from top buds flowered in 1959. None of the Murcott trees were observed to flower in 1960, and in the winter of 1960-61 they were removed to avoid serious crowding of the adjacent permanent trees.

In 1959, three grapefruit trees from top buds fruited and matured 9 fruit, whereas none of the grapefruit trees from basal buds fruited (Table 2).

In spite of some crowding, the grapefruit trees were allowed to remain until the 1960 crop was matured. In 1960, the second year of fruiting, one of the grapefruit trees from a top bud growing on Shekwasha stock produced 7 fruit, but none of the 3 trees from basal buds fruited. On Carrizo stock in 1960 all 3 grapefruit trees from top buds fruited and produced 11 fruit, but none of those from basal buds fruited.

The Weslaco tangerines were rather small, erect trees and did not crowd the permanent trees; consequently, they were not removed until after the bloom period in 1961. When they flowered for the first time in 1961, they were rated as to number of flowering shoots borne by each

Table 2. Fruiting behavior in 1959 of trees grown from basal and top buds.

Kinds of rootstock and bud source	*Pairs of trees (no.)*	*Basal buds*		*Top buds*	
		Trees fruiting (no.)	*Fruit borne (no.)*	*Trees fruiting (no.)*	*Fruit borne (no.)*
Shekwasha stock:					
Rangpur 1	3	3	71	3	119
Rangpur 2	3	3	73	3	171
Rangpur 3	3	3	138	3	16
Iran 6	3	2	2	3	8
Iran 15	3	1	3	2	9
Grapefruit	3	0	0	2	7
Carrizo stock:					
Rangpur 1	3	3	73	3	43
Rangpur 2	3	3	60	3	48
Rangpur 3	3	3	77	3	97
Iran 6	3	3	24	3	20
Iran 15	3	3	50	3	62
Grapefruit	3	0	0	1	2

tree. Five or more flowering shoots per tree were rated as "many"; fewer than 5 as "few." Of the 6 Weslaco tangerine trees from basal buds 2 had few flowering shoots and 4 had none. All Weslaco tangerine trees from top buds flowered; 5 had many flowering shoots and one had few. No fruit set on any of the Weslaco tangerine trees.

DISCUSSION AND CONCLUSIONS

In 1958, at the first flowering of the Rangpur lime and Iran lemon trees, almost two-thirds of the trees that flowered were grown from top buds, and the flowering trees from top buds had more than twice as many flowers as those from basal buds. The record of first flowering of the Weslaco tangerine trees was similar to that of the Rangpur lime and Iran lemon trees; that is, three times as many trees from top buds as from basal buds flowered, and the flowering trees from top buds bore more flowers than those from basal buds.

The results of this experiment substantiate previous observations that, in general, trees from top buds flower earlier and more profusely than those from basal buds.

The results of first fruiting are somewhat less conclusive than those of first flowering. At first fruiting of the precocious Rangpur lime all trees fruited, and the numbers of fruit produced by trees from basal and top buds were practically the same.

The Iran lemon was less precocious in fruiting than the Rangpur lime, and at first fruiting slightly more trees from top buds than from basal buds fruited. The number of fruit produced by trees from top buds was also slightly greater than that produced by trees from basal buds.

The trees from basal and top buds of the seedling grapefruit that had been in fruit for 10 years showed the greatest contrast in production of fruit. None of the trees from basal buds fruited in 1959 or 1960; but in both years combined, 4 trees from top buds fruited and produced 16 fruit.

The results of this experiment suggest that the more precocious a variety is in flowering and fruiting, the smaller the difference is likely to be in earliness of flowering and fruiting of trees propagated from basal and top buds. Unfortunately the experiment was terminated before the two least precocious varieties, Murcott and Weslaco tangerines, fruited. From the records of fruiting available, however, it appears that the difference in time of first fruiting of trees from basal and top buds is not great. That there is some difference in time of fruiting of trees propagated from buds taken from different parts of the tree is of considerable interest; but the difference may be too small to be of much practical value except when it is important to obtain even a few fruit as soon as possible after the tree is propagated, as, for example, in tests of new hybrids in breeding work. The aging of a clone that results in early bearing by trees propagated from it is so gradual, in some kinds of citrus being prolonged for many years, that this factor is likely in most in-

stances of propagation from young seedling trees greatly to outweigh the relatively small effect of position on the tree from which the buds were taken. Nevertheless, in the selection of budwood from young seedlings there seems to be sufficient advantage in taking buds from the extremities of the top rather than from sprouts on the trunk or main branches to justify the choice of buds from the extremities of top shoots.

SUMMARY

Times of first flowering and fruiting of pairs of citrus trees propagated from buds from shoots borne at the extreme top (top buds) of young bearing seedlings and from shoots borne at the base of the trunks (basal buds) of the same seedlings were observed. At first flowering 2 or 3 times as many trees from top buds as from basal buds flowered and flowering was more profuse. At first fruiting of precocious Rangpur lime trees all fruited and all produced the same average number of fruit per tree. Iran lemon trees from top buds slightly exceeded those from basal buds in numbers of trees fruiting and fruit borne at first fruiting. Position from which buds were taken had more effect on loss of juvenility in grapefruit, which was relatively slow in coming into bearing, than on that in other fruiting trees. Of 6 grapefruit trees from top buds, 4 fruited; but none from basal buds fruited.

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A Portable Tree Freezer Designed For Studying The Cold-Hardiness of Large Citrus Trees[1]

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The ability of some plants to withstand extremes in temperature in contrast with the great sensitivity of others is one of the oldest problems in plant science. Most of the scanty information on cold-hardiness of citrus is based on field observations after natural freezes. Such observations are valuable, but the infrequent occurrence of "test winters" – only about one in ten–does not permit the proper preparation of experimental trees. Experimental treatments include various stages of dormancy or the application of various cold-hardiness-inducing treatments to the trees. It is, therefore, difficult to obtain sufficient readings from natural freezes to arrive at entirely sound conclusions.

Hawkins (1924), investigating the freezing of citrus fruit on trees in California, constructed a special freezing apparatus designed for freezing trees in the grove. This apparatus consisted of a collapsible, insulated chamber 8 feet high and 9 feet in diameter. It was made up of panels 2½ feet wide and 8 feet high with airtight joints. The top was covered with a tarpaulin. Cold air for freezing was provided by blowing air through a mixture of ice and salt contained in a tank at one side of the insulated chamber; the cold air passed into the chamber through a grating. During operation of the freezer, air was removed from the top of the chammer by an exhaust fan. As low as 2 or 3° F. could be obtained with this apparatus. Temperatures of the fruit were taken with 12 small resistance thermometers inserted in fruit on various parts of the tree. With this equipment Hawkins determined that the freezing point of Washington navel orange ranged from 26 to 28°; Valencia orange from 26.5 to 28.5; and lemon from 27.7 to 29.2. Hawkins also observed that oranges frequently under cooled to as low as 20.5° before freezing and the fruit temperature raised to the true freezing point of 26 to 28.3° during freezing.

Following the 1951 freeze citrus cold-hardiness research was started in Texas. A portable freezer with a 5 x 5 x 5-feet freezing compartment was constructed and used to test cold-hardiness of 3-year-old trees in their natural environment (Cooper et al., 1955; Cooper, 1959). Experience with these small trees indicated possible advantages of working with full-grown trees under normal orchard practice and led to the development of a large portable tree freezer in 1958.

The purpose of this report is to describe the components, performance, and capabilities of this 18 x 18 x 18-feet portable tree freezer.

COMPONENTS OF THE PORTABLE TREE FREEZER

The portable tree freezer consists of 3 basic units: vault, refrigeration and controls, and generator or power source.

The vault (Figure 1) is 18 x 18 x 18 feet. The walls (A) consist of 16 panels 18 feet tall by 44 inches wide and 4 corners, or L's, 18 feet tall and 20 inches wide. The wall panels are fabricated of full 2 x 4-inch pressure-treated wood frame with styrofoam insulation 4 inches thick and are clad on both sides with aluminum 0.0359 inch thick. The wall panels fasten to each other with 4 standard No. 1 roto-lock assemblies on each

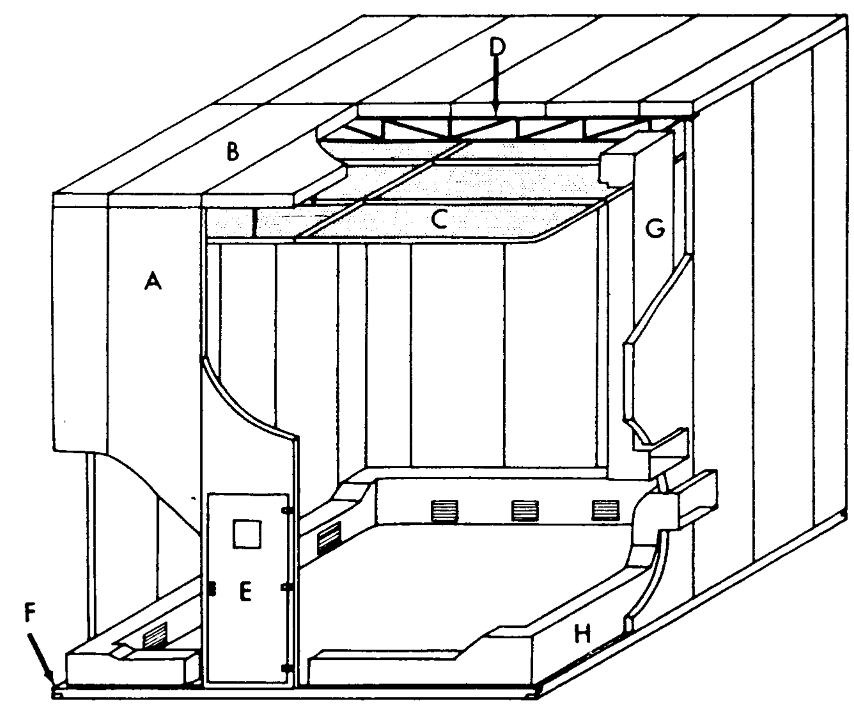

Figure 1. Phantom view of the vault; A, wall panel; B, roof panel; C, false perforated ceiling; D, steel beam support for roof panels; E, door; F, base; G, cold air supply duct; H, air return duct.

[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] The authors acknowledge the collaboration of Chas. Parce, Valley Weathermakers, Inc., Harlingen, Texas, who designed the portable freezer and who contributed much to its usefulness as a research tool.

side and one on top to fasten to roof panels (B) and one on the bottom to fasten to the base (F). All joints are tongue and groove with a strip of rubber weather strip in all grooves. The base (F) is constructed of 4 x 4-inch lumber with a tongue to fit the groove in the wall panels. The roof panels (B) are fabricated in the same manner as the wall panels but are 6 inches thick and 9 feet long; 8 are 44 inches wide and 4 are 20 inches wide and fasten to each other with 2 standard No. 1 roto-lock assemblies. The roof panels are supported by a 10-inch steel beam (D) that runs across the center of the chamber. The beam makes a flat rest for the roof panels. The panels on which the beam rests are double studded under the beam. A perforated aluminum false ceiling (C) hangs 12 inches below the roof and is supported by canvas strap fasteners attached to the roof panels. An insulated air-tight door (E) 3 feet by 6 feet 8 inches is centered in a wall panel and contains a 12 x 12-inch window made of thermopane. All duct work is made of galvanized iron and rests inside the chamber. The air-return duct (H) around the bottom of the chamber has 18 double-deflection registers with dampers. These dampers, when properly adjusted, pull the air from the chamber evenly. The cold-air supply duct (G) discharges into the 12-inch space between the false ceiling and roof panels and enters into the controlled temperature area through the holes in the false ceiling.

The duct work, not shown, that connects the air supply and return from the vault to the refrigeration unit is constructed of galvanized iron and insulated with styrofoam 4 inches thick; the joints are taped with refrigeration tape and insulated with pieces of rug pad; a plastic sheet over the rug pads keeps moisture from condensing on cool rug pads.

The refrigeration unit (Figure 2) consisting of compressor, condenser, cooling coil, blower, recording and controlling instruments, and

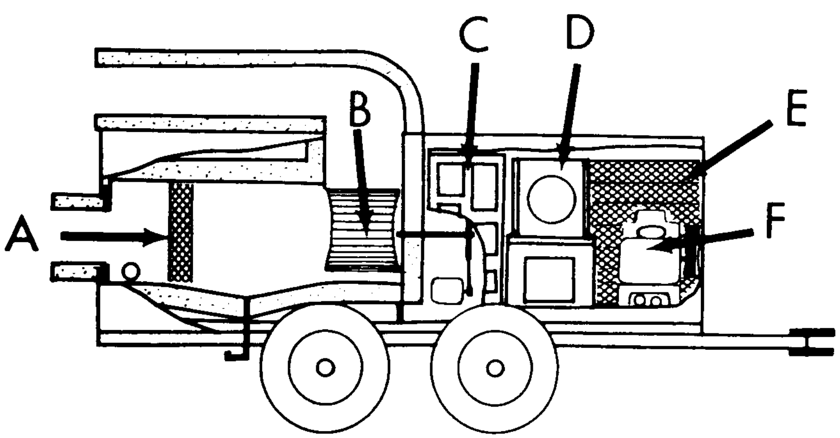

Figure 2. Cut-away side view of the refrigeration unit: A, cooling coil; B, blower; C, control panel; D, temperature and humidity recorder controllers; E, air-cooled condenser; F, refrigeration compressor and motor.

control panel is mounted securely on a 12 x 7-foot flatbed 4-wheel trailer. The equipment is enclosed and fully protected from the weather with hinged access panels to provide ready access and ease of service to the equipment and controls.

The refrigeration compressor unit (F) when operating at a 0° F. suction temperature, 110° condensing temperature, 1750 rev/min maximum, and with freon 12 refrigerant, has a capacity of 35,500 BTU per hour. It is belt-driven by a high torque 7½ hp, 220-volt, 3-phase, 60-cycle motor.

The cooling coil (A) at a 4300 CFM intake and 15° FTD 0° F. suction has a capacity of 35,000 BTU per hour.

The blower (B) is belt-driven with adjustable drive and is connected to a 1½ hp, 3-phase, 220-volt motor.

The air-cooled condenser (E) with 15° TD 90° F. entering air and 110° condensing temperature has a capacity of 56,550 BTU (including heat of rejection). The fan is a belt-driven propeller type. The fan, fan support, and casing are galvanized.

All disconnect switches, magnetic starters for the compressor and blower motors, toggle switches to turn on the different components of the unit, time clock for defrosting and time-delay switches, and all relays are mounted on control panel (C).

A circular chart recorder-controller (D) is used to record the per cent relative humidity. This instrument uses a Q229A electronic humidity element consisting of a pair of gold grid electrodes covered with a film of polyvinyl alcohol and lithium chloride. The relative humidity is only recorded and not controlled.

A strip chart controller-recorder (under D) equipped with an electronic balancing system and a nickle A-bulb sensing element is used for temperature control.

Temperature is controlled by cycling the compressor. This is accomplished by cutting off the compressor as the temperature approaches the set point from the high side and cutting on the compressor as the temperature approaches the set point from the low side. In other systems temperature is controlled by the addition of heat from heater strips with the refrigeration on constantly. Since starting the compressor at each cycle pulled a high amperage, a by-pass line with a solenoid valve on a time-delay switch was installed between the pressure and suction lines to unload the compressor at each start. When the compressor started, the solenoid valve opened, which equalized the pressure of both lines and allowed the compressor to come to full speed within 5 seconds. At that time the time-delay switch closed the solenoid valve putting the load on the compressor. Hot-gas defrosting is initiated by a time clock on control panel (C) which is pre-set at periods as close as 2-hour intervals. Defrosting can also be initiated manually. When defrost is initiated the blower cuts off. When the back pressure reaches

40 pounds, all ice has melted from the cooling coil (A) and drip pans and passed out the defrost drain under cooling coil (A), gas flow returns to normal and the time-delay switch on the blower is activated. Within 2 minutes the cooling coil is down to operating temperature and the time-delay switch turns on the blower.

A 15-kw, 220-volt, 3-phase, 60-cycle gasoline-driven generator mounted on a small 2-wheel trailer is used as power source.

The sensing elements for temperature control and humidity recording are secured on a piece of masonite and hung on the outer edge of the tree about 6 feet from the ground. A 16-point electronic multipoint recorder with a 4½-second synchro-balance printing, with Type T copper-constantan 24B and S gauge wire thermocouples, is used in conjunction with this freezer to record air and tree-tissue temperatures.

ASSEMBLY OF THE PORTABLE TREE FREEZER

Seven men can disassemble the freezer and assemble it over another tree in about 10 hours. The length of the freeze tests, which depended on the night air temperature, the test-temperature sought, and the duration of the test-temperature, usually ran 8 to 14 hours. Night temperatures of 55° F. or lower are usually necessary for the efficient operation of this freezer.

SIMULATION OF THE 1949 FREEZE IN THE RIO GRANDE VALLEY OF TEXAS

To demonstrate the performance and capabilities of the portable freezer, the 1949 freeze in the Rio Grande Valley of Texas was approximated in 1960.

Cooper et al., 1949 gave a vivid description of the 1949 freeze. "It is recalled than on January 29, a wet cold front moved in from the north and lowered the temperatures to 30° F. by noon with accompanying sleet. Temperatures continued to drop and reached a minimum of 25° F. by 4 A.M. leaving a thick coating of ice on leaves, stems, and fruit. Temperatures remained below freezing all day of January 30 while the sky cleared and the wind died down. That night temperatures dropped to a minimum of 20° F. by 4 A.M. and remained there until 7 A.M. There was only a 2 or 3 degree variation in temperatures throughout the Valley."

A thermograph record of temperatures during the 1949 freeze was obtained from the Texas Agricultural Experiment Station in Weslaco and used as a basis for controlling temperatures inside the portable freezer. The critical temperatures and their duration in this freeze test (Figure 3) were similar to those in the 1949 freeze.

The freezer was erected over a 10-year-old Red Blush grapefruit tree on sour orange rootstock. Thermocouples to record the different tissue temperatures every 15 minutes were placed in the following manner:

1. Leaf—between the lower and upper surface of two leaves secured

with two paper clips. The leaves were 6 feet above the ground on the outer edge of the tree canopy.

2. Bark of ⅝-inch diameter branch—under a strip of bark taped back in its original position.
3. Bark of trunk—under a strip of bark taped back in its original position.
4. Fruit rind—under the rind at a slant.
5. Center of fruit—inserted approximately 1 inch toward the center of the fruit, lodged in flesh.
6. Air—in the air 6 feet above the ground on the outer edge of the tree.

