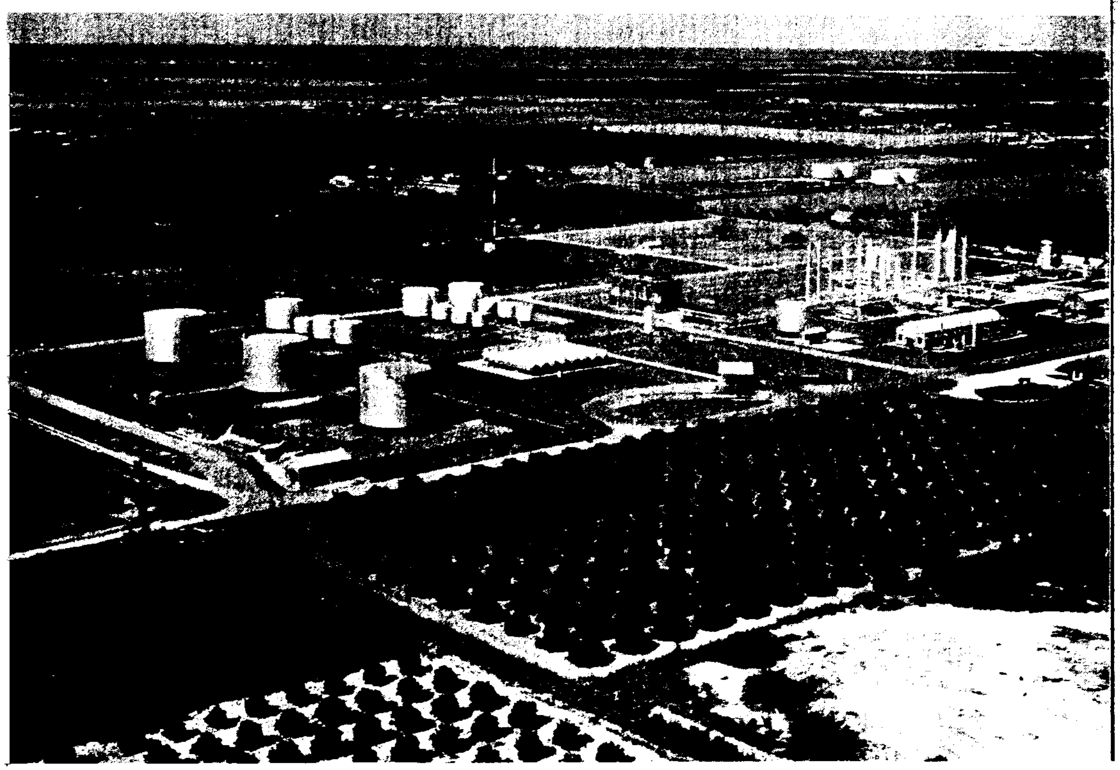
JOURNAL

OF THE

RIO GRANDE VALLEY HORTICULTURAL SOCIETY

Volume 18, 1964



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RIO GRANDE VALLEY HORTICULTURAL SOCIETY

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RIO GRANDE VALLEY HORTICULTURAL SOCIETY

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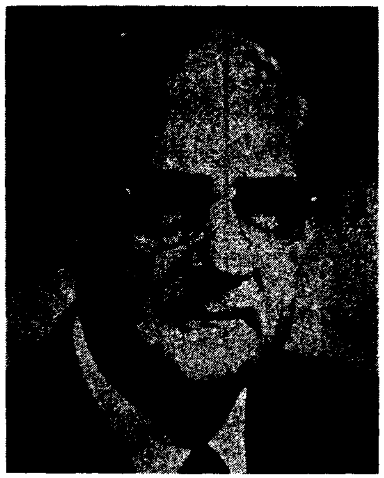
Officers of the Rio Grande Valley Horticultural Society 1963 - 1964



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Program of the Eighteenth Annual Institute of the Society, January 21, 1964

Address of Welcome .... Dr. Bailey Sleeth, President
Rio Grande Valley Horticultural Society

The Influence of Irrigation and Spacing Treatments on Yields of Valley Tomatoes .... Dr. C. J. Gerard,
Soil Physicist, Texas Agricultural Experiment Station, Weslaco

Pecan Growing in South Texas .... Prof. Fred R. Brison, Horticulturist
Texas A & M University, College Station

Buying Fresh Fruits and Vegetables for the Armed Forces .... Lt. Col. C. K. Prichard, Chief
Fresh Fruit and Vegetable Branch, Ft. Worth Region DSSC

Living with Pesticides .... Mr. Parke C. Brinkley, President
National Agricultural Chemicals Assoc. Washington, D. C.

Recent Developments in Vegetable Breeding .... Mr. Paul Leeper and Mr. R. T. Correa,
Horticulturists, Texas Agricultural Experiment Station, Weslaco

Problems Involved in Protecting Citrus Trees by Mechanical Systems .... Prof. Price Hobgood, Head,
Agricultural Engineering Dept., Texas A & M University, College Station

Arthur T. Pott's Award Presentation .... Mr. Bruce Lime,
Past President
Rio Grande Valley Horticultural Society

What Citrus Varieties Ought to be Planted in Texas? .... Panel composed of
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Mr. Noel E. Ryall, grower
Mr. W. Graham Killough, processor
Dr. E. O. Olson, citrus breeder
Mr. Stanley Crockett, nurseryman and grower.

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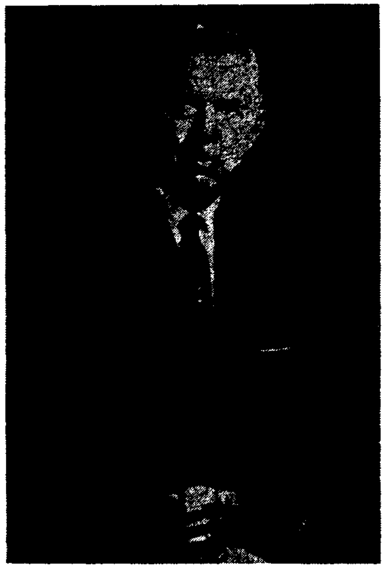

Stanley B. Crockett, Recipient of the Arthur T. Potts Award for 1964

In 1955, the Rio Grande Valley Horticultural Society voted to present an award to one person each year, for outstanding work in horticulture.

The award was named after its first recipient, Arthur T. Potts. Beside Mr. Potts, the list of recipients includes such outstanding personages as Dr. William Popenoe, E. M. Goodwin, Dr. J. B. Webb, Dr. G. H. Godfrey, Dr. W. C. Cooper, Lon C. Hill, W. H. "Bill" Friend, and Paul W. Leeper.

This year's recipient, Mr. Stanley B. Crockett, was at one time associated with the man whose name the award bears, and is well known for his nursery and orchard care service.

Stanley was born on a Missouri farm and came to the Valley with his father in 1919. He graduated from Mercedes High School and then obtained a Bachelor of Science degree in agriculture from the University of Missouri. He also did graduate work at the University of California.

After completing his formal schooling, Stanley appraised farm properties for a development company. In 1927, he joined the Baker-Potts Nursery and was in charge of the planting of thousands of acres of citrus trees. His citrus experience broadened when he took a position with the Texas State Department of Agriculture maturity division. In 1936 he went into the orchard care, nursery and orchard development business.

Stanley's leadership has been demonstrated in many ways. He has served as a member of the U.S.D.A. National Citrus Advisory Committee and the U. S. Chamber of Commerce Agriculture Committee, Chairman of the Texas Citrus Commission, member of the Texas Citrus Advisory Council, President of the Valley Horticultural Society, and was the first President of Texas Citrus Mutual. In 1962 he was given a special award by Texas Citrus Mutual in recognition of his services to the Valley's citrus industry. He is a member of the Valley Advisory Committee to the Texas A. & M. College System, and the Industry Research Advisory Panel for the U. S. Fruit and Vegetable Products Laboratory in Weslaco.