The trunk cambium on this tree was very active and moist. The branch cambium was less active, and the twig cambium was slightly active and not moist. Foliage on the tree was mature and hard.

The freeze test started at 4 p.m. so that the low temperatures would come during the night.

The foliage was observed through the freezer window to detect occurrence of water-soaked spots on leaves. The water-soaked appearance was an indication of initiation of ice formation in citrus leaves (Young and Peynado, 1960). At 10:45 p.m. (Figure 4, arrow 1) after 1½ hours

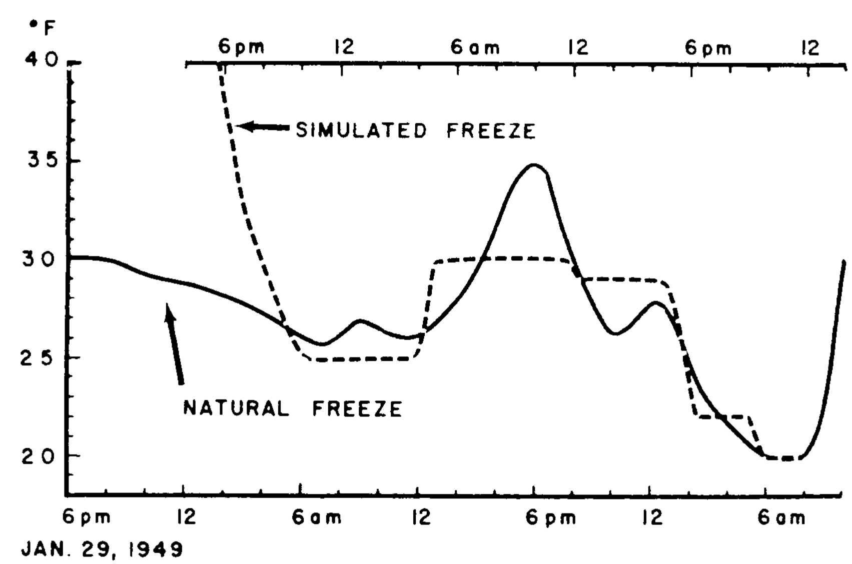

Figure 3. Air temperatures during the 1949 freeze in the Rio Grande Valley of Texas and during the simulated freeze test in 1960.

at 25° F. a trace of spotting was observed, and by 11:00 p.m. (arrow 2) larger spots were observed on some terminals. At 11:30 p.m. (arrow 3) the matured leaves were spotting and by 1:00 a.m. (arrow 4) all the foliage was spotted. All the foliage was completely watersoaked by 3:45 a.m. These observations correlate with the temperature curves of the leaf recorded with the multi-point electronic recorder (Fig. 4). A rise in leaf temperature at 10:30 p.m. (arrow 1) indicated the initiation of ice formation. A second rise in temperature occurred at 1:00 a.m. (arrow 4). Ice formation in plant tissue evolves heat of crystalization with a characteristic temperature rise. The peak of the temperature rise is the true freezing temperature (Hawkins, 1924; Luyet and Gehenio, 1937; Young and Peynado, 1960).

Visual observations of freezing bark and fruit could not be made, although freezing was indicated by the rise in temperature of the tissue. Freezing of the bark of the small branch occurred at approximately the same time as the leaves, both having about the same freezing temperature. In the fruit initial ice formation started after 2½ hours at 25° F.; the rind generally was 1½° to 2° colder than the flesh at all times. The freezing temperature of the fruit was about 2½° higher than that of the leaves and bark of small branches. The bark on the trunk did not freeze by the end of the freeze-test although it was supercooled to 28°. The slow rate of cooling of the bark was mainly due to the stored heat of the trunk. The protection of the canopy of the tree and slight heat radiation from the soil also raised the temperature around the trunk slightly

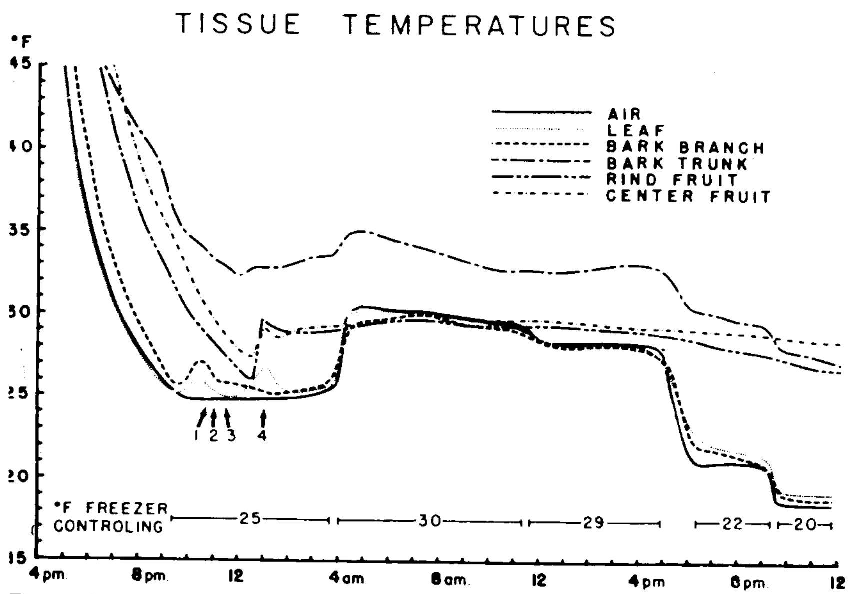

Figure 4. Air and tissue temperatures inside the box as recorded by a multipoint electronic recorder during the test.

Figure 5. Frozen 10-year-old Red Blush grapefruit tree on sour orange rootstock 4 weeks after test and same tree showing recovery and extent of wood kill 4 months later.

(Young and Peynado, 1961, unpublished data).

At the end of the test, all the leaves were frozen and bark was split on wood up to ½ inch in diameter. The rind on the fruit was frozen solid and the flesh was iced.

Two weeks later, the tree was totally defoliated, branches up to 1 inch in diameter and some limbs 1½ inch in diameter were dead and there was light bark splitting on larger limbs. All of the fruit showed internal freeze injury. Most of the fruit dropped within 2 weeks after the freeze test.

The frozen tree 4 weeks after freeze-test and the same tree 4 months later is shown in Figure 5. The resulting freeze-injury appeared very similar to that observed on many trees after the 1949 freeze in Texas.

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Seasonal Changes in the Cold-Hardiness of Ten-Year-Old Red Blush Grapefruit Trees As Related to Dormancy and Temperature[1]

Roger Young and Ascension Peynado

U. S. Department of Agriculture and Texas Agricultural

Bud dormancy is an important factor in the development of cold-hardiness of citrus. Cooper et al. (1955) demonstrated that a 3-year-old Red Blush grapefruit tree with actively growing buds was freeze-injured at a higher temperature than one with dormant buds. These results corroborated similar observations made during natural freezes (Rohrbaugh et al., 1948; Wilder, 1948; Young, 1929). Young et al. (1960), also freezing 3-year-old Red Blush grapefruit trees, indicated that the earlier the dormancy started the greater the cold-hardiness during the winter.

Small trees are useful in the study of cold resistance of citrus. However, the behavior of young trees does not necessarily approximate the behaviour of large trees of the same species. Therefore, several experiments were initiated to explore the cold-hardiness behavior of large Red Blush grapefruit trees.

The purpose of this report is to summarize the results of several experiments designed to follow the changes in the cold-hardiness of large Red Blush grapefruit trees during the fall and winter and to correlate those changes in hardiness with changes in temperature and in the dormancy status of the cambium and buds of the tree.

METHODS AND MATERIALS

Plant materials used were 10-year-old Red Blush grapefruit trees on sour orange, Triumph grapefruit, rough lemon, Cleopatra mandarin, and ThongDee shaddock rootstocks. These trees, located on the Valley Experiment Station, Weslaco, were part of a 10-acre rootstock planting.

Freeze trials consisted of two basic experiments. The first included trees exposed to 23° F. for 4 hours between November 16-30, 1960, December 19-23, 1960, January 3-13, 1961, and February 20-22, 1961; also included were trees exposed to 25° for 4 hours between November 16-30, 1960, and March 8-9, 1961. The second trial included trees exposed

[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.

for 4 hours in January 1961 to the following temperatures: 25°, 23° and 21°. An additional set of trees was exposed to 23° for 6 hours. The basic operation of the freezing chamber was similar to that previously described by Peynado and Cooper (1961).

Data recorded on all trees included bud-growth status and ease-of-peeling of twig bark (cambial activity) the day before freezing, per cent leaf defoliation, per cent twig injury (twigs up to ⅛-inch diameter), and bark splitting 2 weeks after freezing. Cambial activity of the twigs and bud activity were numerically rated as previously described (Young et al., 1960; Cooper et al., 1955) and summarized as a percentage of the total possible activity.

Temperatures under the bark of twigs, branches, and trunks and of leaves were recorded on trees in the studies reported herein. To record the temperature under the bark, a small "T-cut" was made in the bark, a thermocouple placed under the bark, and the bark taped back into place. Leaves used for temperature measurements were folded over a thermocouple and clamped tight with a paper clip.

Fruit temperatures were also recorded and injury evaluated for the same trees. These data are summarized in another report (Young and Peynado, 1961).

Average weekly day and night temperatures were summarized for November and December 1960 and January and February 1961. Each mean day and night temperature was determined by averaging the actual temperatures occurring at 6 different times during the day and 6 during the night: 6, 8, 10, 12, 2, and 4.

RESULTS AND DISCUSSION

The injury to 10-year-old Red Blush grapefruit trees exposed to 23° F. for 4 hours in November and December 1960 and January and February 1961 is summarized in Figures 1 and 5. More leaf and twig injury occurred on trees frozen in November than in December or January. Little or no injury to any of the trees was noted on limbs larger than ½ inch in diameter. Bark splitting, although more severe on trees frozen in November than in January, was found only on the twigs up to ½ inch in diameter.

Summarized in Figure 2 are the temperature changes under the bark of a limb and the trunk and of a leaf on a tree exposed to 23° F. for 4 hours. The leaf temperature averaged about 1° lower than the air until a temperature of 22° was reached. At that point the leaf temperature began to rise, an indication that the leaf was freezing (Young and Peynado, 1960). Temperatures under the bark of the limb remained about 2° warmer than the air. The critical temperature for damage to branches and trunks apparently was not reached.

These data indicated that the trees increased in cold-hardiness from November to January. Concomitant with this increase in cold-hardiness

was a decrease in cambial activity of the twigs. However, the decrease in cambial activity of the twigs was not closely related to the increased cold-hardiness of the twigs. The greatest decrease in susceptibility of twigs to freeze injury occurred between November and December, whereas the greatest change in cambial activity occurred between December and January. No visible change in bud-growth status was apparent from November through January; all buds were inactive.

The average weekly day and night temperatures (Figure 3) indicated a sharp decrease in day and night temperatures during the second week of December. These temperature changes occurred approximately 2 weeks prior to the December freeze trials and may account for the substantial increase in cold-hardiness from November to December. Average weekly day temperatures from the second week of December to the second week of February ranged from 50° F. to 59° F., approximately 11° to 20° cooler than the last 3 weeks in November. Average weekly night temperatures for the same period ranged from 47° to 50°, approximately 15° to 18° cooler than the last 3 weeks in November. Since the minimum temperature for bud growth of grapefruit trees is approximately 50° (Cooper and Peynado, 1959), the increase in cold-hardiness noted from December to January probably resulted from the prolonged cool weather during the 2 months.

In the second week of February the average day and night temperatures increased and nearly approximated those occurring in November. Concomitant with warmer weather was the breaking of bud dormancy, increasing of cambial activity in the twigs, and initiation of shoot extension. Ten days subsequent to the breaking of bud dormancy on February 10, several trees were exposed to 23° F. for 4 hours. These trees

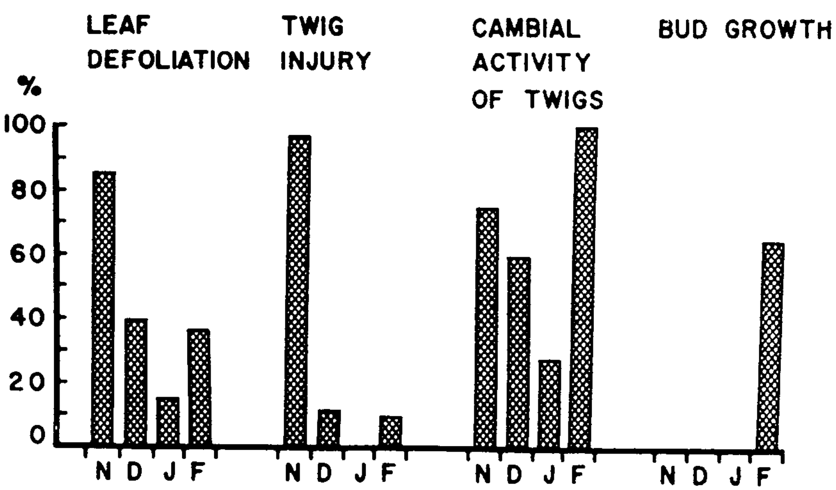

Figure 1. Cold-hardiness of 10-year-old Red Blush grapefruit trees exposed to 23° F. for 4 hours in November and December 1960 and January and February 1961.

had new shoots approximately 1/4 to 3/4 inches long, and cambial activity in the twigs was at its maximum. Although these trees showed more cambial activity than those frozen in November, cold-hardiness was considerably greater. Therefore, it appeared that as bud dormancy broke in the spring and cambial activity of twigs increased, there was a lag in the loss of cold-hardiness.

To determine the duration of this lag in loss of cold-hardiness, several trees were frozen in March. These trees were exposed to 25° F. for 4 hours, and the results were compared with the results from several trees exposed to 25° for 4 hours in November (Figure 4). Contrary to

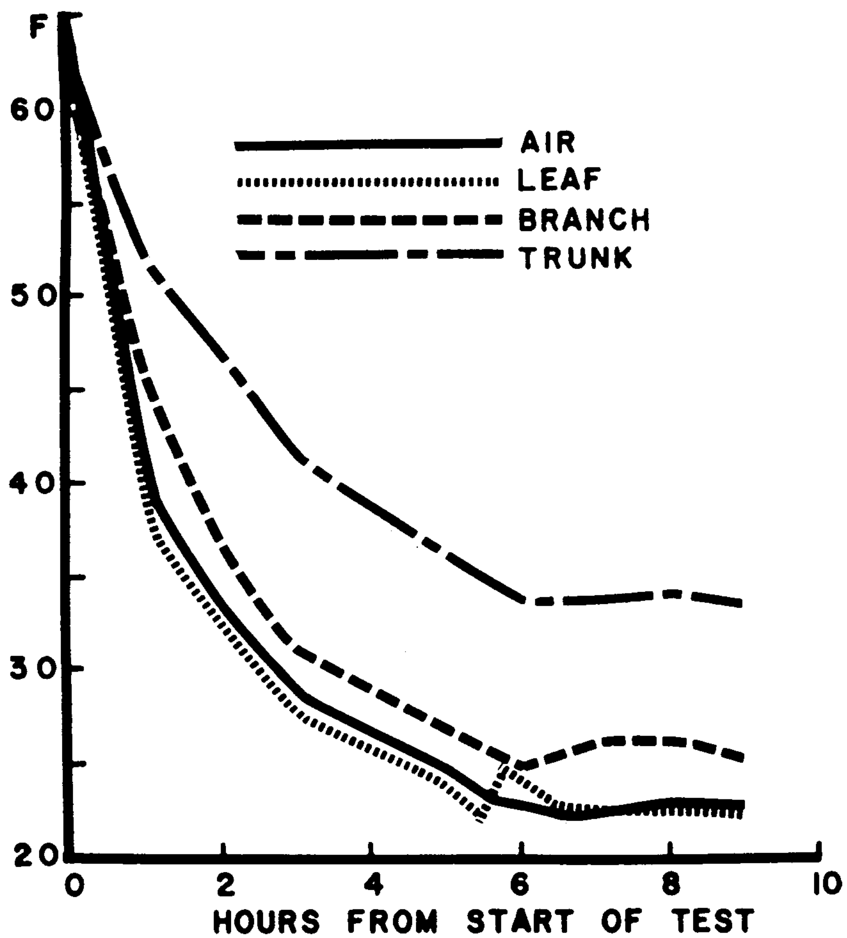

Figure 2. Temperature changes in a leaf and under the bark of a large limb and the trunk of a Red Blush grapefruit tree exposed to 23° F. for 4 hours.

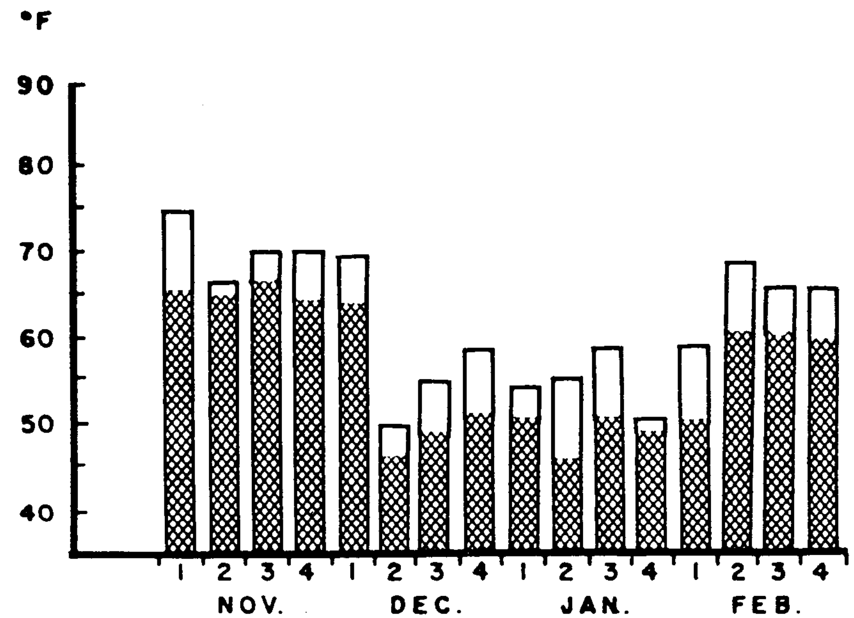

Figure 3. Average weekly day and night temperatures for November and December 1960 and January and February 1961. Shaded areas represent night temperatures and unshaded areas represent day temperatures.