Special Gifts

Central Power & Light Company
Corpus Christi, Texas

Rio Grande Valley Gas Company
Brownsville, Texas

Dennison's
Weslaco, Texas

SUSTAINING ASSOCIATES

Walter Baxter Seed Company, Weslaco
Pan-Am Foods, Inc., Brownsville
Harlingen Canning Company, Harlingen
Stauffer Chemical Company, Weslaco
Texsun Corporation, Weslaco
Sherry-Barbee Implement Company, Weslaco
Swift and Company, Harlingen
Niagara Chemical Division, Los Fresnos
Crockett Groves, Inc., Harlingen
First National Bank, Harlingen
First National Bank, Mercedes
First National Bank, Weslaco
First National Bank, Mission

ADDRESS OF WELCOME

DR. BAILEY SLEETH
President
Rio Grande Valley Horticultural Society

To welcome each and everyone of you to the Eighteenth Annual Horticultural Institute is a pleasure. Today's program is a well balanced one, – both interesting and informative. The subjects are timely and the speakers outstanding in their respective fields. We are indeed complimented by the high quality of the speakers on today's program. They have taken time out from their regular duties, some have travelled far, to participate in this meeting. You are assured that this the 18th Annual Horticultural Institute will equal, if not exceed, the excellence of those of the past.

Many events have happened since the first Institute was held in 1946, which by the way was a 3-day event, two days for formal presentation of talks on citrus and the third day was devoted to Field Exhibits, which was attended by some 500 people. Our present one-day program reflects the trend of our time, – automation, transistors and compact cars, – higher quality in smaller packages.

At the First Horticultural Institute, problems of the citrus industry were discussed, as soil properties, nutrition, water requirements, rootstocks, pruning, processing, marketing and diseases. Of particular interest to the plant pathologist, were two talks on citrus diseases "The Psorosis Disease of Citrus in California" by Dr. J. M. Wallace and "Infectious Wood Necrosis and Gummosis of Citrus" by Dr. G. H. Godfrey.

Psorosis has been brought under control, – through research and a program of citrus nursery stock certification. The second disease, better known as Rio Grande Gummosis, is no longer considered a threat to citrus trees because of a better understanding of its cause and associated factors.

Much research work has been done and considerable progress has been made in the past 18 years, but many of the problems are yet far

from being solved, as in the areas of tree tolerance to low temperature or if you will, damaging freezes, rootstocks, improved varieties, lowe production costs, processing, marketing and the most important, a reason able assurance of a profitable return to the grower of citrus and othe horticultural crops.

The purpose of the Horticultural Institute today is the same as i was 18 years ago, "to acquire – new ideas from the speakers, each c whom is an expert in his particular field, – and to exchange ideas be tween growers, field men, shippers and technical men". In this manne the Horticultural Society serves the Valley well by stimulating and pro moting the science and art of horticulture.

Your presence here today is indicative of your interest in some phas of horticulture, as citrus, vegetables, ornamentals, special fruits, nuts c related activities. Through your attendance, you are contributing to th Horticultural Society's program in its efforts to promote the interests c horticulture in the Valley. If you are not already an active paid-up mem ber, you are cordially invited to become an active participant in th affairs of the Society by filling out a membership card and payment c annual dues.

My sincere thanks are extended to all who have made this Institut possible and to those present may it be a profitable one.

P. W. Rohrbaugh

P. W. ROHRBAUGH

Dr. P. W. Rohrbaugh was a man of keen mind and great visic His life was devoted to citrus and he contributed much to the improv ment of its culture. His vast knowledge in this field was recognized men in research and in the industry throughout the Rio Grande Vall and from California to Florida.

He will be remembered by hundreds of people who attended l classes on citrus production over the years. He met many more in th orchards when called upon for advice or information. He was alwa willing to take time to discuss the problems growers brought to him.

He recognized the need for improvement in the care and culture citrus in Texas and for the use of adequate freeze protection systen Under his leadership research programs were established at the Te A & I Citrus Center to achieve these objectives. The citrus industry w continue to realize the benefits of his research for years to come.

His confidence and optimism in the future of citrus in Texas was source of encouragement to all who were concerned with the indust

He was born in Jefferson County, Nebraska, and received an A. degree from Nebraska Wesleyan University, an M.S. degree from Io State College, and a Ph.D. degree from U.C.L.A.

After instructing in botany at Iowa State College he joined the st of the University of California Citrus Experiment Station at Riversic California. He then became associated with the research department Sunkist Growers and later joined the faculty of the California State Po technical College at San Dimas where he was head of the Citricult department at the time he was appointed Director of the Texas A & Citrus Center.

Dr. Rohrbaugh, Director of the Texas A & I Citrus Center sin 1948, died December 25, 1963.

By-Laws of the
Rio Grande Valley Horticultural Society

ARTICLE I. NAME

This organization shall be known as the Rio Grande Valley Horticultural Society.

ARTICLE II. PURPOSE

The purpose of this Society shall be the advancement and development of horticulture from a scientific and practical standpoint in the Lower Rio Grande Valley of Texas. The horticultural crops shall include citrus, vegetables, ornamental plants, and special fruits, as avocados, grapes, peaches, berries and nuts.

ARTICLE III. YEAR

The fiscal year shall begin January 1 and close December 31.

ARTICLE IV. MEMBERSHIP AND DUES

1. *Eligibility and Election.* Any person or firm interested in any of the phases of horticulture may become a member of this Society upon payment of prescribed annual dues to the Treasurer.

2. *Classification.* There shall be three classifications of annual active membership: INDIVIDUAL, SUSTAINING, PATRON. Three classes of members upon payment of dues may vote and are entitled to publications of the Society for the calendar year for which he has paid his dues. If requested, dues or contributions from Sustaining or Patron members may be listed as GIFTS. Annual Subscribing Members (Institutional Members) are not eligible to vote.

3. *Dues.* The annual dues for the four classes of membership shall be:

Annual Individual	$ 4.00
Annual Sustaining	$25.00
Annual Patron	$50.00 or more
Annual Subscribing	$ 3.00

The dues are payable at the time application is made and thereafter shall become due and payable on January 1st of each year.

4. *Good Standing.* Only members whose dues are paid shall be entitled to vote at meetings of the Society, and only such shall be eligible for office.

5. *Termination of Membership.* The membership of any member may be terminated for cause by a two-thirds vote of the members of the Board of Directors, and the accused shall be given an opportunity to appear before the Board of Directors to give reasons why his mem-

bership should not be terminated, prior to final action by the Board.

6. *Honorary Membership.* Individuals who have made outstan ing contributions to the science and practice of horticulture or to tl Society may be elected to honorary membership upon recommendati of the Board of Directors and approval by two-thirds of the membe present and voting at any regular meeting of the Society. Such honora members shall be exempt from payment of dues.

7. *A. T. Potts Award Recipient.* Each year a distinguished hor culturist may be elected to Honorary Membership in the Society a presented with The Professor A. T. Potts Life Membership Annu Award, consisting of an appropriate plaque, at the Annual Horticultu Institute. These persons shall compose the list of A. T. Potts Awa Recipients as well as being on the list of *Honorary Members.* The awa recipient being an honorary member shall be exempt from the payme of dues.

ARTICLE V. SECTIONS

1. The Society shall be divided into Sections representing the va ous interests of horticulture in the Rio Grande Valley.

Citrus
Vegetables
Special Fruits
Ornamentals

2. Other Sections may be added at any annual meeting by an a firmative majority vote of the membership present when such has be approved and recommended by a majority of the entire Board of D rectors.

ARTICLE VI. MEETINGS

1. There shall be at least six monthly meetings, each to be he on the last Thursday of each month. Special meetings may be call by the President, or a majority of the Board of Directors.

2. Attendance of all members at the monthly meetings is expect but not required.

3. The various Sections of the Society will be in charge of t programs throughout the year. Ample notice of the monthly meetin shall be given to the members of the Society.

4. An Annual Horticultural Society Institute shall be held on each year, preferably in January, to present the latest developments scientific and practical horticulture to all interested persons in t Valley.

5. The various meetings of the Society and the Annual Hortic tural Society Institute, shall be devoted only to horticultural topics fro scientific and practical standpoints (ARTICLE II), and the presidi officer shall rule out of order all motions, resolutions, and discussio

tending to commit the Society to partisan politics or commercial ventures.

6. Twenty-five members entitled to vote shall constitute a quorum at any meeting of the members of the Society for the transaction of business. In matters of procedure, unless otherwise indicated in the by-laws, Roberts Rules of Order shall be observed.

ARTICLE VII. DIRECTORS AND OFFICERS

1. *Board of Directors.* The government of this Society, the direction of its work, and the control of its property and funds shall be vested in a Board of Directors consisting of eleven members. These members shall include the President, a Vice-President and a Director from each Section, and sufficient Directors-at-large to make a total of eleven Directors.

2. *Nomination.* The President, not less than thirty days before the last monthly meeting of the year, shall appoint a nominating committee consisting of five persons, including one from each Section. This committee shall make nominations for officers and Directors at the annual meeting of the Society. Such nominations by the committee, however, shall not preclude nominations from the floor.

3. *Election.* The President, Vice-Presidents, and Directors-at-large shall be elected by a majority vote of the membership present at the annual meeting of the year which shall be held in November or December, and shall assume duties following termination of the Annual Horticultural Institute held in January following election to office. The old officers shall continue to serve until the newly elected officers are installed.

4. *Term of Office.* The term of office of President shall be for one year. A Director of each Section shall be elected for a term of two years. His second year in office shall be as Vice-President of his Section. Thus each year there shall be elected one Director for each Section. Directors-at-large shall serve two years. Directors' term of office shall be staggered so that one-half will be elected in each year in order to provide a continuing Board of Directors.

5. *Secretary and Treasurer.* The Board of Directors shall elect a Secretary and a Treasurer who may or may not be a Director and who shall hold office during the pleasure of the Board.

6. *Journal Editor and News Letter Editor.* The Board of Directors shall elect a Journal Editor and a News Letter Editor who shall hold office subject to the pleasure of the Board of Directors.

7. *Gratis Members.* In appreciation for services rendered the Society, the following appointive officers are gratis members during their terms in office: Secretary, Treasurer, Journal Editor, and News Letter Editor.

8. *Succession.* At the first meeting of the new year, the Board of

Directors shall appoint a line of succession of Vice-Presidents to serve temporarily.

9. *Meetings of the Board.* The meetings of the Board may be called at any time by order of the President, or by the Vice-President first in succession, acting in his absence, and shall also be called at the request in writing of three members of the Board. A majority of the Board of Directors shall constitute a quorum.

ARTICLE VIII. DUTIES OF THE OFFICERS

1. *President.* The President shall preside at all meetings of the members of the Board of Directors. The President shall preside over the monthly meetings of the Society and submit an annual report of the doings of the Board of Directors and officers and operation of the Society during the preceding year, at the annual meeting.

2. *Vice-President of the Sections.* Each Vice-President shall be a member of the Board of Directors, shall serve as a member of the program committee for the monthly meetings, and shall recommend to the Board of Directors the appointment of a sectional committee which he deems desirable to carry on the work of his Section.

3. *Treasurer.* The Treasurer shall be the financial officer of the Society. He shall collect the dues of the members, receive all monies that may be paid to him by virtue of this office, have charge of the funds and make a report of receipts and disbursements at meetings of the Board of Directors and a complete report to the members at the annual meeting of the Society.

4. *Secretary.* The Secretary shall have charge of general correspondence, keep minutes of the meetings, and other secretarial duties. He shall be authorized to hire secretarial help at the discretion of the Board.

ARTICLE IX. COMMITTEES

1. *Nominating Committee.* (prescribed in ARTICLE VII, Section 2.)

2. *Editorial Committee.* The President, with the approval of the Board of Directors, shall appoint an Editorial Committee consisting of an Editor, who shall serve as Chairman of the Committee, and one or more Associate Editors. This Committee shall be responsible for assembling and publishing an annual proceedings (JOURNAL) of the Society. The Journal shall include reports of Committees and articles of scientific and practical nature pertaining to horticulture. The Journal shall provide a continuing record of progress in horticulture in the Rio Grande Valley.

3. *Sectional Committees.* These Committees, appointed by each Vice-President with the approval of the Board of Directors (ARTICLE VIII, Section 2), shall consist of three or more members and shall carry on the work of the Sections including the arranging of programs for the

monthly meetings held under the auspices of the individual Sections. These Sectional Committees shall be known as the Citrus Committee, the Vegetable Committee, Special Fruits Committee, and the Ornamentals Committee, etc.

4. *Annual Horticultural Society Institute Committee.* This committee shall be appointed by the *President* of the Society (ARTICLE VI, Section 4). This committee shall plan the activities of the Annual Institute and shall appoint such sub-committees as shall be deemed necessary.

5. *Advisory Committee.* The President, with the approval of the Board of Directors, may appoint an Advisory Committee to the Board of Directors consisting of certain members of State and Federal Agencies concerned with research, education, extension, and regulatory matters in Rio Grande Valley horticulture.

6. *Publicity Committee.* The President, with the approval of the Board of Directors, shall appoint a Publicity Committee consisting of certain members of the Press, Radio and TV, and other people who may be helpful.

7. *Auditing Committee.* The President, with the approval of the Board of Directors, shall appoint as Auditing Committee which Committee shall confer with the Treasurer in preparing an audit to be presented by the Treasurer at the annual meeting.

8. The President shall appoint such other committees as may be deemed desirable and advisable by the Board of Directors and approved by the Board of Directors.

ARTICLE X. AMENDMENTS

These by-laws may be changed or amended at any regular meeting of the Society by a two-thirds vote of all members present at such meeting when approved by the Board of Directors.

The above revised by-laws were approved September 26, 1963 by the Horticultural Society.

CITRUS AND SUBTROPICAL FRUIT SECTION

Engineering Problems in Freeze Protection of Citrus[1]

PRICE HOBGOOD[2]

Freeze protection has been a problem throughout history in the production of crops which have little cold tolerance. Usually freeze damage is very expensive and something that most producers feel quite helpless in combatting. In order to effectively minimize this damage it is necessary that we look carefully at physical facts concerning the conditions when freezing in plants occurs. Excessively low temperatures can be compared with darkness. This is true in the sense that darkness exists only when there is no light and low temperatures exist when a major portion of the heat which was present has been absorbed or moved out. Freeze damage occurs when we do not effectively retard the movement of the heat away from plants and the surrounding environment or when we cannot effectively replace that heat which is being moved away at a rate sufficiently fast to prevent the temperature of the plant from dropping below that point at which damage occurs.

Every producer at some time or other has been tempted to invest in equipment to serve as insurance against these reoccurring hazards and usually it is quite easy to find a very sound reason for buying a particular type of equipment since there are specific instances in which each and every type of equipment will lessen freeze damage, or may prevent it entirely. *Unfortunately,* none of the measures commonly used offer satisfactory protection in all cases. Consequently, it is much sounder practice to examine each of the situations carefully and determine what equipment or procedures offer the greatest benefit in time of serious need.

There is no simple short-cut solution to the problems involved since limiting heat movement or replacing heat is an expensive process requiring a complete understanding of the principles involved. I would like to compare the process of conserving heat energy or replacing it with your management of the bank balance. Heat is measured in quantity (B.t.u.) just as our cash reserves are measured in dollars. In attempting to prevent freeze damage we must manage the use and movement of heat just as skillfully as we manage the cash resources. Otherwise expenses involved will be excessive. This is to say that freeze protection through management of the energy is a delicate, exacting and often difficult job. It is one that you must exhibit considerable skill and take advantage of all of the physical factors involved if you are to receive

[1] Presented before the Rio Grande Valley Horticultural Society January 21, 1964 at Weslaco, Texas.

[2] Professor and Head Dept. of Agricultural Engineering, Texas A and M University College Station.

the most protection for a cost that is justified. Certainly knowledge of the exact character of the storm is necessary.