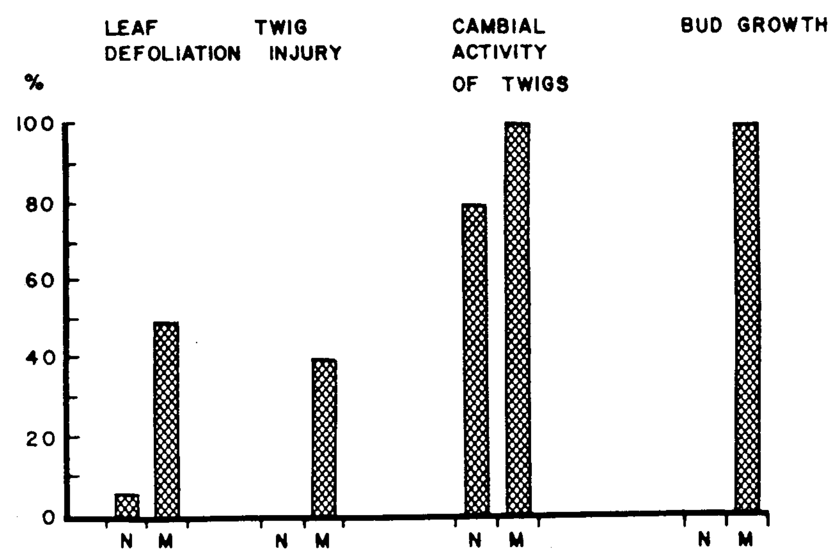

Figure 4. Cold-hardiness of 10-year-old Red Blush grapefruit trees exposed to 25° F. for 4 hours in November and March.

the trees frozen in November, trees frozen in March were in a full flush of growth. New shoots were 4 to 8 inches long and twig-cambial activity was at its maximum. Resulting leaf and twig injury on these trees were considerably greater than on the trees frozen in November. Since these trees were less cold-hardy than those frozen in November, they had lost the cold-hardiness which had been developed from December to January.

Thus, a definite seasonal change in cold-hardiness was measured. Cold-hardiness increased from November to January and was partially correlated with the development of cambium dormancy. Some cold-hardiness was lost in February when bud dormancy was broken and cambial activity increased, but the loss of hardiness lagged behind the breaking of bud dormancy. All winter-induced hardiness was lost by the time new shoots had grown 4 to 8 inches in length in mid-March. The development of coldhardiness appeared related to changes in day and night temperatures and their effects on the physiological condition of the leaves and twigs of the trees. Apparently, one or more unknown factors associated with cambial dormancy were also involved since cambial dormancy itself was not completely correlated with the hardiness of the trees.

Previous results indicated that trees exposed to 23° F. for 4 hours in January were not significantly injured (Figure 1). To determine the degree of cold-hardiness which had been developed in January, the following treatments were employed: 25° for 4 hours, 23° for 4 hours, 23° for 6 hours, and 21° for 4 hours (Table 1). Trees exposed to these treatments were similar physiologically. Buds were dormant on all trees and cambial activity of the twigs was similar to that previously described for trees frozen in January (Figure 1). Greatest leaf and twig injury occurred on trees exposed to 21° for 4 hours whereas no injury occurred on trees exposed to 25° for 4 hours. Trees exposed to 23° for 4 and 6 hours were intermediately injured. Listed in Table 1 are the temperatures at the end of the freeze test of leaves, twigs, branches, and trunks of trees exposed to 25°, 23°, and 21° for 4 hours. Generally, leaf and twig temperatures were similar to air temperatures whereas branch and trunk temperatures were warmer than the air. As the test temperature used was lower tissue temperatures were progressively lower. Branch and trunk temperatures did not reach the critical point for damage as no bark splitting was noted.

From these results, it was clear that trees frozen in March at 25° F. (Figure 4) had incurred approximately as much injury as trees frozen in January at 21° (Table 1). Therefore, the onset of winter bud-dormancy and the decrease in twig-cambial activity plus aging of the twig tissue and the possible change in several other unknown factors within the twigs may have accounted for the development of at least 4° of cold-hardiness during the 1960-61 winter. Similar results with young Red Blush grapefruit trees were previously reported by Cooper et al., (1954), and Cooper, (1959).

Table 1. Injury on 10-year-old Red Blush grapefruit trees and temperatures of various tissues at the end of freeze tests as a result of different temperatures and lengths of exposure to cold in January.

Treatment temperature (°F.)	*Duration of exposure (hours)*	*Trees exposed (number)*	*Leaf defoliation (percent)*	*Twig injury (percent)*[a]	*Final temperature (°F.) of:* Leaf	Twig	Limb	Trunk
25	4	2	0	0	25.0	25.0	26.8	33.8
23	4	5	14	0	22.8	23.2	24.5	28.3
23	6	2	63	1	....	....	....	....
21	4	2	90	20	20.8	21.0	....	26.0

[a] Injury to twigs up to ⅛ inch diameter.

SUMMARY

Ten-year-old Red Blush grapefruit trees were frozen in November and December 1960 and January, February, and March, 1961. Cold-hardiness increased during December and January. This cold-hardiness, which was associated with bud and cambium dormancy, appeared to be controlled by changes in day and night temperatures. When bud dormancy was broken in February a lag in the loss of cold-hardiness was apparent. All winter-induced cold-hardiness was lost by mid-March when the trees were in full flush. Since bud and cambium dormancy were not completely correlated with cold-hardiness, aging of the twig tissue and other unknown factor(s) may have also contributed to the hardiness of the trees. It was apparent that trees in January had developed at least 4° F. of cold-hardiness and that an extensive flush of new growth destroyed this cold-hardiness.

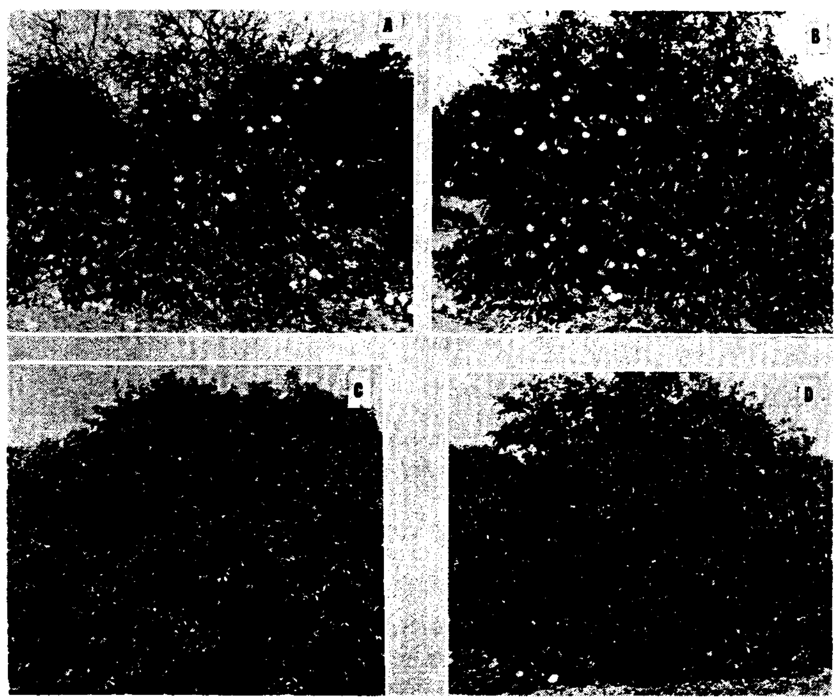

Figure 5. Freeze injury on 10-year-old Red Blush grapefruit trees exposed to 23° F. for 4 hours in (A) November and (B) December 1960, and (C) January and (D) February 1961.

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Effects of Artificial Freezing on Red Blush Grapefruit[1]

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Repeated grower experience suggests that citrus fruit increases in cold-hardiness during the winter. Precise data substantiating this increase in cold-hardiness during the winter is lacking since natural freezes are uncontrolled and conditions vary with each. Effects of artificially controlled freezes on fruiting trees during the winter have not been attempted until this year.

The damaging effects of natural freezes on fruit are well known. Bailey and Wilson (1916) found that frozen lemons left on the tree dry out and lose their acid. Bartholomew et al., (1950), followed seasonal changes in Valencia oranges and Marsh grapefruit after the 1949 freeze in California. Generally, frozen fruit contained less sugar, acid, and juice than non-frozen. Greater injury was noted in the stem-end than in the center or stylar-end, and outside fruit were more injured than inside.

Following the 1949 and 1951 freezes in Texas, quality was also adversely affected in frozen fruit, particularly on the severely injured trees (Ryall and Johnson, 1950; Rohrbaugh et al., 1948; and Burdick, 1951). In addition, small grapefruit were found to be more severely injured than large.

The purpose of this report is to summarize the injury to fruit on trees exposed to artificially controlled freezes previously described (Young and Peynado, 1961). Relations between fruit injury and size, location on tree, and severity of tree injury are indicated. Effects of freezing injury on fruit quality are also discussed.

METHODS AND MATERIALS

Plant materials and freezing techniques used were those previously described (Peynado and Cooper, 1961; Young and Peynado, 1961). Temperature changes under the rind and in the center of the fruit were recorded with thermocouples. A small ⅛-inch cut was made in the rind, and the thermocouples were pushed through the cut under the rind or into the center of the fruit.

[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.

Fruit samples for determining freeze injury were harvested March 6 to 17. Samples consisted of 100 fruit from each tree, 50 fruit picked from the outside perimeter and 50 fruit picked inside. Each of the 50-fruit samples was divided into 10-fruit lots of the following diameter sizes: 10.5 cm, 10.0 cm, 9.5 cm, 9.0 cm, 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. An injured segment was one with visible injury including cell breakdown, drying, separation of segment walls, gum, and crystal deposits. Freeze injury was similar to that described by Burdick (1951). Values reported in Table 1 were averages of 100-fruit lots from 2 trees each test month. Those reported in Tables 3 and 4 and Figure 2 were averages of 100-fruit lots from 10 trees.

Samples harvested for quality analysis consisted of 30 relatively uniform fruit, 10.0 cm in diameter, randomly selected around the outside of each tree. Each value reported in Table 2 and Figure 1 is an average of 2 replications. All fruit analyzed in Table 2 were harvested February 10 and those analyzed in Figure 1 were harvested March 15.

Total soluble solids was determined with a refractometer while total acid was measured by standard titration.

RESULTS AND DISCUSSION

Total numbers of injured segments per fruit from trees frozen in November and December 1960 and January and February 1961 is listed in Table 1. In fruit harvested in March, more injured segments were apparent in fruit frozen in November than in fruit frozen in December, January, or February. A general decrease in injured segments was observed in fruit on trees frozen later in the winter. Injury consisted of dry segments and separated segment walls and in some cases included cell

Table 1. Injured segments in Red Blush grapefruit on different trees exposed to 23° F. for 4 hours in November and December 1960 and January and February 1961.

Month of Freeze test	*Number of segments injured per fruit*[a]
November	4.9[b]
December	4.2
January	2.2
February	0.8

[a] Average number of injured segments in stem-end, center, and stylar-end of fruit. Fruit harvested March 6 to 17.

[b] Not completely representative, since the more severely frozen fruit had fallen to the ground and were not available for sampling.

breakdown and crystal and gum deposits. Temperatures under the rind at the end of the freeze test ranged from 27° F. to 28° and those in the center of the fruit averaged about 0.5° to 1.0° higher. Final fruit temperatures reached were obviously below the freezing point since considerable injury was observed. The actual freezing point of Red Blush grapefruit was not determined in these studies, but Peynado and Cooper (1961) observed that the freezing point recorded on one fruit in December was 29.5°.

Fruit samples from trees frozen in November, December, and January were harvested February 10 for quality analysis (Table 2). Fruit from unfrozen trees served as a control. Fruit frozen in November had reduced soluble solids whereas those frozen in December and January were similar to the unfrozen controls. Acid was lowest in fruit frozen in November and was progressively higher in those frozen in December and January. General quality was poorest in fruit frozen in November and was progressively better in fruit frozen in December and January. Freeze injury effects on quality appeared correlated with injury on other parts of the tree.

These data suggested a seasonal change in the cold-hardiness of the fruit. Some doubt of this seasonal change remained since in this test the lengths of time for visible freeze injury to develop in November-frozen and January-frozen fruit were different. When quality analysis was made on February 10, little injury was visible in any fruit. About February 10, a warming trend in the weather occurred (Young and Peynado, 1961). In the second week of March, fruit from the same trees were classified for freeze injury (Table 1) and considerable freeze injury was visible. Therefore, all visible injury apparently had developed during 1 month's warm weather. In the third week of May, spot checks on fruit damage were made on the trees. It was clear at that time that no further damage had developed. These observations suggested that all visible damage occurred between February 10 and March 17 and the development of visible damage appeared to have been promoted by warm weather. Freeze-injury effects on fruit quality were present before the injury became visible.

Table 2. The effect of exposure to 23° F. for 4 hours in November and December 1960 and January 1961 on the resulting fruit quality of 10-cm diameter Red Blush grapefruit harvested February 10, 1961.

Group	*Soluble solids (percent)*	*Acid (percent)*	*Soluble solids–acid ratio*
Frozen fruit:			
November	8.2	1.03	8.0
December	9.2	1.07	8.6
January	9.3	1.12	8.3
Unfrozen fruit	9.4	1.14	8.2

The effects of several temperatures and lengths of exposure on fruit injury are listed in Table 3. Fruit were frozen between January 3 and 13 and were examined for injury between March 6 and 17. Fruit exposed to 23° F. for 4 hours were least injured while those exposed to 21° for 4 hours were most injured. Exposure to 23° for 6 hours resulted in a large increase in fruit injury over those exposed to the same temperature for 4 hours. Fruit outside the tree were much more severely injured than inside, and in general fruit injury coincided with tree injury.

Distribution of freeze injury in Red Blush grapefruit is listed in Table 4. More injury was apparent in the stem-end than in the center or stylar-end of the fruit. These results are similar to those previously reported (Rohrbaugh et al., 1948; Ryall and Johnson, 1950).

Since small fruit cool much faster than large fruit, one would expect more cold injury to small fruit than to large fruit. Previous reports (Rohrbaugh et al., 1948) suggested an inverse relationship between size of grapefruit and freeze injury. The relationship between fruit size and injury after freezing is summarized in Figure 1. The strong inverse correlation indicated more injury occurred in the smaller fruit. The effects of fruit size on the quality of frozen and unfrozen fruit are summarized in Figure 2. These fruit were on trees exposed to 21° F. for 4 hours in January. Acid content decreased considerably while soluble solids con-

Table 3. Injured segments in Red Blush grapefruit in different locations on tree as a result of different temperatures and lengths of exposure to cold during January 1961.[a]

Temperature (°F.)	*Duration of exposure (hours)*	*Inside fruit (number)*	*Outside fruit (number)*	*Average (number)*
23°	4	0.2	0.4	0.3
23°	6	1.9	2.8	2.4
21°	4	2.6	4.7	3.7

[a] Average number of segments injured in stem-end, center, and stylar-end of fruit.

Table 4. Distribution of injured segments in sectioned Red Blush grapefruit picked inside and outside the tree.[a]

Section of fruit	*Inside fruit (number)*	*Outside fruit (number)*	*Average (number)*
Stem-end	5.7	9.9	7.8
Center	3.6	7.3	5.4
Stylar-end	2.9	5.3	4.1
Average (number)	4.1	7.5	

[a] These data are reworked from results reported in Tables 1 and 3.

tent decreased only slightly as fruit sizes increased; juice content increased with fruit size. In all quality measurements, frozen fruit were inferior to unfrozen with the smaller fruit showing the greatest differences.

Listed in Table 5 are the average number of hours below 28° F. in Red Blush grapefruit on a tree exposed to 25° for 4 hours in March 1961. As fruit size decreased, the number of hours below 28° increased. The rind of the fruit was below 28° longer than was the center of the fruit;

Table 5. Average number of hours below 28° F. in Red Blush grapefruit on a tree exposed to 25° for 4 hours in March 1961.

Size	*Inside fruit*		*Outside fruit*	
(cm)	*under rind*	*center*	*under rind*	*center*
8.5	6.0	5.5	7.3	5.0
9.5	4.3	4.0	6.3	3.8
10.5	4.3	0.5	6.0	3.5

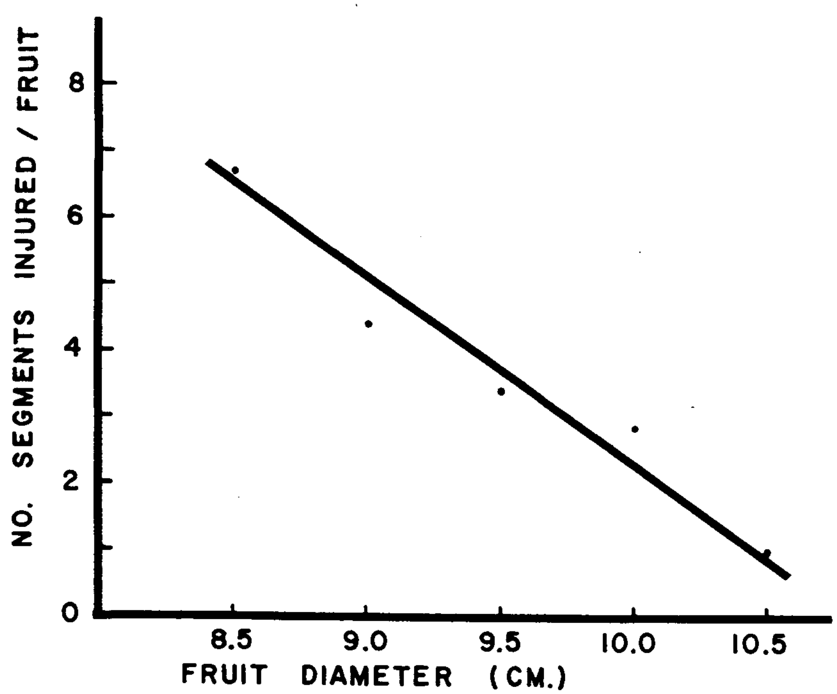

Figure 1. Correlation between fruit size and freeze injury. These data are reworked from results reported in Tables 1 and 3.