I would like to suggest that the first line of defense against freezing or frost damage be in the cultural practices and selection of varieties that offer the most protection. This is a segment of management that is more easily controlled than the heat balance in the orchard. The second approach should be to utilize effectively those management practices which will minimize freeze damage in ordinary low temperature conditions which can be expected in the area. I would suggest that the third and last line of defense be that of providing some means of adding additional heat in groves or fields when low temperatures that may be hazardous occur. This additional heat may be provided in any one or a combination of several different ways and it is well to look at each method critically to determine which one fits into the existing or modified management practice and will yield the greatest return in terms of protection offered. I am sure that you are well versed in all of these management practices unless it is possibly that of heat balance.

Let's look at the problem of attempting to gain heat balance rather carefully. It is more than heating a given mass of air for so many degrees and thus saving a crop. For example, it would take only about 112,000 BTU to heat the air mass traveling across an acre by 10 degrees when the rate of travel is one mile per hour and the depth of the air column is 15 feet. Yet Brooks and Schultz in California found that about 9,000,000 BTU were required per acre to maintain a 10° rise with a 1 to 1½ mile per hour wind on a clear night with little inversion. A hasty glances at the above will tell us that only about 1/80 of the heat supplied actually heated the air around the trees. The remainder was absorbed by the plants, the ground, radiation to outer space with much of it lost through thermal movement.

Let's look at some of the common things around us to be sure that we are thinking alike. On a clear day the sun strikes the surface of the earth, the plants, the ground and particles of dust or moisture in the air. The radiant energy is absorbed by these objects and heat is stored thus warming the environment. Usually the moist compact soil absorbs radiant heat more readily than does the soil covered with vegetation or one that is loose and dry on top. As a result it is a better heat sink for future use. Any heat source whether it be an orchard heater of some type or the moist soil will give up heat as cool air moves in contact with the warm surfaces. The warmed air then tends to move upward. At the same time wind movement across any of these objects which have heat stored or being produced, will tend to pick up the heat and move it away where it can be dissipated in colder areas. Remember our heat balance system always tends to equalize temperature extremes. The trees or plants absorb radiation from heated surface near them and at the same time they will give up radiant heat to areas such as the cold sky and thus cool the body of the plant, the leaves and the trunk. As the warm air rises from the heated surfaces that have absorbed energy from the sun or other source it may form a warm air mass overhead that remains fairly static

during the night. This air mass may be at a few feet above the ground or it can be rather high. When the warm air mass is only a few feet above the ground and is considerably warmer than the orchard it lends itself to being stirred and pushed down into the orchard area and thus causing a warmer condition. At the same time this warm air helps to keep the heat which we supply for other heat sources from rising out of the area of the plants. When the ceiling is high or the warm air mass is 50 or more feet up above the ground level, there is little opportunity for moving this warm air back into the area of the trees and it also provides a ready means of dissipating the heat which we may provide from artificial sources. The large inversion or low ceiling as you may want to call it will often permit a much better use of heaters than the small inversion or high ceiling. In fact, when the warm air mass above is 15 to 20° above that near the ground, it is possible to get almost twice as much heating effect from heaters as when the air mass is only 10° above that at ground level. In addition to the heaters being considerably more effective with a large inversion wind machines can often be used to pull this warm air back into the orchard area and thus prevent much freeze damage. However, wind machines are practically useless when the large inversion does not exist. They depend totally upon the heat in the warmer areas of air immediately above the earth's surface.

There are many recommendations for the placement of orchard heaters and certainly the need is dictated by the severeness of the temperatures expected. Extra border heaters are usually considered a necessity on all sides of an isolated orchard. This is logical when we consider that the up-draft effect of the rising heat from the various heaters will cause an inflow of cool air from the edges and thus make it extremely difficult to heat those trees near the edge.

There have been a few isolated cases of individuals working with water sprays to lessen freeze damage for many years. The phenonenom of releasing heat through freezing water and thus maintaining a temperature of approximately 30 to 31 degrees is a very powerful tool when closely controlled or well managed. For example, applying .236 inches of water per hour in the form of a spray on the surface of plants will

Table 1. Approximate heat available from water spray.

Spray Density	*°L.P.G. Equivalent*	*Heat Released – BTU/Hr.*
.059 in./hr.	19.4 gal./ac.	1,940,000
.075 " "	24.6 " "	2,460,000
.087 " "	28.5 " "	2,850,000
.089 " "	32.1 " "	3,210,000
.118 " "	38.7 " "	3,807,000
.134 " "	44.0 " "	4,400,000
.177 " "	58.0 " "	5,800,000
.236 " "	77.5 " "	7,750,000

°Assume 100,000 Btu/gal.

release a heat equivalent of 77.5 gallons of LP gas or possibly 50 to 60 gallons of fuel oil per hour. I would like to discuss the work of Karl Witte briefly since he has made some rather exacting studies and the data can be verified through calculation. *He has indicated that plants sprinkled for frost protection seem to decrease in natural ability to resist frost damage.* Because of this apparent situation, once the spraying is begun, it must be continued at a rate compatible with freeze prevention. Freeze damage is higher on inadequately sprayed plants than it would be without any protection at all. To avoid damage due to undercooling while the ice is forming to release latent heat, it is considered good practice to start spraying when the temperatures drop below 32°F. Spraying can be discontinued when the atmosphere reaches 32°F. and remains at this level or higher until ice is melted. *The one basic premise that must be well understood is that it is necessary to have adequate water and be able to keep it flowing at the desired rate if spraying is to be used as freeze protection.* This could be quite a problem under severe conditions unless the equipment is well designed and skillfully managed.

Again, Witte has shown that on tobacco spray rates of .059 to .079 inches per hour offer sufficient protection from light frost without wind. He also found that rates of .276 inches per hour would prevent freeze damage at temperatures in the order of 15°F. or that .394 inches per hour was adequate for protection at temperatures down to 8.6°F. These rates have a wide variation and you will note that .276 or .394 is a rather high rate of application and would require large quantities of water for freezes of long duration. However, they might well be extremely useful in freezes of short duration. This would also indicate that when applying sprays for freeze prevention, it is necessary to be very conscious of the temperatures that you are dealing with and thus regulate the water flow so as to keep water in the presence of ice all of the time. Witte has shown us that the interruption of the spray of water can be very damaging to plants with applications of .059 inches per hour at 14°F. temperatures.

Table 2. Effect of interruption of spray[1].

Spray Density in./hr.	Discontinuation Period in Minutes							
	1		2		3		4	
	Lab.	*Open*	*Lab.*	*Open*	*Lab.*	*Open*	*Lab.*	*Open*
.059	23.9°F.		25.7		26.6		27.5	
.075		22.1		23				
.087						23.9		
.098								
.118	22.1	21.2	22.8		23		23.9	
.134		20.3						
.177	19.4		21.2		22.1		23	
.236	15.3		16.7		17.8		21.2	

1 Winds definitely limit this protection below about 23°F.

Interruptions of one minute or longer produce severe temperature drop in the plant. This drop is much less severe at rates of .236 inches per hour and 10°F. However, interruptions of 1 to 2 minutes at this higher rate may be potentially hazardous. Witte recommends that 1 minute be as long as allowed for interrupting the flow of water if best results are to be obtained. This normally means a fast rotating sprinkler action.

Winds definitely affect the distribution and operation of sprays for freeze prevention.

At present the state of art in using sprinklers on citrus would make us seriously question recommending it. However, when we examine the amount of heat that is potentially available to prevent serious damage by this method, it might be well for us to study this problem in detail. It has much potential if we are sufficiently skillful in application and management.

I have not attempted to tell you how to prevent freeze damage in orchards in the Rio Grande Valley but rather to point to the fundamental things that we must consider if we are to successfully extend the productive life of our plantings. It makes little difference whether a machine is driven by a ram jet with considerable noise or some other device. It can only provide protection to the extent that it can supply *additional heat* through energy released by the machine or through moving warm air masses containing sufficient heat to raise the temperature in the orchard. Spray systems with poor control and management may increase the hazards. Heaters to be effective must be skillfully placed and piped to use the available heat for each storm condition.