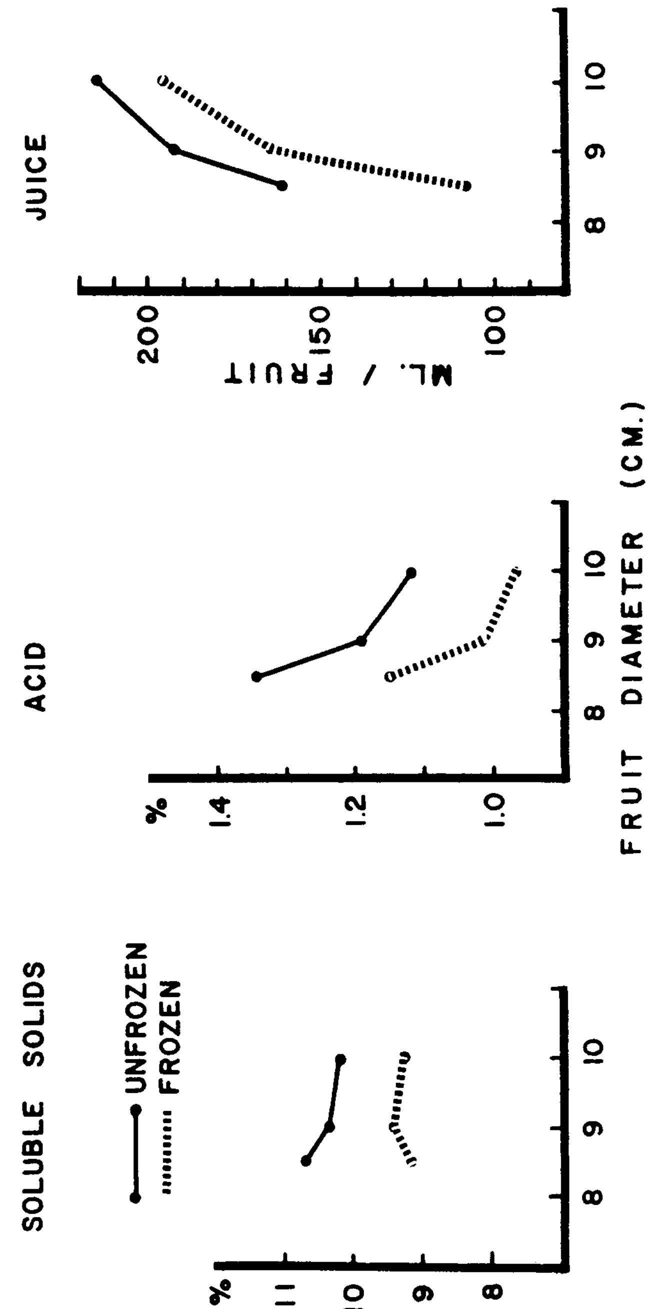

Figure 2. The effect of fruit size on the resulting quality of frozen and unfrozen fruit.

and outside fruit generally were below 28° longer than were inside fruit. These data indicated that size and location materially affected the cooling rate of the fruit.

SUMMARY

Fruit from different trees frozen in November and December 1960 and January and February 1961 were classified in March for resulting visible injury and in February for effects on fruit quality. More fruit injury was apparent in fruit frozen in November and injury was less in fruit frozen in December, January, and February. Injury consisted of dry segments, separated segment walls, cell breakdown, and crystal and gum deposits.

Injury was more in outside fruit than in inside fruit and greater in the stem-end than in the stylar-end of the fruit. Greatest injury was found in smaller fruit.

Size and location on the tree affected the rate of cooling of the fruit, explaining the observed differences in injury and resulting fruit quality. Quality of frozen fruit was inferior to that of unfrozen fruit; the decrease in fruit quality of small frozen fruit was apparently correlated with the increase in injury of small fruit.

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Some Effects Of Gibberellic Acid and 2,4,5-Trichlorophenoxyacetic Acid On Navel Orange Production[1]

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The poor production of navel oranges in the Rio Grande Valley is a concern for growers having existing plantings and for those considering new plantings. As navel oranges usually bring a premium price, an economical practice that would result in increased production would be most valuable to the industry.

Attempts have been made to increase production in some citrus varieties by using the growth regulator, gibberellic acid. Soosts (1958) reported increased fruit set on Clementine (Algerian) mandarin by spraying the flowers, when in full bloom, with gibberellic acid. Hield, Coggins and Garber (1958), in preliminary experiments, increased the fruit set on Bearss lime, Eureka lemon, and Washington navel through application of gibberellic acid on young fruit and flowers. Coggins, Hield, and Garber (1960), noted a slight increase in the production of Valencia oranges when the trees were sprayed with potassium gibberellate. However, the treatments also increased the percentage of mature fruit that dropped. Potassium gibberellate reduced the total production of Lisbon lemons because of fruit drop (Coggins, Hield, and Boswell, 1960). Mature fruit drop has been delayed on Washington navels by spraying with 2,4-D (Stewart, Klotz, and Hield, 1951). Spray combinations with gibberellic acid and 2,4,5-Trichlorophenoxyacetic acid have shown some promise in increasing fruit set with citrus.[2] Some effects of gibberellic acid (GA) and 2,4,5-Trichlorophenoxyacetic (2,4,5-T) on fruit production of Washington navel oranges are described in this report.

MATERIALS AND METHODS

Twelve four-year-old Washington navel orange trees of uniform size were selected for the test. The trees were located on the Texas A&I Citrus Center farm. They were treated in four replicated blocks of three trees each.

At the peak of bloom on March 23, 1959, the trees were sprayed to run-off with GA at 0, 25, and 100 ppm concentrations in water solutions.

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1 Gibberellic acid and 2,4,5-Trichlorophenoxyacetic acid was furnished by Eli Lilly and Company, Greenfield, Indiana.

2 Personal correspondence with Dr. E. F. Alder, Eli Lilly and Company, Greenfield, Indiana.

A wetting agent, Tween 20, was used at the rate of 0.5 ml per liter of solution.

On April 24, a foliar spray of 5 ppm 2,4,5-T was applied to all trees that had been treated with 25 and 100 ppm GA.

On September 18, 1959, counts were made to determine the effect of GA and 2,4,5-T on fruit drop, sunburning, and yield.

RESULTS AND DISCUSSION

A greater number of mature fruit split and dropped from treated trees than untreated trees (Table 1). When expressed as percent of the total crop, mature fruit drop was significantly higher from trees receiving the higher concentration of GA than from controls. The difference in the per cent of drop between the two rates of GA was small. Splitting of the fruit began at the navel or blossom end and was found on all the mature fruit that dropped.

There was a reduction in yield due to treatment. Table 1 indicates a trend towards decreased yields with increased concentration of GA. At the rates used the differences between treatments were not statistically significant. When the number of mature fruit that had split and dropped was added to the crop harvested the total yield reflected equal production on the controls and on the plots treated with GA at the lowest concentration, however, there was still reduced yield on the higher GA plots.

The number of sunburned fruit was found to be significantly higher on treated trees than on controls (Table 1). This fruit was still hanging on the trees and was harvested but in grading it would have been discarded as cull fruit. Reasons for the increase in sunburning and also the drop of mature fruit on treated trees has not been determined. Splitting of navel oranges is not uncommon in Texas during some seasons.

The results show GA and 2,4,5-T may have adverse effects on navel orange production in Texas when used at concentrations and timing reported in this experiment. Mature fruit drop was a factor in lowering

Table 1. Fruit drop, yield, and sunburning of Washington navel oranges in response to treatment with gibberellic acid and 2,4,5-T.

Treatment		*Fruit Drop*		*Yield*	*Sunburning*
GA ppm	*2,4,5-T ppm*	*Number per tree*	*Percent of total crop*	*Number fruit per tree*[a]	*Number per tree*
0	0	4.25	7.8	50.0	1.5
25	5	17.75	32.7	36.5	3.0
100	5	15.00	42.5	20.3	4.5
L.S.D. .05*		14.65	28.2	32.0	0.4

[a] Does not include fruit split and dropped prior to harvest.
* Difference needed for significance at the 0.05 level.

yield and substantiates similar results in California (Coggins, et al. 1960, Coggins, et al. 1960-a). Further investigations should consider variations in timing of application and concentration.

SUMMARY

Gibberelic acid (GA) in concentrations of 0, 25, and 100ppm was sprayed on Washington navel orange trees in full bloom at Weslaco, Texas in March, 1959. In April 1959, trees previously treated with GA were sprayed with 5 ppm 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T).

Treatment with GA caused a significant increase in the drop of mature fruit. Splitting of the fruit from the navel or blossom end was associated with the drop.

Yield was reduced on treated trees. When total yield was calculated to include the mature fruit that had dropped the only yield reduction was with the highest concentration of GA.

The number of sunburned fruit was significantly greater on treated trees.

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Observations on the Color of Red Grapefruit Seedlings

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The color of Ruby Red grapefruit has been considered one of the major problems in utilizing the fruit in juice products. Unfortunately, the reproductive mechanism of grapefruit offers little possibility of a systematic breeding program for the development of more desirable hybrids which can be processed into pleasingly colored juice. However, genetic changes, hybridization and mutations, do occur in grapefruit, so it is expedient to examine any system which may increase the frequency of these genetic changes. Growing bearing trees from red grapefruit seedlings may be such a system.

Several years ago Texas A. & I. College planted 1500 red grapefruit seedlings to obtain disease-free nucellar red grapefruit stock. These seedlings were budded onto Cleopatra mandarin rootstock and planted in an orchard in February, 1955. Many of the trees bore significant amounts of fruit for the first time in the season of 1960-1961.

Several fruit from each bearing tree were cut and the color was compared with the color of fruit of Webb Redblush grapefruit grown on sour orange rootstock ("old line"). Comparisons were made on September 1, 1960, at which time the color of "old line" fruit was at its maximum, and December 30, 1960, when the color of "old line" fruit had faded (Purcell, 1959). The visual estimates of color were verified by pigment analysis of selected samples of fruit.

Differences in color were noted on both dates, but in all samples except one, the differences were less than between pink and red varieties. One tree bore white fruit. Some of the fruit were less colored and some were more colored than "old line" fruit. Some fruit appeared to hold color better than "old line" fruit, while others faded more rapidly.

It is suspected that some of the variations noted may be due to "juvenile" characteristics of the trees but some variation may be due to genetic change. A true estimate of variations will require several consecutive years of study. When it appears that variation due to juvenile

[1] One of the laboratories of the Southern Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture.

characteristics have decreased other factors of fruit quality will also be evaluated.

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Marketing Texas Fruit Under Federal Marketing Order[1]

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Prior to 1937, producers of various commodities endeavored to improve quality and grades for their particular commodity by forming various voluntary groups, such as Cooperatives, Marketing Associations, Granges, Bureaus, etc. This proved satisfactory in limited commodities and was of limited effectiveness, since these organizations were never able to get every producer's cooperation. Even a small minority of nonmembers could keep the group from being sufficiently effective. From this situation came the Agricultural Marketing Agreement Act of 1937. This Act has been re-enacted and amended several times since 1937.

This Act sets up machinery for establishing Marketing Agreements and Orders. At present, there are more than thirty Orders in existence, five of which are now in force in the Lower Rio Grande Valley.

These Orders come into being in this manner: The producers in a given area request the U.S.D.A. to hold hearings and compile evidence preparatory to a Proposed Marketing Order. After due notice to all known producers and public notice, a referendum vote is taken to see if at least 65% of the producers and 65% of the volume desire a Marketing Order. If the ballots indicate the producers want the Order, a Committee is nominated to make recommendations to the Secretary of the U.S.D.A., for grade, size, containers, etc. Each Order is tailor-made to fit the needs of a particular product in a particular area.

For instance, the Marketing Order on California oranges is entirely different from the Order governing Valley oranges, because our problems and needs are different from theirs. California makes no attempt to regulate grade and size, and their regulations only control the movement of fruit to market. At the beginning of their season they pro-rate the shipments to shippers by weeks based on the tonnage they control.

Florida regulations are more similar to ours, but they vary from ours in numerous ways. Marketing Orders are just a tool to be used to improve the producer's position in the marketing of his product, and like any other tool, we have to learn its proper use from experience.

Like any other tool, it needs adjustment from time to time. This can be accomplished in two ways, i.e.:

[1] Talk given Mar. 30, 1961, before Rio Grande Valley Horticultural Society.

(1) The Committee, through the Committee manager, can compile sufficient statistical information on which to base changes in regulations at any time they deem advisable, if these changes are authorized in the Order;

(2) If it is found that the Order doesn't give certain authority that would tend to effectuate the desired results, the Committee can recommend to the Secretary of the U.S.D.A. that a hearing and referendum be held and they can propose some changes to amend the Order. If there is need for the amendments, the producers will be given an opportunity to ballot on the amendment.

Compulsory inspection is the very heart of most Marketing Order Agreements. With the exception of California, which has its own inspection service, I believe all Orders have this provision.

Incidentally, the history of the inspection service is a very interesting study. The first inspection service was established on potatoes in 1917, so that warehouse receipts could be used as collateral on loans. Then in 1918, the armed forces asked that a terminal inspection service be established so that they could be assured of receiving fruit and vegetables of the best quality.

Then in 1922, shipping-point inspection service was authorized by Congress and U. S. Standards were established on numerous products.

There has been some criticism of Marketing Orders by some individuals to the effect that the Secretary of the U.S.D.A., sitting behind a desk in Washington, has the sole authority to make decisions and that the Committee can only recommend.

While this is true, it is easily understood that our lawmaking representatives could not delegate powers to groups such as those making up the Committee. Also, the Secretary has the responsibility of protecting the public and this is specifically spelled out in the Act.

To my knowledge, the Secretary has never failed to adopt the regulation recommended if it was possible to do so under the Act, or authorized by the Order.

It has been my experience that the Committee members who once objected to Marketing Orders, after serving on the Committee and becoming familiar with the way it works, have in most instances, become a booster for the Order. It is just human nature to object to things we do not understand. Evidently, the majority of the producers in the Valley see a great deal of merit in the Marketing Order Program, as evidenced by the passage of the five orders now in effect by a heavy majority. I know of at least two or more commodities that are being considered for Marketing Order Agreements.

Progress Report on Texas Citrus Marketing Order[1]

Noel E. Ryall
Chairman Marketing Committee and Citrus Grower, Los Fresnos

Before making any direct comment on the operation of the Citrus Marketing Committee, or Order, I feel it would be good to review briefly the general situation here in the Valley before the Marketing Order was voted into effect. The agricultural history, and especially of the citrus industry, of our Valley is "young" in years, and history repeats itself in that many years of trial-and-error methods normally are spent before real organization and long-lasting constructive policies are put into force. It is unfortunate that a good or high economy of an area such as our Valley can delay recognition and adoption of certain basic needs. A low economy felt by us as growers through the real "pinch" of increasingly higher production costs together with lowered returns for our products shocks us into action. Traditionally farmers, whether citrus or otherwise, are an independent class of people and a difficult group to "stand fast" and withhold his crops from an over-supplied market. We have been slow in looking at our "big brothers," so to speak, meaning the much older and larger citrus producing areas of both California and Florida. We know, of course, that the approach of a problem in one area might be different in another; however, there is much they *are* doing which we can benefit by. Both these areas have spent, and still are, spending millions on advertising, research, and various phases of the industry where we are spending only relatively few dollars.

We have had our Farm Bureau, a most excellent organization working diligently for all phases of our agricultural economy. Texas Citrus Mutual, under its very able leadership, is a great step in the right direction for our citrus industry. It provides a real service in its search for better ways of doing what we have done in the past, and new approaches to new problems which will help us in the future. Texa-Sweet, an organization of the shippers or handlers of the Valley is a most worthy group who, through a unity of purpose, can be a stabilizing factor in our citrus industry. It is indeed hoped that through their organization they may be able to, at some future near time, be able to control general quotations of our concentrated Valley area. This is of vital importance to both shipper and grower. These various organizations through their sincere individual efforts for their common good can only lead to a more stable and cooperative effort of all phases of the industry, and which will add confidence and trust one with the other. In years past, and even today, some growers and some shippers think of each other with that proper lack of trust and understanding. Actually both are at fault—it is

[1] Talk given Mar. 30, 1961 before Rio Grande Valley Horticultural Society.

true there will always be members of both groups which refuse to want to show a real understanding. Let us face this *fact*—both groups depend on the other and neither can exist without the other.

The Citrus Marketing Order, I feel, has been a very wise step in the right direction, and a most timely one this marketing season. The records will show it has been a stabilizing influence and factor in the orderly movement of fruit this season, and without it we would certainly have had a serious break and decline in the grapefruit market structure before the Christmas holiday season. Many growers, especially of oranges, who were critical of the regulations before the first of the year were sold on the Marketing Order with a later improvement of the price structure. The Citrus Marketing Order is "*no cure-all*" and the committee members are not infallible to error in judgment. Even though the Committee members serve without pay (they are allowed mileage) the member attendance has been very high. This evidences a real sincere interest and effort on their part in getting the job done as they see it. Regardless of the particular regulations adopted, some growers and possibly some shippers will disagree. The meetings are open to the public and the Committee welcomes growers coming before the Committee and stating their views.

We must be realistic about our present situation, particularly the depressing grapefruit market. In my mind, and I feel I speak in this instance for all Committee members, some of the best things to come from the Marketing Order this season which are not directly reflected in higher or lower prices for fruit, are some basic things started which will lead to a more sound, more lasting, a more constructive program in searching and putting into effect those policies long needed to build confidence and cooperation with all connected facets of the Valley Citrus Industry. Committee members have had differences of opinion, and which is natural; however, there has been a common spirit of cooperation between growers and shippers which is an encouraging thing to see. We as growers have certain obligations to shippers and vice-versa. There has been a lack of both in past seasons; if each group respects and understands the other's problems a more common confidence can be cemented. The time is past when the grower can grow his fruit, and tell the packer to "come and get it"; he must learn to interpret the needs of the consumer, the quality and variety of fruit he desires and know at various times through the season the size and volume of fruit consumed. If he is informed he then can understand what his Marketing Order Committee members are trying to do. We, as growers, must put forth every effort to use wisely and timely judgment in cultural, irrigation, fertilization, pesticide programs. When he has done this then under normal conditions he will have much of that kind of fruit the market will demand.

Another very constructive effort of the committee this season is the study and adoption of standardization of containers. Many irregular or odd sized containers have been eliminated. Some of it has been by trial and error; however, shippers have been very interested and cooperative. The benefits are obvious but one of the greatest is that it puts shippers more on an "equal" basis in fruit quotations to the trade. The marketing committee appointed a sub-committee of three and invited Texas Citrus Mutual and Texa-Sweet to do likewise and invited members of State-Federal inspection service to meet and make a study of the present Federal grades for citrus. Following the 1951 freezes an emergency request was made and granted and the old standards relaxed somewhat. A representative of USDA Grades is scheduled to be in the Valley at an early date and meet with this committee. I would like to express the appreciation of the committee for the fine cooperation and support given by Mr. Dallas Engels and his State inspection service. Their staff has been very helpful with our able manager, and they have given of their personal time to attend our meetings. This appreciation is also extended to representatives of the press, radio and TV in their very cooperative reporting service.

We have many major problems facing our young and expanding citrus industry. Let us try and be informed in every phase of our work, keep an open mind, and not leave it to your neighbor to give that one thing which it will take to get the job done—your own individual cooperative support.