I hope that we can look at the various ways of conserving the heat available and adding heat where necessary in order that we may use it when the conditions are such that severe damage will occur without it. I think we need to learn much more about the inversions in the Valley, the wind conditions that we must deal with and then give serious study to the most feasible system of having the quantity of heat needed readily available when the necessity arises.

Frost Formation on 'Red Blush' Grapefruit Trees During a Mild Radiation Freeze as Affected by Heaters and Windmachines[1]

ROGER YOUNG and ASCENSION PEYNADO[2]

The use of heaters and windmachines for frost and freeze protection of citrus has been extensive in California and Florida. Detailed studies have shown that heaters, if spaced properly and burned at a proper rate, may raise the grove temperature several degrees and with it tree temperatures (Kepner, 1951; Young, 1947). Due to the release of radiant energy, heaters are often effective for frost prevention without raising grove temperatures. The presence of a large temperature inversion and the absence of wind increased the effectiveness of heaters (Kepner, 1950).

Windmachines have been very effective in California. Their success has been attributed to (1) mixing warmer air aloft with cold air near the ground, thus raising grove temperatures, (2) distributing heat from heaters throughout the grove, and (3) preventing leaf temperature from subcooling below air temperature (Wallis, 1963; Adams, 1951; Brooks, 1960). One can expect the effectiveness of a windmachine to be no more than three-fourths the temperature inversion. In most reports, windmachines have raised grove temperatures 3°F. to 4°. The combination of both heaters and windmachines in California has generally proved most effective (Adams, 1951; Brooks, 1960).

In the Rio Grande Valley of Texas, few reports on the effectiveness of heaters and windmachines for freeze and frost protection are available (Maxwell and Otey, 1954; Leyden and Rohrbaugh, 1963). Grower experience with heaters and windmachines has been quite variable. This report summarizes studies on the effects of heaters and windmachines on frost formation during a mild radiation freeze in a 'Red Blush' grapefruit grove.

METHODS AND MATERIALS

Studies with heaters and windmachines were conducted in a 20-acre grove of 12-year-old 'Red Blush' (Ruby) grapefruit trees near Alamo, Texas, during the night of December 23 and 24, 1963. Trees were planted 20 feet apart north and south and 25 feet apart east and west. Semi-sod and non-cultivation practices were employed during the winter months. One windmachine, with two 110 h.p. motors on a 30-foot tower, was located 400 feet east and 300 feet south of the northwest corner of the grove. The windmachine rotated uniformly one 360° revolution every 9 minutes.

[1] The work was part of a cooperative project of the Agricultural Research Service, U. S. Department of Agriculture, and the Texas Agricultural Experiment Station, Texas A. & M. University.

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

Heaters, University Return Stack and Jumbo Cone types, were placed uniformly throughout the grove, 20 per acre. A border row of heaters, one per tree, was located on the north side of the grove, and two rows of heaters, one per tree, were located on the west side of the grove. Heaters were omitted in a one-acre area around the windmachine. Diesel oil was used as fuel in the heaters which were burned at a rate of approximately three-quarters gallon per hour.

Temperature readings were taken periodically during the freeze period with laboratory-grade, mercury thermometers, calibrated in 1°F. increments with a ±0.5° accuracy. They were placed in weather shelters (5 foot level) at 100-foot intervals on 45° tangents radiating from the windmachine at the center. The tangents were north, northeast, east, southeast, etc.

Temperatures of tree tissues were taken 200 feet east of the windmachine with a multipoint recorder and copper-constantan thermocouples. Air temperatures at 40, 60, and 100 feet were recorded with thermocouples attached to a weather balloon.

In an unprotected Valencia orange grove near Mercedes, tree tissue and air temperatures during a mild radiation freeze on February 8, 1964, were also recorded with a multipoint recorder and copper-constantan thermocouples. Air temperatures at 20 and 40 feet were recorded with thermocouples on a permanent tower in the grove.

Frost injury in the grove at Alamo was recorded one week after the frost.

RESULTS

Temperature changes in a grapefruit grove with heaters and a windmachine were recorded during a mild radiation freeze the night of December 23 and 24, 1963. Skies were clear and winds were less than 2 mph from the southeast. Winds from 9:00 pm to 3:00 am were calm, but from 3:00 am until daylight increased slightly. Relative humidity during the night ranged from 59 to 73 percent, and maximum radiation of heat from the grove occurred during the night. Minimum temperatures were reached by 9:30 pm and remained constant until 7:00 am.

At 8:00 pm, grove temperatures were at or near 32°F. and dew was forming on the leaves. At 9:30 pm temperatures in the grove ranged from 27.5° to 31.5° with most of the thermometers reading 28° to 29°, and scattered frost had begun to form.

At 10:45 pm when the windmachine was started temperatures ranged between 27.5°F. and 29°. Air temperatures near the windmachine increased greatly with the air circulation and the dew and frost on the leaves of trees hit by the wind from the windmachine began disappearing. After one hour, 11:40 pm, temperatures around the windmachine ranged from 33° to 36° (Figure 1-A). The general area of influence (area above 29°) at 11:40 pm was 10.5 acres with about 2.5 acres 32° and above (Table 1). Cold areas 30° or lower remained in the west 10 rows and the east half of the grove. Warmest temperatures were located about 100 feet downdrift of the windmachine.

Border heaters were fired at 11:45 pm in a pattern which consisted of two rows, one heater per tree, on the west side and one row, one heater per tree, on the north side. By 1:30 am (Figure 1-B), the cold area on the west side had disappeared but the east half of the grove remained 29°F. or lower. Temperatures on the east border of the grove were as low as 26°. Heavy frost was present in most of the grove, except within 100 feet of the windmachine where it was light.

Heaters in the east half of the grove were fired at 1:15 am. At 2:30 am the general area of influence (area above 29°F.) by the windmachine was 9.7 acres and the east half of the grove remained 30° or lower with minimums of 27° being recorded (Figure 1-C). Temperatures around the windmachine ranged between 34° and 36°. Frost remainded heavy through most of the grove.

After 3:00 am the general effectiveness of the windmachine began to decline (Figures 1-D and 1-E). Maximum temperatures in the grove at 6:00 am were 32°F. near the windmachine. The east half of the grove remained 30° or lower and temperatures in the northwest and southwest sides of the grove dropped to 29° or lower. Heavy frost was present throught the grove. Air temperature recordings at 40 and 60 feet indicated inversions up to 5° most of the night and that inversions declined rapidly after 5:00 am (Table 2).

Table 1. General area of influence of a windmachine in a 20 acre grove, December 23, 1963.

Time	*Area of influence*[a] *(Acres)*	*Area 32° F. or above (Acres)*
11:40	10.5	2.5
12:30	6.2	3.0
1.30	6.9	2.0
2:30	9.7	3.4
3:45	11.4	1.9
5:00	8.7	2.2
6:00	4.6	0.1
6:45	7.3	1.0
Ave.	8.1	2.0

[a]Area above 29°.

Table 2. Air, leaf, and inversion temperatures in groves with and without windmachines on nights of maximum radiational cooling.

Date and time	*Air temperature (5') Unprotected*	*Air temperature (5') Protected*[a]	*Exposed leaf temperature (°F.)*	*Upper air temperatures 20'*	*Upper air temperatures 40'*	*Inversion* T_{40}-T_5	*Inversion* T_{60}-T_5
Unprotected grove							
Feb. 8, 1964:							
3:00 am	30.2	-	27.5	34.6	36.2	6.0	-
4:00 am	31.2	-	29.0	33.5	35.0	3.8	-
5:30 am	27.7	-	24.9	32.7	36.1	8.4	-
6:30 am	27.5	-	23.8	33.3	37.0	9.5	-
7:00 am	26.5	-	23.0	33.0	36.7	10.2	-
Protected grove							
Dec. 23, 1963:							
2:30 am	28.0	30.2	30.2[a]	-	34.4	4.2	4.8
3:30 am	28.0	31.0	31.0[a]	-	35.7	4.7	5.0
4:00 am	27.0	30.5	30.5[a]	-	34.7	4.2	4.2
5:00 am	28.0	31.5	32.0[a]	-	33.0	1.5	2.0

[a] Temperatures recorded 200 feet east of windmachine but within affected area.