VEGETABLE SECTION

Further Studies on Gibberellin Foliar Spray for Fresh Market Carrots

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Gibberellic acid has been shown to influence the growth rate of aerial plant parts in various crops. Some of the most comprehensive reports on plants affected were given from 1956 to 1958 (Bukovac and Wittwer, 1956; Wittwer and Bukovac, 1957, 1958, 1959), which mention that root growth was either decreased or not affected when gibberellin was applied on the above ground plant parts. During the 1958-59 season when foliage diseases caused extensive damage in the Texas Winter Garden it was shown that an application of Gibberellin on carrot foliage did result in a yield increase of marketable roots. This paper reports 1959-60 results of tests of the same nature during a season when foliage diseases were not so widespread.

PROCEDURE

Six locations on two widely diverse soil types and five ages of plants were included in the 1959-60 season's tests. Earliest plants were on Uvalde silty clay loam, a dark colored soil, where field No. 1 was planted August 20, and field No. 2 was planted September 15. The other locations were on Maverick silty clay loam, a red soil, where field No. 3 was planted August 31, No. 4 on September 15, No. 5 on September 28 and No. 6 on October 30.

A Latin square design having six treatments and six replications was used. Plots were 10 feet long on single rows 36 inches wide. Yield records were taken from 5 feet in the middle of each plot. Alternate rows were treated to avoid any effect of drifted spray. Spray treatments consisted of untreated, water, 5, 10, 15 and 25 parts per million of emulsifiable Gibberellin as 0.5 per cent potassium gibberellate.[1] Solutions were applied in four gallons of liquid per acre on November 16, at 20 pounds per square inch pressure and four miles per hour ground speed with a three-gallon hand sprayer. Wind movement was about 2 miles per hour at the time of application. In the test on youngest plants, field No. 6, plots were divided with one-half receiving a second application on December 21. All other locations received one application.

Harvest records were taken in field No. 1 on December 29, field No. 2 on February 8, No. 3 and 4 on February 11, No. 5 on May 3 and No. 6 on May 13.

[1] Samples under the trade name Gibrel were supplied by Merck and Co., Rahway, New Jersey.

Table 1. Mean yield in pounds per acre of marketable carrots resulting from Gibberellin foliar spray in the Winter Garden Area.

Treatments	*Uvalde Silty Clay* Field No. 1	*Uvalde Silty Clay* Field No. 2	*Marketable Silty Clay Loam* Field No. 3	*Marketable Silty Clay Loam* Field No. 4	*Marketable Silty Clay Loam* Field No. 5	*Field No. 6* 1 Appl	*Field No. 6* 2 Appl
Check (Nothing)	5,808	8,204	9,460	8,022	11,238	10,512	11,347
Check (Water)	5,242	9,315	10,346	8,785	11,072	12,632	10,934
5 parts per million (ppm)	4,937	9,162	10,796	7,608	10,984	10,926	10,970
10 ppm	6,084	8,879	9,133	7,819	10,868	10,600	10,934
15 ppm	5,176	9,111	9,598	8,676	11,086	11,580	10,963
25 ppm	5,750	9,126	9,075	8,146	10,926	11,297	11,289
Day from treatment to harvest	131	146	164	149	218	195	

RESULTS

Weather conditions during the season were more favorable for carrot growth than the 1958-59 season with respect to proportions of infection by cercospora leaf spot and similar blight diseases. Temperatures were not extremely low, but during the growing season over 1300 hours below 50 degrees F. were recorded indicating that cool weather prevailed through most of the season. The relative humidity was low enough to keep blight diseases from expressing symptoms in the foliage.

Analysis of yield records indicated no significant difference between any of the treatments (Table 1). Yields of marketable roots varied between planting dates but not treatments. Weight of roots from plants on diverse soil types with the same seeding date and three days between harvests, as in fields 2 and 4, show that soil effect was negligible.

During the growing season small samples were taken for comparison of root size. No effects of treatment could be found in these comparisons at any time. These records indicated that no treatment effects were lost by leaving plants in the ground through the longest period of 218 days in field No. 5.

CONCLUSIONS

Results of this series of tests confirm the hypothesis formed from previous tests (Buffington, 1960). When climatic conditions are favorable for growing fresh market carrots, the application of gibberellin spray will probably not affect carrot tonnage. Therefore, the use of this material for this purpose is of doubtful value in the Winter Garden area of Texas.

SUMMARY

During the 1959-60 carrot growing season a test was conducted to find whether or not application of gibberellin to the foliage would increase marketable yield under field conditions. Plots were in a Latin square design with two checks and four levels of emulsifiable gibberellin as 0.5 per cent potassium gibberellate. In six locations on two soil types and using five ages of plants no significant difference in yield was found.

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Some Marketing and Management Practices of the Texas Fruit and Vegetable Canning Industry

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INTRODUCTION

The Texas Fruit and Vegetable Canning Industry operates throughout the State. Processing plants are located in most vegetable producing areas. With the diversity of locations and production areas, a variety of crops are handled. The attempt to survive in a competitive business has caused a number of plants to diversify and try to keep their plant in operation throughout the year. In the citrus producing area, for example, the processing of citrus juice started as a single strength juice operation during the latter part of the 1920's. The disastrous freeze of 1951, however, caused a change to diversification of products handled.

A survey of the known 62 fruit and vegetable canning companies in Texas was conducted by a mail questionnaire during the summer of 1960 to determine the present economic status and provide more comprehensive information about the canning industry in the State.

The response to the mail questionnaire was excellent, with 68 per cent return. The response from 42 companies revealed that only 53 per cent were packing fruit and vegetables, 33 per cent had gone out of business, 7 per cent no longer processed fruit and vegetables and 7 per cent had sold out and were now operating as a second unit to another plant.

MANAGEMENT

The stability of a business may be indicated by the length of time the firm has been in operation and by the type of ownership. The canners responding to the questionnaire had been in business for an average of more than 21 years, ranging from 10 years to 42 years of operation. Consolidation and incorporation has been a big item with many canners: 81 per cent of the companies reporting were corporations while the remainder were equally divided between individual and partnership owners. One-third of the companies have another business for a sideline to help pay the cost of utilities, labor and maintenance of equipment throughout the year.

The fact that so many are corporations might indicate the operation is a big business. Ninety per cent of the companies own their facilities. Investments per plant averaged $360,000 with at least one plant with an investment of over a million dollars; machinery accounts for over 56 per cent of the investments, building 38 per cent, and the remainder of the investment in land.

The canners have had to warehouse their packs in order to meet the needs of their customers who want to reduce inventory expenses. The necessity for warehousing the canned product at the processing plants required considerable storage facilities. The average storage space of the companies was more than 51,000 square feet with one firm reporting storage space of 460,000 square feet.

PRODUCTION AND MARKETING

Pack—The three leading vegetables canned in the Lower Rio Grande Valley are tomatoes, beans and beets. During the 1958-59 season in the Lower Rio Grande Valley area, there were 10 different kinds of vegetables canned and an output of 16 different vegetable products. Diversification of products was practiced by 38 per cent of the companies reporting. The processed products also included concentrated fruit juice, dry pack, canned meats and Mexican products. Even with this diversification, however, these companies estimated that more than 73 per cent of the volume was canned fruit and vegetables.

With 22 companies reporting annual volume packed for 1957, 1958 and 1959, the largest pack, 8.6 million cases, was reported in 1959. There was a steady increase in pack from the 7.2 million cases processed in 1957 to the estimated pack of 9.2 million cases in 1960. Fruit and vegetable products comprised 50 per cent of their output; 20 per cent were juices, 28 per cent were dry pack and the remainder was other products.

Supplies—It is estimated that 94 per cent of the vegetables produced for canning and freezing in the United States are now grown under some form of contract. Contracts range from a simple agreement calling for the processor to take the entire output of grower's crop at an agreed price to detailed contracts specifying items such as date of planting, variety, cultural and spray programs and schedule of prices by grades, sizes and varieties.

This study shows that the source of raw products to the plant is controlled primarily by: growing their own product, 10 per cent; contracts and purchases on the open market, 85 per cent; and other buyers, 5 per cent. These methods of procurement gave some control of the freshness of the raw product and regulation of the flow of the raw materials to the plant in accordance with the daily capacity of the plant.

The distance required in hauling raw products can be an important and costly factor to canning companies. Results of this study indicate that supplies of raw products are secured wherever possible; 43 per cent was obtained within a 50-mile radius while 49 per cent was transported from further away but still within the state of Texas. The remaining 8 per cent of raw product supplies are obtained from out of state; a part of this may be locally purchased if a plant is located near the state's borders.

Plant Efficiencies—Canning plants operate seasonally; none operate throughout the year. Attempts to utilize facilities and labor more fully partially account for the diversification in pack to include concentrated fruit juices, dry packs, canned meat and other products. But even this diversification does not provide for continuous daily operation. The spring season was the most active period of plant operation; 69 per cent of the companies reported operating during this season. Even during this busiest period, the plants did not operate more than half the time. The slack period occurs during the summer with only 56 per cent operating all or a part of this period. There are, therefore, inefficiencies in most operations. The inefficiencies occur because of labor turnover, extra sanitation required, the nonavailability of semi-skilled labor, the constant retraining and adjustment to the necessary hand operations and many other factors associated with seasonal operations.

Sales—Considerable effort, time, raw products, labor and money are required to prepare a product for sale. The canners have several alternatives for making the sale, such as the use of the mails, telephone, telegraph, use of company salesmen, standing orders from special customers and brokers. The manager often acts as company salesman when he goes to a convention. The use of mail, wire and telephone require a good reputation for fair dealings and delivering high quality products. Sometimes a company cannot afford and does not have contacts throughout the sales area. A reliable broker is used by 65 per cent of the canners, 30 per cent use the telephone for sales while mail accounts for 25 per cent of sales. A canned product is not as perishable as the fresh product; thus, the broker is very effective in disposing of the pack.

Selling under the company's own label is important to the Texas canner. About 69 per cent of the volume is under such labels. The effectiveness of the label may be influenced by the number of years a company has been in operation in that the reputation of a label is established over a period of time. A good portion, over 27 per cent, of the Texas pack is for wholesale disposal outside the state; the remainder of the pack is sold under national labels in the state of Texas.

Texas canned fruit and vegetables are being sold in significant volume outside the state. Sales to wholesale firms outside of Texas account for over 45 per cent of the volume. Sales to wholesalers in Texas account for about 53 per cent of the volume and the remainder of the pack is sold to in-state institutions and restaurants.

During the last few years, two services, transportation and credit sales, have become costly items of operation. These costly services are partially due to the use of brokers for the major part of the volume sold. Wholesalers are trying to reduce inventories, thus necessitating the use of large warehouse space for warehousing of packs. The canners use firm-owned trucks fo delivery of the major part of the output, about 73 per cent, and use the common carrier truck for another 17 per cent. Thus, it can be seen that trucks have just about eliminated the use of rail freight or express as a means of hauling products.

When the primary sales are made by three nonpersonal contacts — broker, mail and telephone — extension of credit is important. Credit sales account for 74 per cent of the volume of business for the canner. Other

methods of sales are cash, 25 per cent of volume, and the remainder are contracts sales, less than one-half of one per cent.

PROBLEMS

The need for all types of research is great in the canning industry. These include research on new products, new varieties, disease resistance, higher yields, new cultural practices, new processing techniques, fertilizer requirements and improvements of the quality of the raw and canned product.

In the field of marketing research, information is requested in such areas as merchandising techniques, consumer education and transportation costs. This type of information will provide the canner a better competitive position with the large wholesalers and chain stores and result in more effective financing, better use of personnel and many other improvements critically needed by canners.

SUMMARY

1. Investments average $360,000 per plant with machinery accounting for more than 56 per cent; building, 38 per cent and the remainder of investments in land.

2. The source of raw products to the processing plant is controlled primarily by: growing their own product, 10 per cent; contracts and purchases on the open market, 85 per cent; and other buyers, 5 per cent.

3. Twenty-two plants reported a volume pack of 8.6 million cases in 1959 with about 50 per cent of their output going to fruit and vegetables, 20 per cent to juices, 28 per cent for dry pack and the remainder to other products.

A Laboratory Model Rotary Screen Grader For Southern Peas

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Canned Southern peas *(Vigna sinensis)* according to Blackhurst, Paterson and Singleterry (1959), is a favorite vegetable of many families of the South. Canned Food Pack Statistics (1959) stated that more than 2,275,000 cases (basis 24 No. 303's) were canned in 1958. In the procedures outlined by Cruess (1948) such vegetables as garden peas, asparagus, green beans, lima beans, beets, etc., are sized and graded before being canned to improve the canned quality. Southern peas are not commonly sized into grades prior to canning, but are canned as a "field run" product.

The purpose of this investigation was to develop a laboratory model grader for Southern peas. A design was sought which could be easily fabricated or the principle adapted to present grading equipment so it could be used in commercial canning plants engaged in canning Southern peas.

MATERIALS AND METHODS

The width of each screen opening was determined by measuring the diameter of 100 peas from 5-pound lots of cleaned, shelled Southern peas. Three varieties commonly used for canning were selected from 3 of the horticultural groups suggested by Brittingham and Mortensen (1951), which would be typical of the size of each group. California Blackeye No. 5, with a size range of .150 to .307 inches, represented the blackeye group, Purple Hull 49, with a size range of .200 to .295 inches, the purple hull group, and Cream 40, with a size range of .156 to .291 inches, the cream group. Size ranges of 0-.175, .175-.200, .200-.225, .225-.250, and .250 inches and larger screen openings were arbitrarily selected.

Efficiency of the grader was determined by thoroughly mixing 12,000 grams of California Blackeye No. 5 peas and dividing them into four equal lots of 3,000 grams and sizing each lot through the screens.

Rotary Screen Grader. The grader in operation is shown in Figure 1. A diagram of the grader is shown in Figure 2. In constructing the grader the 5 supporting wheels for the sizing screens were made using a piece of steel pipe ½ inch wide and 8 inches in diameter. Four spokes were equally spaced and welded into each wheel with a ¾ inch hub at the center. The first wheel was fastened 8 inches from the end of a ¾ inch steel shaft 88 inches long. A second wheel was fastened to the shaft 15 inches from the first. Steel welding rods ⅛ inch in diameter and 18 inches long were spaced around the outer periphery of the wheels, .175 inches apart and projecting 3 inches beyond the first wheel. The rods

[1] One of the laboratories of the Southern Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture.

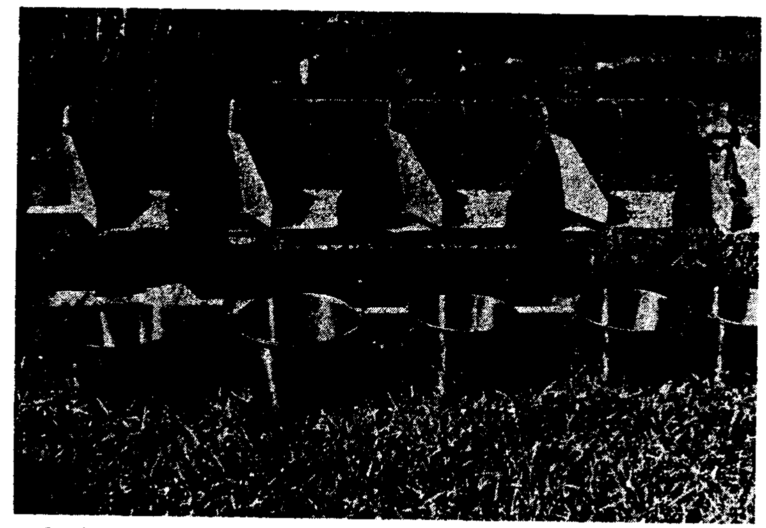

Figure 1. Rotary Screen Grader for Southern peas.

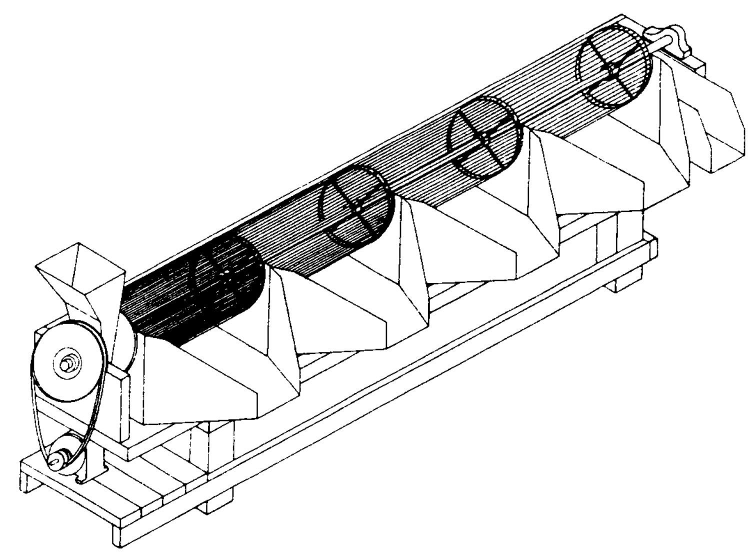

Figure 2. Construction view of rotary screen grader.

were soldered securely to each wheel to form the first size screen. The supporting wheel was fastened 3 inches back inside the first screen so the discharge end of the loading hopper could extend into the screen. A flange constructed of 28 gauge galvanized metal projecting 1¾ inches to the inside of the screen, forming a lip, was soldered flush to the ends of the rods which projected 3 inches from the first wheel to prevent peas from falling from the screen. The third, fourth and fifth wheels were fastened 18 inches apart along the shaft. The ⅛ inch welding rods were soldered .200 inches apart, around and extending from the second to the third wheel, to form the second size screen. The third and fourth screens were constructed by soldering the rods .225 and .250 inches apart, respectively, around the third and fourth and fourth and fifth wheels. Pillow blocks, ¾ inch size, were placed on the shaft and an 8 inch diameter V-belt pulley attached to the end of the shaft next to the .175 inch size screen.

A wooden frame was constructed 6 inches deep, 10 inches wide and 81½ inches long. A bin was fabricated from 28 gauge galvanized metal 8 inches high at the front, 10 inches high at the back, 12 inches wide and 81 inches long, and fitted within the frame. Five chutes were built on the front side of the bin; one at the discharge end of the screens and the other 4 at positions corresponding to the 4 sizes of screens. Baffles with 8¼ inch diameter semi-circles cut in the top half were fitted and soldered within the bin to coincide with the ends of each screen. A rubber flap ⅛ inch thick was fastened at the top and perpendicular to the back of the bin, extending outward 2 inches to ride on the surface of the sizing screens when they were in position. The pillow blocks were bolted to the wooden frame and a loading hopper attached.

The legs of the grader were adjustable so the screens could be tilted 2° from the loading to the discharge end. A variable speed drive and motor were mounted beneath the 8-inch V-belt pulley and adjusted to drive the screens 50 r.p.m. The screens rotate in a clockwise direction when observed from the end on which the loading hopper is attached.

RESULTS AND DISCUSSION

The rotary rod grader is not a new type machine for sizing vegetables. The principle has been used in sizing apples, peaches, potatoes, beets and other vegetables. However, the use of a sizing technique for Southern peas is new. The equipment built and described establishes the size openings in the screens, and presents operational procedures which adequately separate Southern peas (California Blackeye No. 5) into 5 sieve sizes (Table 1). Most of the trash, skins and small pod pieces were removed from each lot through the 0 to .175 inch screen. The canning plant operator could install a sizing screen in the canning line equipment and eliminate the split reel normally used to remove split peas and skins. The large broken pods were discharged from the end of the screen along with peas .250 inches and larger in diameter and were easily removed by visual inspection. An additional size screen .250 inches was added after the first season because a large percentage of the Cali-

Table 1. Percentage Southern peas separated through each screen size.

Sample	Screen sizes 0-.175 in. %	.175-.200 in. %	.200-.225 in. %	.225-.250 in. %	.250 in.+ %
1st lot	3.6	11.8	47.4	27.4	9.8
2nd lot	4.1	11.3	47.4	27.5	9.7
3rd lot	4.4	12.0	47.6	27.2	8.7
4th lot	4.3	11.9	47.3	27.2	9.3

Confidence limits for each single siz class is ±0.8%.

fornia Blackeye No. 5 was larger than .225 inches and discharged from the end of the screens. Also new strains of peas being developed by the Texas Agricultural Experiment Stations are extra large and an additional screen size would be useful in separating these large peas.

The peas were poured through the loading hopper into the screens slowly so they would move down the inclined screens from one size to the next without piling too deep in any one screen size. The rubbing action between the rods and the peas on the bottom of the pile has a tendency to break the seed coat of some peas which causes more split peas.

The rubber flap fastened to the back of the grader and riding on the sizing screens forced those peas lodged between the rods back into the screens so they could move on to the next larger size. The original model of the grader had a 3-inch diameter fiber brush, the length of the screens, mounted above and riding on the screens. As the brush rotated it forced the lodged peas back into the screens. The brush type cleaner is mentioned because it was more efficient than the rubber flap. Unfortunately, it was impossible with the materials and equipment available to construct a brush of sufficient length to fit the new and longer screen.

The ability of the machine to repeat itself on repeated runs from the same lot of peas is such that there is 95 per cent confidence that the true per cent of peas in any particular size class, for this lot and by this machine, is within ±0.8 per cent of the value actually obtained (Table 1).

SUMMARY

A laboratory model rotary screen grader for Southern peas has been constructed. The size openings of the screens and the operation of the machine has been adjusted to consistently separate Southern peas, California Blackeye No. 5, into sizes 0 to .175, .175 to .200, .200 to .225, .225 to .250 and .250 and larger inches in diameter.

ACKNOWLEDGEMENT

The author wishes to express his appreciation to Mr. E. Fred Schultz, Jr., Biometrical Services, Southern Utilization Research and Development Division, for his help with the statistical analysis, and to Mr. H. T. Tobola, shop foreman, U. S. Fruit and Vegetable Products Laboratory, for help in constructing the machine.

The author is also indebted to the Pan-Am Foods, Inc., Brownsville, Texas, for the peas used in the investigation.

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Varietal Resistance of Canning Beets To Internal Black Spot

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Internal black spot of canning beets is a cause of extensive losses to beat growers in the Lower Rio Grande Valley. The losses vary from year to year and from field to field. Entire fields of beets may not be harvested because of a high incidence of black spot. The disorder is more prevalent towards the end of the canning season than in mid-season and has not been observed in young rapidly growing beets less than 8 weeks old.

SYMPTOMS

The early internal black spot symptoms in the tap root of the beet are irregular necrotic spots that vary in size, shape and location and are hard and corky in texture. These spots become more evident in the canning process and present an unsightly appearance to the sliced or diced beets. The spots usually occur in the outer rings of the beet, but are not evident on the surface in the early stages. When the black spots occur just beneath the surface, a rough black scab-like spot is left by the "mechanical peeler" giving rise to the descriptive term scab, which is used by inspectors to identify the disorder.

External symptoms such as distinctive changes in color, or characteristic growth pattern of the leaves or top, have not been recognized in Valley beets prior to the development of the black spots in the beet. If such symptoms were evident, the grower would be able to initiate remedial measures before serious damage was done. In old or mature beets, discolored areas may be observed on the root surface, or even cracks or large canker way develop, this condition indicates a well advanced stage of the disease.

The black spot symptoms, as found in Valley beets, are similar to those that have been described for boron deficiency and called black rot in some areas. Because of this similarity of symptoms and Valley soil conditions that are seemingly conducive to a boron deficiency, especially in a crop that has a comparatively high boron requirement, it is presumed that the black spots are caused by or related to a lack of readily available boron. The application of boron to the soil in Northern beet growing areas is commonly recommended as a control measure, but it is not always effective in preventing the occurrence of black spot. Also, it has been shown (Kelly and Cabelman, 1960) that beet varieties and strains differ in their tolerance to boron deficiency.

EXPERIMENTAL TRIALS

In the past two years, field-plot variety trials have been conducted to compare the resistance of the various beet selections to the development of black spot. The results indicate a considerable difference in resistance between many selections. Since the results of both years' work are comparable, only data for the 1960-61 field trial are reported.

MATERIALS AND PROCEDURES

On November 6, 1960, 28 beet varieties and strains were planted in a sandy loam soil, 4 miles north of Weslaco. The planting consisted of 50-foot bed plots—two rows to a bed, and 5 replications. A pre-plant application of 40 pounds of nitrogen was made and an additional 70 pounds of nitrogen was applied as a sidedressing in early February 1961. On March 30, 1961, sample plots of 0.001 acre were harvested, weighed and a 40 beet sample from each plot was cut and examined for black spots. The results are given in Table 1.

RESULTS AND DISCUSSION

The occurrence of internal black spot varied from none to 25.0 per cent in the 28 beet selections when dug 150 days after planting. The differences between the 14 selections with the lowest percentage of black spot and the 7 beet selections with the highest percentage were highly significant. The intermediate selections with 5.0 to 8.5 per cent black spot were significantly different from either the highest or lowest affected beets. In general the Detroit Perfected selections were more resistant to black spot than the Detroit Dark Red. However, there were 3 or 4 exceptions in which Detroit Dark Red selections were equally resistant as Detroit Perfected.

The results given in Table 1 are in general agreement with recent results reported by Kelly and Gabelman (1960). In both cases, Seneca Detroit was free of black spot and selections of Detroit Perfected and King Red were highly resistant to black spot. It is interesting to note that the black spot incidence in the Wisconsin trials of 57 beet varieties and strains ranged from none to 76 per cent, which is a considerable greater range than was observed in Valley trials.

The acre yield of beets was exceptionally good, 16 to 23 tons per acre. This is considerable larger than the Valley average of 6 to 8 tons per acre. With the higher yielding black spot resistant strains and good cultural practices, Valley farmers should have no difficulty in increasing their yields of quality beets by 6 to 10 tons per acre or more.

SUMMARY

In 28 varieties and strains of beets grown in a sandy loam irrigated soil, the incidence of internal black spot ranged from none to 25 per cent. The incidence of black spot in Seneca Detroit, Ruby Queen, King

Red, 3 strains of Detroit Red and 3 strains of Detroit Perfected was one per cent or less. The yields ranged from 16 to 23 tons per acre.

Table 1. Resistance to black spot and yield of 28 beet varieties and strains.

Variety	*Entry number*	*Yield Tons/a.*	*Black spot Percent*
Seneca Detroit	2	16.6	0.0
Ruby Queen	11	16.3	0.0
Detroit Perfected	17	18.5	0.0
Detroit Dark Red	4	19.1	0.5
King Red	10	19.9	0.5
Detroit Perfected	14	17.9	0.5
Detroit Dark Red	20	19.4	0.5
Detroit Dark Red	26	19.1	0.5
Detroit Medium Top	1	21.8	1.0
Detroit Perfected	7	19.2	1.0
Detroit Perfected	8	18.0	1.0
Detroit Perfected	16	17.4	1.0
Beet Number 34	18	17.9	1.0
Beet Number 5	19	22.5	2.0
Detroit Dark Red	23	20.0	2.5
Detroit Short Top	9	23.4	3.0
Detroit Dark Red	24	20.1	4.0
Detroit Short Top	12	21.7	5.0
Detroit Short Top	15	20.4	5.0
Detroit Dark Red	5	23.6	6.0
Detroit Dark Red	21	21.4	6.5
Detroit Dark Red	25	20.3	8.5
Detroit Dark Red	3	22.2	9.0
Detroit Short Top	13	19.9	9.5
Detroit Short Top	6	22.0	13.0
Detroit Dark Red	22	21.5	13.5
Green Top	27	16.7	25.0
L.S.D. at 5% level		4.8	4.2
L.S.D. at 1% level		6.4	5.7

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The Effect of Fertilizers on the Yield and Size Distribution of Canning Beets

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INTRODUCTION

The production of canning beets is considered a low-income enterprise by most growers in the Lower Rio Grande Valley of Texas. Unfortunately the crop is usually planted on depleted soils of low fertility and produced with a minimum of cultural practices. Thus, potentials for high yields are not exploited and economic returns are usually low.

Fertilizer trials with canning beets were conducted during the 1960-61 season by the Texas Agricultural Experiment Station at Weslaco in cooperation with Alamo Products Company of Alamo, Texas. Results of these trials indicate that beet yields may be significantly increased by fertilization and that the use of fertilizers provides profitable returns even on soils of relatively high levels of fertility.

METHODS AND MATERIALS

The experiment was conducted on a Hidalgo clay loam soil at the Milton Kerston farm north of Donna, Texas.

Fertilizer treatments included 0, 40, 80 and 120 pounds of nitrogen (N); 0, 40 and 80 pounds of phosphorus (P_2O_5); and 0 and 40 pounds of potassium (K_2O). These treatments were used alone and in all possible combinations making a total of 24 different fertilizer treatments.

The nitrogen was applied as ammonium nitrate (33.3% N), phosphorus as superphosphate (46% P_2O_5) and potassium as muriate of potash (60% K_2O).

The fertilizers were applied in the center of vegetable beds 3-4 inches below the seed zone on November 10. The variety, Detroit Dark Red, was seeded at the rate of 13 pounds per acre in two rows on 38-inch beds the following day. The test area was then irrigated to provide adequate moisture for germination of the seed.

The experiment design was a 4x3x2 complete factorial with four replications. Each plot consisted of four double rows 50 feet long. Yield data were taken from the two middle rows of each plot.

The beets were hand harvested on March 15, 125 days after planting,

and separated into the following sizes (Cruess, 1948):

Small – less than 1 inch in diameter.
Medium – 1 to 1½ inches in diameter.
Large – 1½ to 2 inches in diameter.
Extra large – larger than 2 inches in diameter.

RESULTS AND DISCUSSION

The addition of nitrogen significantly increased yields of canning beets. The average yield of beets without nitrogen was 8.0 tons per acre which is as high or higher than the Valley average; however, yields were increased to 12.5, 15.1 and 15.6 tons respectively from 40, 80 and 120 pounds of nitrogen (N) per acre (Figure 1). Phosphorus and potassium fertilizers did not increase total yields significantly.

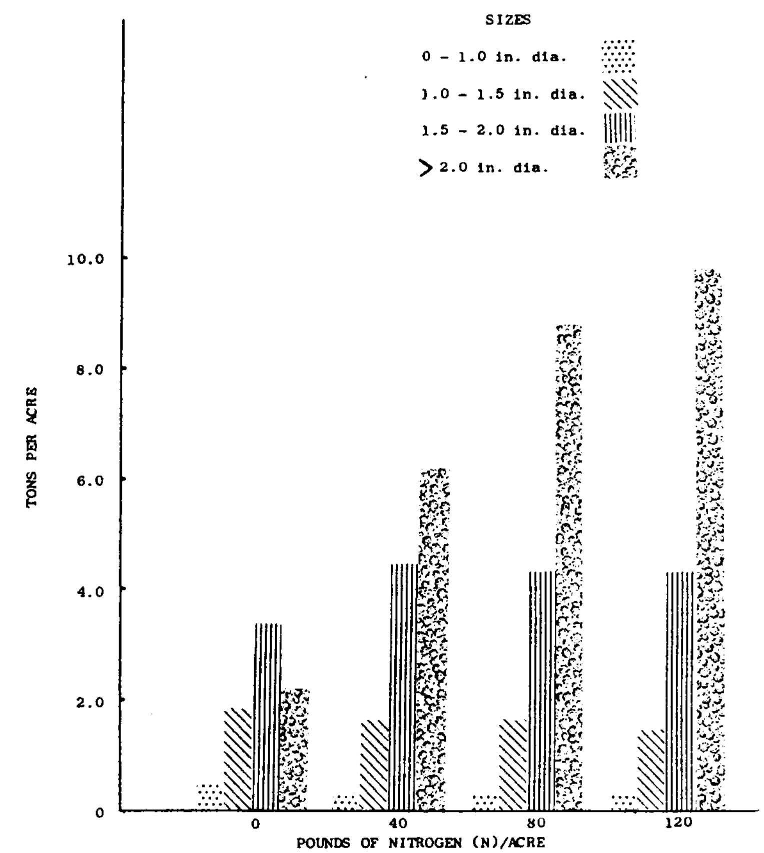

Figure 1. The effect of nitrogen fertilizers on the average yield and size distribution of canning beets.

Both nitrogen and phosphorus additions influenced the size distribution of beets. The yield of beets in the two smaller size classes remained at a rather constant tonnage regardless of the amount of nitrogen fertilizer used. The 40 pound rate of nitrogen increased the tonnage of both of the larger sizes. At the 80 and 120 pound rates of nitrogen the tonnage of the beets produced in the first three size classes was not different from that where only 40 pounds of nitrogen were used; however, the yields of beets in the largest size group (greater than 2.0 in.) were significantly increased. From these data it is indicated that the increased production from nitrogent additions at rates above 40 pounds per acre will largely be reflected in increases in the tonnage of beets larger than 2 inches in diameter. The effect of nitrogen on the yield and size distribution of canning beets is shown in Figure 1.

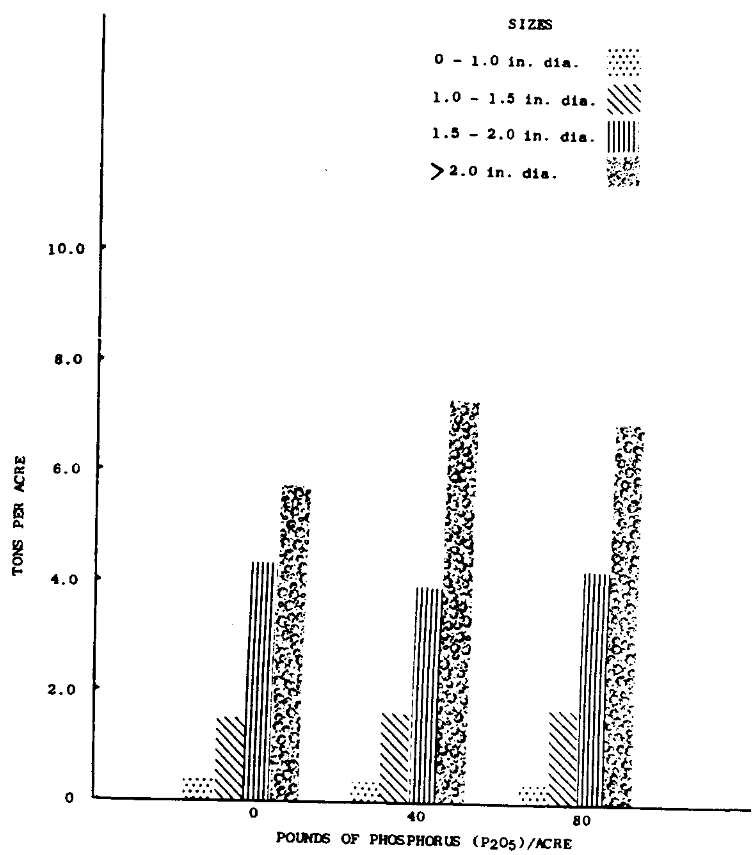

Figure 2. The effect of phosphorus fertilizers on the average yield and size distribution of canning beets.

Phosphorus fertilizer affected the size distribution of beets mainly by increasing tonnage of beets larger than 2 inches in diameter (Figure 2).

The size distribution of beets as affected by fertilizer treatment will no doubt vary with age at harvest and with plant populations. Further research is needed to determine the interaction of fertilization, age and plant populations on the yield and size distribution of canning beets.

CONCLUSIONS

The yield of canning beets was increased from 8.0 tons per acre without nitrogen to 12.5, 15.1 and 15.6 tons respectively with 40, 80 and 120 pounds of nitrogen per acre.

Phosphorus and potassium fertilizers did not significantly affect total yields.

Both nitrogen and phosphorus fertilizers affected the size distribution of beets, mainly by increasing the tonnage of the larger size beets.

The results of this experiment indicate that profitable increases in yields can be obtained with fertilizers; however, further research is needed to determine the interaction of fertilization, age at harvest and plant population on the yield and size distribution of beets.

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ACKNOWLEDGMENT

The assistance and cooperation of Milton Kersten, on whose farm this experiment was located, is gratefully acknowledged.

Nitrogen Requirements of Cabbage[1]

MARVIN D. HEILMAN, JAMES R. THOMAS, and
CHARLES A. BURLESON[2]

More Nitrogen—Higher Yields—More Profit Per Acre. This is the summation of results of various cabbage fertility trials conducted in the Lower Rio Grande Valley during the past 15 years (Burleson and Cowley, 1958; Burleson et al, 1950; Cowley et al, 1949; and Morris et al, 1949). Acreages grown, average yields, and per acre values of cabbage in ten previous seasons were as follows:

Year[3]	*Total acreage*	*Average yield Tons per acre*	*Value Dollars per acre*
1949-58	19,300	5.8	143.21
1958-59	17,500	5.6	108.85
1959-60	22,000	7.5	218.54

[3] United States Department of Agriculture Marketing Service.

Yields of 15-25 tons per acre are possible with proper nitrogen fertilization (Burleson, 1959). It can readily be seen that maximum yields have not been attained.