DISCUSSION

The effectiveness of the windmachine to raise air temperatures in the grove was related to the strength of the temperature inversions aloft. Early in the night when temperature inversions at 40 and 60 feet were 4.2°F. to 5.0° the windmachine was more effective. Near daylight when temperature inversions had declined to 1.5° to 2.0° the effectiveness decreased. The average area of influence (area above 29°) throughout the night by the windmachine was 8.1 acres and an average of 2.0 acres were held 32° or higher. Temperatures above 29° resulted from the effects of the windmachine since most of the east half of the grove remained between 28° and 29° from 9:30 pm to 7:00 am.

Frost, which was present in the grove for at least 10 hours, was reduced near the windmachine where the direct blast of air hit the leaves, but considerable frost was present on the opposite sides of the trees away from the direct air blast. The east half of the grove was unaffected by the windmachine.

Leaf temperatures on trees in the area affected by the windmachine remained similar to air temperature (Table 2). The mixing of warmer air at 40 to 60 feet with colder air near the ground resulted in warmer air temperatures around the trees and, consequently, warmer leaf temperatures. Air turbulence by the windmachine prevented leaf temperatures from subcooling below air temperatures. In an unprotected grove leaves subcooled several degrees below air temperature. Windmachines

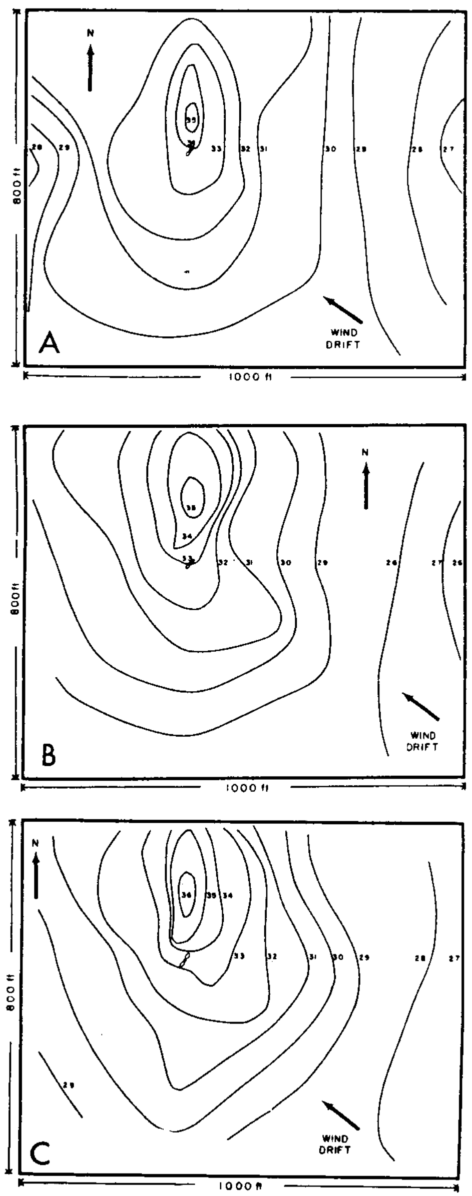

Figure 1. Isotherm patterns around the windmachine at (A) 11:40 pm with no heaters burning, (B) 1:30 am with border heaters burning, (C) 2:30 am with heaters on the borders and in the east half of the grove burning.

have been shown by Turrell, et al. (1960) to prevent the cooling of leaves below air temperature during radiation freezes.

Burning heaters on the borders and in the east half of the grove had no effect on air temperatures. Frost formation was heavy throughout the heated area and was present on leaves within 10 feet of the heaters. Air temperatures in the heated area ranged between 26°F. and 29° from 9:30 pm to 7:00 am.

Frost injury one week later was slight but general throughout the grove, including around the windmachine. Slightly more injury *was* present where 26 to 28 degree minimums occurred in the east side of the grove.

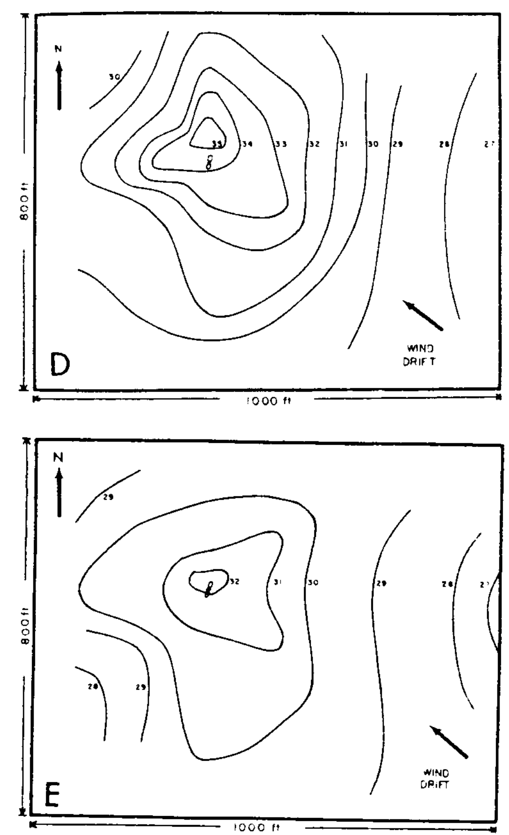

Figure 1. Isotherm patterns around the windmachine at (D) 5:00 am and, (E) 6:00 am with heaters on the borders and in the east half of the grove burning.

SUMMARY

The effects of heaters and a windmachine on frost formation on 'Red Blush' grapefruit trees were studied during a mild radiation freeze.

1. The average area of influence by the windmachine was 8.1 acres with an average of 2.0 acres held at or above 32°F.
2. The effectiveness of the windmachine declined near daylight when temperature inversions at 40 and 60 feet decreased from 4.2°-5.0° to 1.5°-2.0°.
3. The windmachine kept leaf temperatures similar to air temperature in the affected area.
4. Frost formation was reduced where the wind from the machine hit the leaves of the tree directly, but frost formation was general within the area of influence of the machine.
5. The burning of 20 diesel oil heaters per acre at a rate of three-quarters gallon per hour did not raise grove temperatures or prevent frost formation. Heavy frost formation was present within 10 feet of the heaters.
6. Frost injury was slight but general throughout the entire grove.

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Temperatures in and around Grapefruit Trees as Affected by Under-the-Tree Heat Sources[1]

Roger Young, Norman Maxwell, Morris Bailey, and W. R. Cowley[2]

Conventional heat sources used for freeze and frost protection have normally been placed between trees. Convectional and radiational heat liberated from heaters between trees is absorbed by the soil, sky, and the tree. The small portion of heat absorbed by the tree leaves is re-radiated to the sky and other tree parts. Conventional heat sources in many instances in Texas have not provided the protection required during frost or freeze conditions (Leyden and Rohrbaugh, 1963; Young and Peynado, 1964).

The use of under-the-tree heat sources takes advantage of the tree canopy which retains most of the heat liberated from a heat source and re-radiates it to other tree parts.

The following report summarizes preliminary studies to evaluate the use of several different types of small heat sources for under-the-tree freeze protection.

METHODS AND MATERIALS

Heat sources used in the studies were of three types. The first was a solid, petroleum by-product fuel block in a treated cardboard container with an outer foil cover. The blocks tested were 6 inches deep and 7x8, 7x12, 7x17, and 10x10 inches wide. A 7x8-inch block burned with a 6- to 8-inch flame approximately 8 hours at a rate of 32,000 B.T.U./hour and was easily lighted with a gasoline torch.