The two objectives of this experiment were (1), to determine the effects of different amounts of nitrogen fertilizer on yields of marketable cabbage, and (2), to determine the percentage of the applied fertilizer used by cabbage.

METHODS AND MATERIALS

The soil at the experimental site is Hidalgo fine sandy loam. Soil analyses showed a moderate supply of nitrate nitrogen (10-14 ppm), a low level of available phosphorus (5-12 ppm), a total nitrogen content of .090 per cent, a soil reaction of 7.8 and 330 ppm soluble salts in the surface foot. The field was leveled in 1957. Superphosphate (46% P_2O_5) was applied at rates of 144 pounds P_2O_5 per acre on the cut area and 72 pounds P_2O_5 per acre on the fill area. Nitrogen treatments were 0, 60, 120, and 180 pounds per acre applied as ammonium nitrate (33.3 per cent N). The fertilizer was broadcast and disked into the soil immediately preceding planting. Globe variety cabbage was planted in double rows,

[1] Joint contribution from Soil and Water Conservation Research Division, Agricultural Research Service, U. S. Department of Agriculture, Texas Experiment Station cooperating.

[2] Soil Scientists, U.S.D.A., and Agronomist, Texas Agricultural Experiment Station, Weslaco, Texas.

on beds 38 inches apart, on November 3, 1959. Following thinning, the spacing between plants in the row ranged from 9 to 12 inches. The plot size was 25⅓ feet by 60 feet. Treatments were arranged in a randomized block design and were replicated 8 times.

The plots were harvested on March 1 and April 4, 1960, for yield of marketable cabbage. The cabbage was weighed and graded according to the following classifications:

Number 1: Firm, round heads.

Number 2: Pointed heads and small cabbage.

Culls: Split and soft heads.

Yield of total plant material was determined by one harvest on April 6, 1960. Total nitrogen (Kjeldahl method) was determined on plant material. Nitrogen percentages are reported on a dry weight basis.

A multiple regression equation showing yield of marketable cabbage as a function of nitrogen content of the cabbage was calculated on an individual plot basis.

In addition to the field study, relative responses of cabbage to nitrogen fertilization on the major irrigated Valley soils were calculated from published data (Burleson and Cowley, 1958; Burleson et al, 1950; Cowley et al, 1949; and Morris et al, 1949).

RESULTS AND DISCUSSION

Yields of total plant material and marketable cabbage increased with successive increments of nitrogen through 180 pounds per acre (Table 1). The largest yield increase in both total plant material and marketable cabbage for any 60-pound increment of nitrogen occurred with the first increment. Total plant yield increased by 9.29 tons per acre, above the check, while the yield of marketable cabbage increased by 6.37 tons per acre. Each additional 60-pound increment of nitrogen increased marketable cabbage yield by approximately 3.0 tons per acre. The proportion of the total yield that was marketable increased with successive increments of nitrogen through 120 pounds per acre.

Table 1. Yield of total plant material and marketable cabbage as affected by nitrogen fertilization.

	Yields		
Nitrogen applied to cabbage Pounds/acre	*Total plant material Tons/acre*	*Marketable cabbage Tons/acre*	*Percent marketable of total*
0	28.57	13.83	48
60	37.86	20.20	53
120	40.15	23.20	57
180	45.91	26.18	57

Grade distribution of marketable cabbage is presented in Table 2. Nitrogen fertilization increased cabbage quality. Without fertilizer only 32 per cent of the cabbage was Grade 1, but with the addition of 180 pounds of nitrogen the percentage of Grade 1 cabbage was approximately doubled. The fertilizer treatments had no effect upon the percentage of Grade 2 cabbage; however, the percentage of culls decreased in proportion to the increase of Grade 1 cabbage. Most of the culls in the fertilized plots were large split heads. Most of the cabbage on the fertilized plots was harvested in the first cutting, indicating that an earlier harvest date can be obtained by nitrogen fertilization. Cabbage seeded in August and September is hard to establish because of hot temperatures. Nitrogen-fertilized cabbage could be planted approximately two weeks later than non-fertilized cabbage and still be ready for market at the same time.

The yield of marketable cabbage was directly related to the nitrogen content of the cabbage at harvest (Figure 1). High yields were associated with cabbage having high nitrogen content. As the nitrogen content increased from 1.8 to 2.8 per cent, yield of marketable cabbage increased 10 tons per acre.

Table 3 shows that although cabbage was an efficient user of fertilizer nitrogen, a considerable portion of the nitrogen applied was returned to the soil in the plant residue. The total quantity of nitrogen car-

Table 2. Effect of nitrogen fertilizer on the grade distribution of cabbage.

Nitrogen applied to cabbage Pounds/acre	Grade No. 1 Percent	No. 2 Percent	Culls Percent
0	32	20	48
60	48	20	32
120	55	21	24
180	60	19	21

Table 3. Percentage utilization of nitrogen fertilizer and amount of nitrogen remaining in soil after harvest.

Nitrogen applied to cabbage Pounds/acre	Yield of nitrogen Pounds/acre	Fertilizer N recovered Percent	Nitrogen returned to soil in plant residue Pounds/acre	Total nitrogen carried-over[1] Pounds/acre
0	112.7	....	58.6	58.6
60	166.7	90	78.4	84.4
120	180.9	57	77.8	129.4
180	247.9	75	106.6	151.6

[1] Unused fertilizer N plus nitrogen returned in plant residue.

Table 4. Effect of nitrogen content of soils on yield and relative yield increases of marketable cabbage.

Soil	Total nitrogen Percent	Yield No fertilizer Tons/acre	Increase in yield from 80 pounds nitrogen Percent
Willacy fsl	.040	2.8	232
Brennan fsl	.049	6.0	108
Hidalgo fsl	.055	7.4	66
Hidalgo scl	.087	13.8	60
Harlingen c	.109	10.2	104

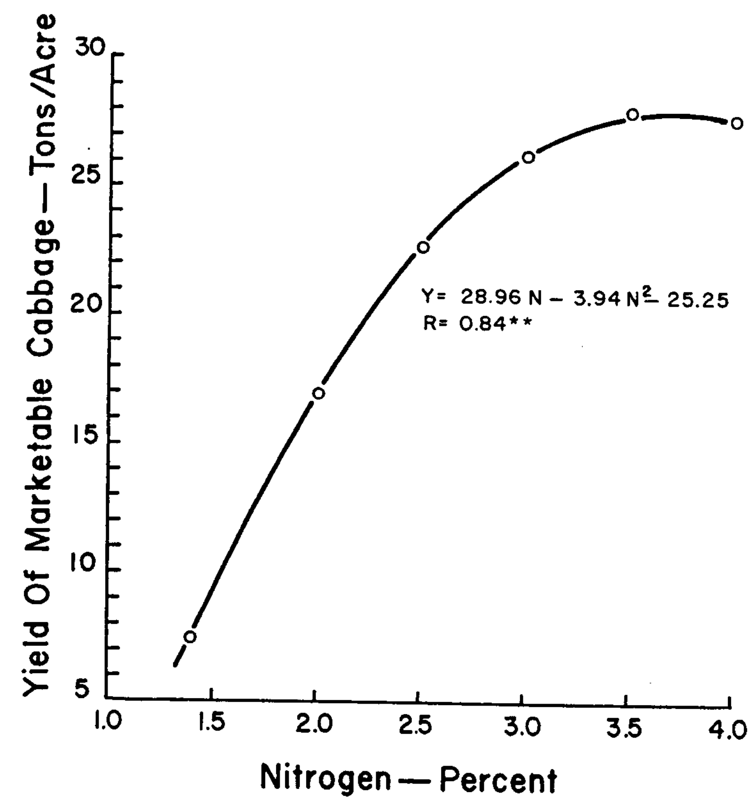

Figure 1. Relationship between nitrogen content (N) of the cabbage plant and the yield (Y) of marketable cabbage. Percent nitrogen expressed on oven dried basis.

ried over is a significant factor to be considered in designing future fertilizer programs. Farming practices that aid in the decomposition of the plant residue and conserve the nitrogen should be followed. Under the climatic conditions of the Lower Rio Grande Valley, plant residues should be incorporated into the soil. When plant material decomposes on the soil surface a considerable proportion of the nitrogen may be lost.

The degree of response by cabbage to nitrogen fertilizer depends to some extent on the soil type (Figure 2). An 80-pound nitrogen appli-

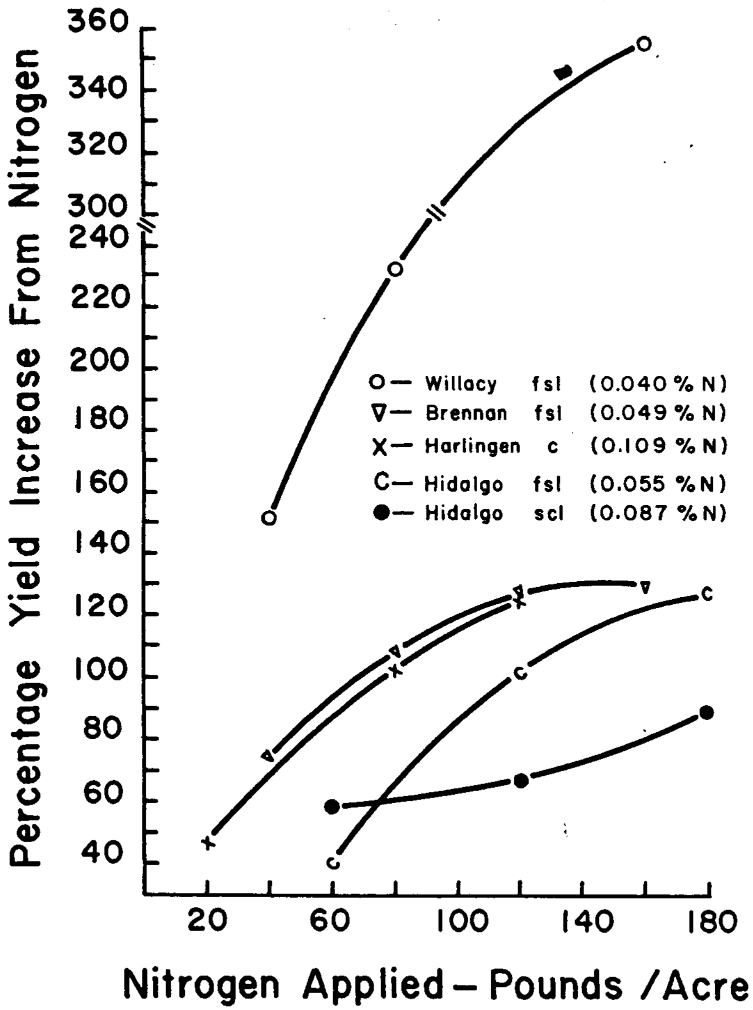

Figure 2. Percentage increase in marketable cabbage from application of nitrogen fertilizer on several Valley soils.

cation increased yields by 66, 108, and 232 per cent, respectively, on the Hidalgo, Brennan, and Willacy fine sandy loams. The data of Table 4 and Figure 2 suggest that both cabbage yield and degree of response to nitrogen fertilizer were related to the total nitrogen content of the soil. Previous studies on these soils (Burleson and Cowley, 1958; Burleson et al, 1950; Cowley et al, 1949; and Morris et al, 1949) indicated that nitrogen was the principal plant nutrient affecting cabbage yields. Cold soil temperatures probably caused the Harlingen clay to react differently from the other soils. Cabbage harvest was delayed approximately one month due to this factor.

SUMMARY

The yields of marketable cabbage and total plant material increased with successive 60-pound increments of nitrogen through 180 pounds per acre. Yields were directly related to the nitrogen content of the plant material. Nitrogen fertilization also increased the percentage of total plant material that was marketable.

Nitrogen recovery was 90, 57, and 75 per cent from 60, 120, and 180 pounds of nitrogen respectively.

Nitrogen response by cabbage on different soil types is apparently related to the nitrogen content of the soil as reflected by the total nitrogen percentage. This is particularly true with the loam soils.

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MISCELLANEOUS

Quality and Quantity of Rio Grande Water[1]

K. M. SMITH, *Special Water Master,*
93rd District Court, Hidalgo County, Texas

In 1913, the United States Government completed construction of Elephant Butte Dam on the Rio Grande above El Paso, Texas, in an effort to quell serious international border troubles between water users of the United States and Mexico in the El Paso-Juarez region. This trouble was chiefly caused by upstream diverters on the Rio Grande in Colorado and New Mexico increasing their diversions therefrom in major proportions. Construction of Elephant Butte Dam reduced the drainage basin of the Lower Rio Grande by nearly 26,000 square miles and for all practical purposes, owing to subsequent total retention and consumption of all flows above, Fort Quitman, Texas became the head-waters of the Lower Rio Grande.

Following the completion of the construction of Elephant Butte Dam in 1913, it was not until exhaustive hearings were held in 1924 before the Committee of Foreign Affairs of the House of Representatives that it was decided by the Act of May 13, 1924, to appoint Commissioners to cooperate with Mexican representatives in a study of flood control and the equitable use of available waters of the Lower Rio Grande below Fort Quitman, Texas.

Mexico, in the meantime, was constructing large reservoirs on the Conchos, Salado and San Juan tributaries to the Rio Grande below Fort Quitman, thus further depleting the available flow to the Lower Rio Grande Valley and by 1940 Mexico had constructed canal headings to divert the entire low water flow of the Rio Grande, causing grave concern to irrigators in the United States.

Plans for flood control and conservation of Rio Grande waters are closely related to the problem of division of waters between the two countries. The flood disaster of 1922 resulted in interested counties in the Lower Rio Grande Valley of the United States voting bond issues on a tax remission basis in order to build levees. The flood disaster of 1932 proved that these levees could not, without reservoir storage, provide adequate protection.

From Fort Quitman, Texas, to the Gulf of Mexico, some 1,160 river miles, the contributing drainage area is approximately 140,000 square miles. The preponderance of runoff from this watershed is controlled by the Falcon Dam on the Rio Grande located about 270 miles upstream

[1] A portion of a talk before the September, 1960 meeting of the Rio Grande Valley Horticultural Society.

from the mouth of the river, and by dams located on both the United States and Mexican main tributaries. Below Falcon Dam and upstream from the Gulf of Mexico, there is an uncontrolled drainage area amounting to approximately 3,900 square miles. The principal tributaries in this area are Los Olmos Creek in the United States, which enters the river just below Rio Grande City and drains an area of 535 square miles; the Rio San Juan, which enters the river from the Mexican side opposite Rio Grande City and drains an area of 206 square miles below Marte Gomez Dam; and the Mexican tributary Rio Alamo, which enters the river about 22 miles upstream from the Rio San Juan and drains an area of 1,663 square miles. The approximate average annual unused runoff of rainfall on the Rio Grande above Laredo, Texas, in acre-feet per square mile from 1900 to 1913 was 29.3 and from 1924 to 1958 was 22.0, a decrease of 25%.

Falcon Dam constructed by the Water Treaty of 1944 between the United States and Mexico includes storage capacities (1954 Survey) as follows:

Elevation	*Description*	*At Indicated Elevation*		*Between Indicated Elevations*	
		Reservoir Capacity Acre-feet	*Reservoir Area Acres*	*Storage Volume Acre-feet*	*Type of Storage*
175.0	River Bed at Dam Axis	0	0		
203.33	Lowest Outlet (Mexican Penstock)	15,036	1,363	15,036	Silt and Dead
296.4	Top of Conservation Storage	2,440,528	78,451	2,425,492	Silt and Conservation
306.7	Top of Spillway Gates Maximum Water	3,349,287	98,805	908,759	Ordinary Flood
314.2	Surface	4,150,971	115,581	801,684	Super Flood

During the winter months, 400,000 acre-feet of the flood control capacity may be utilized for additional conservation storage.

The 1944 Treaty between United States and Mexico, *Section I—Preliminary Provisions — Article 3;* and *Section II — Rio Grande — Article 4;* reads as follows:

Article 3. "In matters in which the Commission may be called upon to make provision for the joint use of international waters, the following order of preferences shall serve as a guide:

1. Domestic and municipal uses.
2. Agriculture and stock raising.
3. Electric power.
4. Other industrial uses.
5. Navigation.

6. Fishing and hunting.
7. Any other beneficial uses which may be determined by the Commission.

All of the foregoing uses shall be subject to any sanitary measures or works which may be mutually agreed upon by the two Governments, which hereby agree to give preferential attention to the solution of all border sanitation problems."

Article 4. "The waters of the Rio Grande (Rio Bravo) between Fort Quitman, Texas and the Gulf of Mexico are hereby allotted to the two countries in the following manner:

A. To Mexico:

(a) All of the waters reaching the main channel of the Rio Grande (Rio Bravo) from the San Juan and Alamo Rivers, including the return flow from the lands irrigated from the latter two rivers.

(b) One-half of the flow in the main channel of the Rio Grande (Rio Bravo) below the lowest major international storage dam, so far as said flow is not specifically allotted under this Treaty to either of the two countries.

(c) Two-thirds of the flow reaching the main channel of the Rio Grande (Rio Bravo) from the Conchos, San Diego, San Rodrigo, Escondido and Salado Rivers and the Las Vacas Arroyo, subject to the provisions of subparagraph (c) of Paragraph B of this Article.

(d) One-half of all other flows not otherwise allotted by this Article occurring in the main channel of the Rio Grande (Rio Bravo), including the contributions from all the unmeasured tributaries, which are those not named in this Article, between Fort Quitman and the lowest major international storage dam.

B. To the United States:

(a) All of the waters reaching the main channel of the Rio Grande (Rio Bravo) from the Pecos and Devils Rivers, Goodenough Spring, and Alamito, Terlingua, San Felipe and Pinto Creeks.

(b) One-half of the flow in the main channel of the Rio Grande (Rio Bravo) below the lowest major international storage dam, so far as said flow is not specifically allotted under this Treaty to either of the two countries.

(c) One-third of the flow reaching the main channel of the Rio Grande (Rio Bravo) from the Conchos, San Diego, San Rodrigo, Escondido and Salado Rivers and the Las Vacas Arroyo, provided that this third shall not be less, as an average amount in cycles of five consecutive years, than 350,000 acre-feet (431,721,000 cubic meters) annually. The United States shall not acquire any right by the use of the waters of the tributaries named in this subparagraph, in excess of the said 350,000 acre-feet (431,721,000 cubic meters) annually, except the right to use one-third of the flow reaching the Rio Grande (Rio Bravo) from said tributaries, although such one-third may be in excess of that amount.