The second heat sources was a 5-gallon can with a specially-designed top to control the burning rate. Diesel oil fuel in the can burned for approximately 10 hours at a rate of 51,300 B.T.U./hour. The oil burned with a 6- to 12-inch flame, but during surges often had a 24-inch flame.

The third heat source was a 3-foot diameter circular ring of ¾-inch pipe with 3 burners evenly spaced on the ring. Butane or propane was circulated under 2 to 2½ pounds pressure in the pipe and ignited at the burners. Cast iron reflector pods were placed over the burners.

The butane heaters were about 1½ feet from the tree trunk during

[1] The work was part of a cooperative project of the Agricultural Research Service, U. S. Department of Agriculture, and the Texas Agricultural Experiment Station, Texas A. & M. University.

[2] Plant Physiologist, CRD-ARS-USDA; Horticulturist, TAES; Extension Horticultural Specialist, TAES; and Superintendent, TAES Substation 15, Weslaco, Texas.

the tests while the solid petroleum blocks were 2 to 3 feet and the cans 3 to 4 feet. The butane heaters released both convective and radiant heat while the solid petroleum blocks and cans released primarily convective heat.

Heat distribution studies were conducted under single 'Red Blush' grapefruit trees about 15 feet tall which had semi-open canopies starting about 2 to 3 feet above the ground. Laboratory grade mercury thermometers, calibrated in 1°F. increments with an accuracy of ±0.5°, were placed in the skirt line of the heated and unheated trees at the 5-foot level on the north, south, east, and west sides as well as in the center of the tree. In some tests, thermometers in weather shelters were placed on the north, south, east, and west sides of the tree (5-foot level) 6 inches outside the skirt line.

A multipoint recorder with copper constantan thermocouples was used to measure temperatures of tree tissues.

Seven separate tests were conducted during nights of widely varying weather conditions. Temperature data reported are the differences between heated and unheated trees and will be referred to as temperature differentials.

RESULTS AND DISCUSSION

Weather conditions during tests. Tests were conducted under widely varying weather conditions (Table 1). Three test nights were calm and clear with radiative cooling, two were overcast and windy (3 to 10 mph), one was overcast and calm, and one was clear and windy (1 to 6 mph). Temperature inversions at the tree top (about 15 feet) ranged from 1.4°F. to 4.4° on calm, clear nights to 0.0° to 1.4° during windy nights. Winds during the tests were generally from the north, northwest, or northeast. Most of the tests were conducted during early morning

Table 1. Weather conditions during under-the-tree heater trests.

Date of test	Time	Weather conditions			
		Sky	Wind direction or drift	Wind speed	$T_{15}'-T_1'$[a]
2/18/64	8-10 pm	clear	N	0-2	1.4°-2.4°
2/22/64	3-6 am	overcast	N	0-7	0.0°
2/23/64	3-6 am	clear	N	0	1.4°-2.4°
2/27/64	7-10 am	clear	NE	0-6	0.0°
2/28/64	3-6 am	overcast	NE	5-10	1.4°
3/9/64	3-6 am	clear	NW	0	1.4°-4.4°
3/12/64	2-3 pm	overcast	E	3-5	0.0°

[a] Air temperatures at 15 feet minus air temperature at 1 foot (inversion characteristics). Data from U. S. Weather Bureau Office, Texas Agricultural Experiment Station, Weslaco, Texas.

hours. Temperature minimums in the grove during these tests ranged from 34° to 50°.

General effects of heat sources. The effects of various heat sources on air temperatures in the tree during different weather conditions are tabulated in Table 2. All heat sources raised air temperatures within the test trees, although some heat sources were more effective than others. Three to five solid petroleum blocks were generally more effective (3.2°F. to 12.5°) than one or two cans of diesel (3.2° to 6.4°, except for one instance of 5.4° to 23.1°) or the butane burners (0.8° to 6.3°). Heat distribution in the tree was a function of the type and numbers of heat sources. Three to five solid petroleum blocks, if placed symetrically under the tree, resulted in better heat distribution than one or two blocks or one or two can heaters. Heat distribution with less than three blocks or with the can heaters was generally down-wind of the heat source. Without any wind the heat was concentrated more above the heat source. Heat distribution around the butane heater was near the trunk of the tree up to five feet above the ground.

Wind conditions during the tests affected the amount of heat distributed into the tree. The solid petroleum blocks were less affected by wind than were the can or butane heaters. The presence or absence of a cloud cover did not seem to influence the effectiveness of the various heat sources.

Effectiveness of different solid petroleum block sizes. The size of the solid petroleum block materially influenced the effectiveness in heat distribution in the tree (Table 3). More small blocks (6x7x8) resulted in better heat distribution than few large blocks, although the large blocks released more heat. Heat distribution from the large blocks (6x10x10 and 6x7x17) was similar to the can heaters. The larger blocks also burned with a high enough flame to burn low-hanging leaves and wood on the tree.

Heat distribution in and around the tree. Heat distribution in various locations of the tree as affected by solid petroleum block and can heaters is tabulated in Tables 4 and 5. As the number of solid petroleum blocks or cans was increased, a greater increase in temperature was measured in the skirt and center of the tree. An increase in temperature was measured outside the tree top as well as inside indicating that heat was being distributed through the foliage in the top of the tree. Leaf temperature inside the tree was 3.5°F. to 6.0° warmer during one test with the blocks and outside the tree was 0.5° to 2.0° warmer, suggesting the re-radiation and movement of heat out through the foliage of the tree. Heat distribution in the tree was more variable with the can heaters than with three to four solid petroleum blocks.

Heat movement into different sizes of wood was measured in one test using four solid petroleum blocks as heat sources (Table 5). Large increases in temperature were measured under the bark of wood ranging from one to 10 inches in diameter with the largest increase being under

Table 2. Temperature differentials[a] between unheated and heated trees using various numbers of three different heat sources under the tree during different weather conditions.

Weather conditions during tests	*No. of tests*	*Solid petroleum block heaters (6x7x8)* 1	2	3	4	5	*5-gallon oil can heaters* 1	2	*Butane heater*
clear, no wind	3	1.7°-4.4°	2.8°-7.7°	5.5°-7.2°	5.4°-12.5°	9.2°-11.3°	3.0°-4.5°	5.4°-23.1°	3.9°-6.3°
clear, windy	1	-	-	-	-	6.6°-9.4°	-	1.0°-2.5°	-
overcast, no wind	1	1.8°	2.1°	4.4°	5.6°	9.1°	4.3°	5.5°	-
overcast, windy	2	-	-	-	3.2°	3.7°-10.1°	-	3.2°-6.4°	0.8°-1.8°

[a] Average temperature differences between unheated and heated trees with thermometers (5-foot level) placed at the skirt line of the tree on the north, south, east, and west sides and center of the tree.

Table 3. Temperature differentials[a] between unheated and heated trees using several different sizes and numbers of solid petroleum block heaters.

6x7x8 2	4	*6x7x12* 1	2	*6x10x10* 2	*6x7x17* 1	2
6.5°-7.7°	9.8°-12.1°	4.6°-6.3°	9.6°	8.8°-13.7°	7.0°-9.5°	10.2°-11.8°

[a] Average temperature difference between unheated and heated trees with thermometers (5-foot level) placed at the skirt line of the tree on the north, south, east, and west sides and center of the tree.

Table 4. Temperature differentials between different locations in and around unheated and heated trees as affected by various numbers of two different under-the-tree heat sources.

Location in and around tree	*Solid petroleum block heaters 6x7x8* 1	2	3	4	*5-gallon oil can heaters* 1	2
Inside skirt line of tree[a] (5 feet)	3.8°	5.3°	7.0°	7.5°	3.4°	5.1°-18.2°
Inside tree-center (5 feet)	7.0°	13.0°	8.0°	32.5°	9.0°	10.0°-42.0°
Inside tree-center (15 feet)	4.0°	11.0°	6.0°	10.0°	5.5°	10.5°-40.5°
Outside tree-center (16 feet)	3.0°	5.0°	3.5°	4.0°	10.0°	8.0°-28.0°
Leaf - inside tree	4.5°	3.5°	4.5°	6.0°	-	-
Leaf - outside tree	0.5°	0.5°	1.0°	2.0°	-	-

[a] Average temperature differences between unheated and heated trees with thermometers (5-foot level) placed at the skirt line of the tree on the north, south, east, and west sides of the tree.