(d) One-half of all other flows not otherwise allotted by this Article occurring in the main channel of the Rio Grande (Rio Bravo), including the contributions from all the unmeasured tributaries, which are those not named in this Article, between Fort Quitman and the lowest major international storage dam.

"In the event of extraordinary drought or serious accident to the hydraulic systems on the measured Mexican tributaries, making it difficult for Mexico to make available the run-off of 350,000 acre-feet (431,721,000 cubic meters) annually, allotted in subparagraph (c) of paragraph B of this Article to the United States as the minimum contribution from the aforesaid Mexican tributaries, any deficiencies existing at the end of the aforesaid five-year cycle shall be made up in the following five-year cycle with water from the said measured tributaries.

"Whenever the conservation capacities assigned to the United States in at least two of the major international reservoirs, including the highest major reservoir, are filled with waters belonging to the United States, a cycle of five years shall be considered as terminated and all debits fully paid, whereupon a new five-year cycle shall commence."

Article 4 thus provides that Mexico, in the accounting of ownership of waters belonging to each country, is credited with return flow from lands irrigated from the Alamo and San Juan Rivers. Included in this group of Mexican drains is the Rancherias Drain above the Fort Ringgold Station and the Puertecitos, Huizache, and Morillo Drains below the Fort Ringgold Station. From 1953 to 1958 the drains below the Fort Ringgold Station, excluding all storm water, contributed an annual average of 26,856 acre feet.

The 1944 Treaty between United States and Mexico had as its purpose to obtain the most complete and satisfactory utilization of the waters of the Rio Grande from Fort Quitman to the Gulf of Mexico.

The attached table, among other information used herein, is from the Water Bulletins of the International Boundary and Water Commission, United States Department of State, in accordance with provisions of the 1944 Treaty between the United States and Mexico. The table is from Water Bulletin No. 28, for the year 1958.

The year 1958 was chosen because the period from about April until early September was representative of ordinary water use and commencing in September widespread torrential rains occurred causing sustained flood flows in the Rio Grande below Falcon Dam. This furnishes comparison of salinity in the Rio Grande for ordinary flows and flood flows.

Attention in particular is called to table 1 showing dissolved solids for the Rio Grande above Morillo Drain, Morillo Drain and the Rio

Grande at Anzalduas Dam, 8.4 miles downstream from where the Morillo Drain interest the Rio Grande.

Most everyone in the Rio Grande Valley using Rio Grande water has at one time or another in recent years complained about the salty water. Complaints that I receive become particularly serious and violent when it reaches the point of making coffee unfit to drink. Seriously, most everyone is very familiar with the damaging effect the high saline water of the Rio Grande has on agriculture. Therefore, it is unnecessary to dwell on this point.

The solution to satisfactorily alleviate this devastating salinity situation is going to be difficult and expensive. The main source of our trouble originates in Mexico from their drains into the Rio Grande. As pointed out in the beginning, Mexico receives full credit in the accounting of ownership of waters in the Rio Grande for all irrigation return to the Rio Grande from the Rio Alamo and Rio San Juan. Mexico has an arrangement whereby they are not seriously troubled with their own saline waters. The problem therefore evolves into requiring both a diplomatic and engineering solution.

In addition to the salinity problem it should be borne in mind that we, of course, have the sanitary aspects of water quality. The 1944 Water Treaty with Mexico does, as noted herein, make provision for attention to the sanitary aspects.

Solutions have been suggested as follows: Evaporation Reservoirs; Drainage canal to the Gulf on the Mexican side; Siphon across the Rio

Table 1. Electrical conductivity and salt content of Rio Grande, 1958.

Date of Sample	*Rio Grande Above Morillo Drain*[a]		*Morillo Drain Near Reynosa Vieja, Tamps.*[b]		*Rio Grande at Anzalduas Dam Site*[c]	
	ECx10⁶ @25°C	*Dissolved Solids Tons Per Acre-Foot*	*ECx10⁶ @25°C*	*Dissolved Solids Tons Per Acre-Foot*	*ECx10⁶ @25°C*	*Dissolved Solids Tons Per Acre-Foot*
Jan. 11	788	.663	15,510	16.4	1,070	.840
Feb. 6	1,110	.949	18,600	18.9		
Feb. 17	933	.832	19,660	20.1	1,120	.919
Mar. 4	2,870	2.55	19,270	20.1	3,080	2.91
July 1	744	.662	15,100	15.2	1,300	1.16
Aug. 5	815	.725	22,000	23.4		

[a] Samples taken from Rio Grande at a point 200 feet upstream from Morillo Drain confluence except for last three samples which were taken 25 miles upstream and for which T.A.F. was determined by the equation shown in textual heading.

[b] Morillo Drain enters the Rio Grande 8.4 miles upstream from Anzalduas Dam. Samples collected .25 mile upstream from the confluence. There was no storm run-off in Morillo Drain on dates samples were taken.

[c] Samples taken at Anzalduas Canal gaging station cableway .5 mile below the canal intake.

Grande to the IB&WC Floodways; and a Gravity canal on the American side.

This matter is being given serious consideration by your able Congressman, Honorable Joe M. Kilgore and the Lower Rio Grande Water Committee. Mr. Kilgore and the IB&WC Commissioner, Colonel L. H. Hewitt are fully apprised of the El Morillo Drain saline problem and are working to find a solution to this "tough" problem.

The Rio Grande Valley below Falcon Dam does not, on the average, have an adequate supply of water. If this were not true, the quality aspects of water discussed above, could be greatly solved by releasing sufficient water from Falcon Reservoir to correct the salinity and sanitary problems. In fact this is being done in a small measure when the amount of water in storage in Falcon Reservoir is adequate to permit such releases. It is doubted, however, that when Amistad Reservoir is put into operation, many instances will occur where it would be proper, in the conservation of water, to employ this method to reduce the salinity, even in a small measure.

To improve our situation quantity-wise, it is therefore suggested that:

1. All methods of conserving water be employed. The present land levelling practices are believed to be very important. Although excellent work by the farmers, with the help of their County Agents, Soil Conservation Service, Farm Bureaus and others, is being done in this respect, the land levelling program should be expedited. The program of improvements to distribution systems by Districts and individuals should be continued and expedited. Meters should be used by all of the Districts in determining amounts of water for basis of charging for water furnished to their water users.

2. Channel Storage Dams, including a permanent type of Tide Water Dam, should be constructed.

On the average, water release from Falcon Reservoir requires "travel time" of about one week to run its 270 mile meandering course to the mouth of the Rio Grande at the Gulf of Mexico. All diversions in the United States from the Rio Grande below Falcon Dam to irrigate approximately 755,000 acres of land and to furnish domestic, municipal, livestock and industrial water to approximately 400,000 population, (except for a source of mostly poor quality water from a few wells, used in emergency during shortages of Rio Grande water) are made by pumping.

There are no control works in the Rio Grande to regulate the amount, or rate of flow of the water after it has been released from Falcon Reservoir. Anzalduas Dam is authorized for flood flow diversions only in the United States. Because of the one week of "travel-time," it is necessary each day in ordering the proper amount of water to be released from Falcon Reservoir to carefully and almost impossibly anticipate one week in advance, weather, rainfall, channel changes, pump breakdowns, and

runoff from rainfall over uncontrolled drainage areas below Falcon Dam, so that the diverters will have available at their individual pumps adequate water on the days required without unnecessary surpluses being wasted into the Gulf of Mexico. All such water saved from being wasted into the Gulf of Mexico is water conserved in like amount in Falcon Reservoir for the benefit of everyone downstream.

Preliminary Examination and Survey Report, "Feasibility of Channel Control Dams, Lower Rio Grande," 85th Congress, 1st Session, House Document No. 233 finds that: three channel-control dams on the Rio Grande below Falcon Dam would provide a total of about 23,000 acre-feet of channel storage capacity; would permit conservation of an annual average of 140,000 acre-feet of the waters which, without channel control dams, would otherwise waste into the Gulf of Mexico (with or without the construction of Amistad Dam); the first cost would amount to $7,218,000, and the resulting cost-benefit ratio would be approximately 7:1.

3. Intensive efforts should be made to import water from outside sources, commensurate with economic benefits and financial ability.

The Portland Cement Association states in their booklet, "Water Control" that:

"Water can be either man's best friend or his worst enemy. Controlled, water serves the increasing needs of civilization in greater measure than any other natural resource; uncontrolled, it can create havoc.

"The health and economic well-being of every community and of the nation as a whole depend on an adequate and satisfactory supply of water for municipal, industrial, agricultural and other uses.

"Water use by municipalities, industry and agriculture increased from 40 billion gallons daily in 1900 to 260 billion gallons daily in 1955. This figure is conservatively expected to exceed 450 billion gallons by 1975.

"It is estimated that by 1975 the nation's population will be more than 200 million, industrial production will double and irrigation will increase 40 per cent.

"At present, the greatest use of fresh water is for irrigation. Although irrigation in the past has largely been confined to the 17 western states, more and more acres in the other states are receiving supplemental irrigation to increase crop yields."

All kinds of estimates of our future water needs are being published. It is believed that, in the Rio Grande Valley of Texas, the most optimistic forecasts will be exceeded. Much has been accomplished already by the people of the Rio Grande Valley of Texas. Falcon Dam is really a great accomplishment. This summer when Mexico and the United States were releasing a total of nearly 15,000 cfs from Falcon Reservoir, the flow in the Rio Grande at Laredo was only 1,000 cfs.

Where would we have been without it, this year, 1958, 1954, and, in fact, since it was put into operation, August 25, 1953?

The water users of the Rio Grande Valley of Texas this year enjoyed diversions of unlimited amounts without charge to their credit balances from April 3, 1960, to July 3, 1960, and Jan. 15, 1961 to date, periods of great demand during the year and yet the winter conservation capacity of Falcon Reservoir of about 2,800,000 AF is nearly full to capacity. We are very fortunate in many respects, but a lot of important and urgent work remains to be accomplished.

Rust of Esperanza (Stenolobium stans).

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A rust disease on Esperanza, *Stenolobium stans* (L.) D. Don syn. *Tecoma stans* (L.) Juss., causes unusual, swollen, pustulate-cushion overgrowths on infected plant parts in the Lower Rio Grande Valley of Texas. Severe infections may cause a loss of leaves and an unsightly appearance to this common ornamental shrub. The fungus, *Prospodium appendiculatum* (Wint.) Arth., was reported from Florida (West, 1939) and it is common on this and related plants in the family Bignoniaceae in the tropical and semitropical regions of the Americas (Cummins, 1940). Infections occur during spring and summer and the fungus is perpetuated as spores which overwinter on leaves and other infected plant parts. The recommended control is by fungicides applied during the dormant or semi-dormant period to eradicate the overwintered spores on infected plants.

SYMPTOMS OF THE DISEASE

The first visible symptom is the appearance on young leaves of slightly sunken, chlorotic lesions, with raised centers consisting of small subcuticular, hemispherical, orange-colored, resin-like specks (pycnia) (Figure 1). The lower surface of such lesions are often covered with erumpent, cinnamon-brown, spore masses. Gall-like swellings appear on petioles, leaf midribs, or young stems (Figure 2). Sections through hypertrophied parts show enlargement of the parenchymatous cells which become greatly distended resulting in disappearance of intercellular spaces. Later, infected tissues become covered with light-tan to cinnamon-brown spore masses (urediospores). Seed pods develop wart-like swellings which are covered with urediospores. In late summer and fall, erumpent masses of chestnut-brown to black, glistening, bead-like, 2-celled spores (teliospores) develop promiscuously on the lower leaf surfaces. Often they are associated with uredia and urediospores, but during late fall and winter many leaves showing no evidence of previous infections bear abundant masses of teliospores.

CAUSAL AGENT AND DISEASE CYCLE

Esperanza rust is caused by the fungus *Prospodium appendiculatum*. The genus *Prospodium* comprises about 40 autoecious species all of which occur on Bignoniaceae and Verbenaceae in the tropical areas of the Americas (Cummins, 1959). The cycle of spore development of this species includes pycnia (pycniospores), aecia (aeciospores), uredia (urediospores), and telia (teliospores) all of which develop on Esperanza, Arthur, 1907). Urediospores and aeciospores probably account for

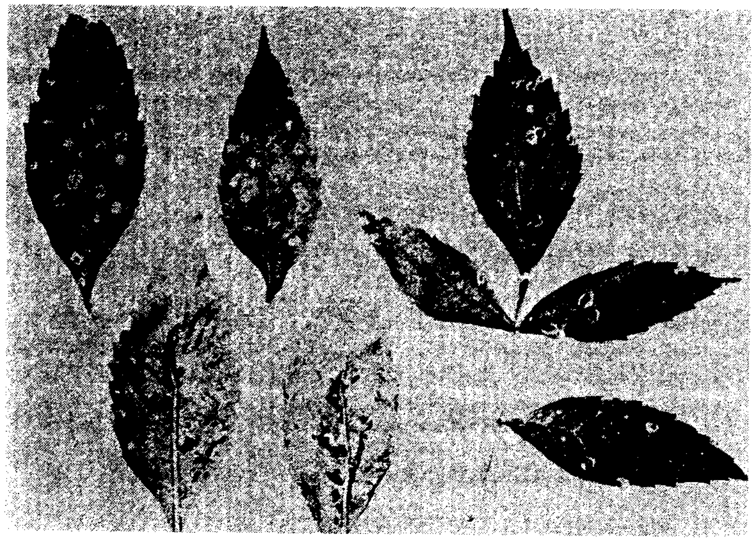

Figure 1. Rust infections on Esperanza leaves, showing pycnia and uredia.

Figure 2. Gall-like swellings on leaves, petioles, and stems of Esperanza caused by the rust fungus. Infected tissues are covered with light-tan to cinnamon-brown masses of urediospores.

the spread of the disease during summer and urediospores which overwinter on infected plants perpetuate the fungus regardless of other spore stages. Urediospores are irregularly round, light-tan to cinnamon-brown in color, and average 28.0 x 34.0 microns. Spore walls are dark colored, with a light, hygroscopic, rather irregular, thick, bluntly-echinulate layer. Urediospores are borne singly on short, light-colored pedicels which separate easily from the spores (Figure 3, A). Urediospores are borne in subepidermal uredia which appear to be naked but are often encircled by sterile paraphyses. There are few distinct pustules (sori), and often urediospore masses cover hypertrophied tissues.

Teliospores are produced during late summer and fall in telia which are frequently encircled by paraphyses similar to those in uredia. Teliospores are 2-celled by a transverse septum, rarely single celled, averaging 27.5 x 47.5 microns. The walls are dark colored with a thin, hyaline, layer which is sparsely papillose-echinulate and often enlarged to a peak at the apex. Teliospores are borne singly on light-colored refractive, persistent, pedicels which are more or less strongly ornamented or appendaged (Figure 3, B). There is one germ pore in each cell of the teliospore, being apical in the upper cell and usually near the pedicel in the lower cell. Teliospores germinate during February and March. The upper cell germinates first and forms an external basidium (promycelium) bearing sporidia (basidiospores) which may infect Esperanza leaves. Basidia from teliospores germinated in the laboratory varied in length, often being longer than the teliospores. Up to four sporidia were borne laterally or one or more appeared to arise from the terminal cell. Sometimes basidia were not visible and sporidia appeared to be sessile

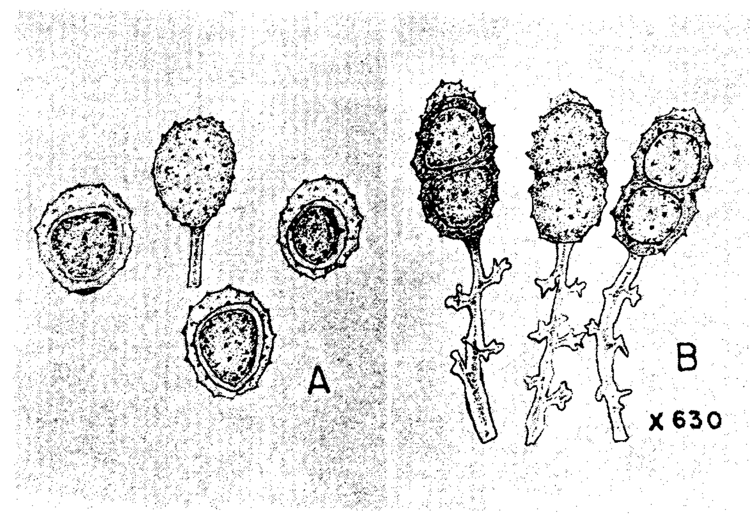

Figure 3. Camera-lucida drawings of spores of Esperanza rust fungus (A) urediospores, (B) teliospores.

on the teliospores. Apparently teliospores are not important in the disease cycle since infections may be perpetuated by urediospores. In Florida, West (1939) reported only the uredinial stage of the fungus on this host.

Disease cycles may be initiated by different spore stages, the principal spread being by urediospores. Urediospores may overwinter on infected plants and incite infections directly in spring. They are carried by wind and may disseminate the fungus over large areas and perpetuate the disease through several cycles during the summer. Teliospores also overwinter on infected plants and germinate in spring but do not infect directly. They give rise to secondary spores (sporidia) which invade usually the upper surfaces of young Esperanza leaves. These infections give rise to aecia and aeciospores which in gross morphology are similar to urediospores. Aeciospores are lighter colored and slightly larger, and have thicker walls than urediospores (Cummin, 1940).

CONTROL

Since Esperanza usually maintains some foliage through the winter, the plants do not reach complete dormancy. Vegetative growth is only arrested during a short winter period, and rust spores subsist on infected plants. Four 3 to 4 ft. nursery plants (in 5-gal. tins) and 2 larger landscape plants in widely separated yards were sprayed in late January with each of the following fungicides: (1) Bordeaux 12-12-100, (2) Calcium polysulfide 3 gals./100, (2) maneb (manganese ethylene-bis-dithiocarbamate) 3 lbs./100, (4) copper sulfate 4 lbs./100, followed within 1 hour with, hydrated lime 6 lbs./100. An equal number of unsprayed plants served as checks. Control of rust was evaluated for each treatment by the number of visible lesions which developed during spring on the sprayed plants as compared with those on unsprayed plants and also by the ability to germinate in the laboratory teliospores taken from plants sprayed with the different fungicides. Results indicate that each of the fungicides killed only part of the overwintered spores and thereby reduced the number of primary infections. Initial infections were much greater on unsprayed plants. Control was obtained in the following order: (1) copper sulfate followed by hydrated lime, (2) maneb, (3) calcium polysulfide, (4) Bordeaux. Copper sulfate was phytotoxic and caused loss of leaves and die-back of young branches. Where rust is severe in Esperanza nursery stocks control of primary infections is recommended by a single application of one of the "clean-up" fungicides applied during the semi-dormant period.

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