Table 5. Temperature differentials of different sizes of wood in an unheated and heated tree with four solid petroleum block heaters. Thermocouples were placed under the bark.

Tissue and Air	*Temperature Range*
1-inch wood	8.8°-13.0°
2-inch wood	10.7°-15.0°
3-inch wood	8.1°-16.0°
4-inch wood	5.7°-14.0°
trunk	15.1°-20.0°
air[a]	9.8°-13.9°

[a] Average temperature differences between unheated and heated trees with thermometers (5-foot level) placed at skirt line of tree on the north, south, east, and west sides and in center of the tree.

the bark of the trunk, which was nearest to the heat source. The increase in temperature in the different wood sizes was of the same magnitude as that of the air temperature in the skirt of the tree.

CONCLUSIONS

Although the tests were limited to single trees, the results suggested that small under-the-tree heat sources have definite promise for freeze protection. More small heat sources, such as the solid petroleum blocks, resulted in better heat distribution throughout the tree than did fewer large heat sources. The larger heat sources, such as the large solid petroleum blocks and the 5-gallon cans, released considerable heat which could also be effective for freeze protection even though distribution through the tree was not as good. The butane heater was the least effective of the heat sources tested.

Temperature measurements in leaves and under the bark of wood of different sizes indicated that considerable heat was being absorbed into the tree tissues when using the solid petroleum blocks as a heat source. During tests with the other heat sources, it is presumed that heat was absorbed into the tree tissues at a rate proportional to the heat output of the specific heat source.

It should be emphasized that more refined and large-scale tests will be required before recommendations can be made on the use of small, under-the-tree heat sources for freeze protection.

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Herbicides Around Newly-Planted Citrus Trees[1]

R. F. Leyden[2]

Some of the residual herbicides developed in recent years have proven to be safe for use in established citrus orchards (Kretchman 1960, McCarty 1962). Karmex and Simazine have label registration for use in California and Florida citrus. To date only Karmex, at the rate of 4 pounds an acre a year, has registration for use in Texas citrus.

California and Florida recommendations limit the use of these materials to trees established in the field for at least one year (Day and McCarty 1957, McCown and Kretchman 1961). Preliminary investigations in Texas suggested that herbicides could be used at the time trees were set out. This paper reports the results of an experiment to determine the effects of various residual herbicides on newly-planted trees and the degree of weed control provided. The study was conducted on a Hidalgo clay loam soil.

MATERIALS AND METHODS

The treatments were: Karmex 80W, Simazine 80W, Simazine 4G, diuron •TCA, diuron •DBSA at 4, 8, and 16 pounds to an acre, and Shell weed oil in repeat applications. Sod culture and clean cultivation were included to permit comparison between chemical weed control and conventional practices with respect to tree growth. A randomized complete block design with 4 replications was used. Individual plots, 10 x 20 feet, contained 2 red grapefruit trees on sour orange rootstock. Permanent borders made each plot a separate basin.

The block had been in permanent sod for about 5 years prior to the test. In spite of several diskings considerable established johnsongrass and bermuda grass was present. The residual herbicides used are not expected to control established grasses. During the first 2 years hoeing and oil sprays were used to eliminate the established grasses.

On May 15, 1961, the trees were planted, herbicides applied and plots irrigated. Thereafter sod culture plots were mowed periodically, cultivated plots were spaded before each irrigation, and Shell weed oil plots were sprayed as needed to maintain a high degree of weed control.

Visual observations of tree condition and weed control were made at

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[1] Cooperative citrus research of Texas College of Arts & Industries and Texas Agricultural Experiment Station of Texas A & M University, Weslaco.

[2] Assoc. Prof. of Agriculture, Texas College of Arts & Industries, Citrus Center, Weslaco, Texas.

regular intervals. Residual herbicides were reapplied in the spring of 1962, and 1963.

Freeze damage in January 1962 was uneven across the block. In order to have uniform experimental material all original trees were removed and new trees planted in the summer of 1963.

RESULTS AND DISCUSSION

Tree condition. Six months after the initial application of residual herbicides in 1961 no visual symptoms of herbicide injury had developed on trees receiving herbicide application at 4 lbs. to an acre. Some foliar symptoms occurred at the 8 lb. rate with each of the materials. Symptoms occurred in one growth flush but not in succeeding flushes. There was no indication that growth had been retarded. With all the residual materials, the application of 16 lbs. to an acre caused foliar symptoms that persisted through several flushes and retarded growth.

Observations of tree condition in the summer of 1962, although confounded by freeze damage, were similar to those of 1961: no injury following the second annual application at 4 lbs. to an acre, mild injury with 8 lbs., and severe injury with 16 lbs.

New trees were planted in July 1963 in plots that had received 3 annual applications of herbicides. Six months after planting trees on plots treated at the 4 lb. rate were normal and healthy, at the 8 lb. rate foliar injury was visible, at the 16 lb. rate foliar injury was visible and growth was retarded.

Weed control. The 8 and 16 lb. an acre rates were included mainly to observe tree reaction to high rates of herbicides. All materials gave a uniformly high degree of control of annual weeds and seedling grasses at these rates, approaching 100% at 16 lbs.

The Karmex label permits the use of 4 lbs. an acre a year. Weed control at this rate is of particular interest. The percent bare ground 6 months after each annual application of the residual herbicides is listed in Table 1.

The degree of weed control possible with a contact herbicide such as Shell weed oil depends on the initial weed population, the number of applications, and the amount of oil used. In order to maintain 90% bare ground in the weed oil plots during the first year it was necessary to make 10 applications of oil at the total rate of 400 gallons an acre a year. During the second year 10 applications and 370 gallons were required; during the third year 8 applications and 300 gallons.

Diuron •TCA and diuron •DBSA were dropped at the end of the first and second years respectively as unsatisfactory.

Karmex and the 2 formulations of Simazine gave satisfactory weed control during each of the 3 years.

Table 1. Degree of weed control 6 months after each annual application of residual herbicide, at the rate of 4 lbs. to an acre, 1961-1963.

Material	*Percent Bare Ground (ave of 4 reps)*		
	1961	*1962*	*1963*
Karmex 80W	74	70	81
Simazine 4G	60	70	70
Simazine 80W	84	87	79
diuron •TCA	40	–	–
diuron •DBSA	40	42	–
Shell weed oil	90[1]	90	90

[1] 1961 - ten applications, 400 gals an acre a year
1962 - ten applications, 370 gals an acre a year
1963 -eight applications, 300gals an acre a year

SUMMARY AND CONCLUSIONS

The residual herbicides Karmex, Simazine, diuron •TCA, and diuron •DBSA at 4, 8, and 16 lbs. to an acre, and the contact herbicide, Shell weed oil, were used around newly-planted citrus trees on a clay loam soil.

Following the initial treatment at time of planting, those trees treated at the rate of 4 lbs. an acre made vigorous growth with no apparent adverse effects. The 8 lb. rate resulted in mild foliar injury, the 16 lb. rate in severe foliar injury with growth definitely retarded.

A similar pattern existed 6 months after the second annual application: no injury at 4 lbs., and symptoms of increasing severity at the higher rates.

Replants, following the third annual application, have shown essentially the same reaction as the original trees. In the 6 months after planting growth was vigorous and healthy at the 4 lb. rate while the higher rates resulted in varying degrees of injury.

Karmex, Simazine 4G, and Simazine 80W at 4 lbs. to an acre have provided satisfactory weed control for at least 6 months after application.

A contact herbicide, such as Shell weed oil, when used alone, can provide a high degree of weed control only with repeated applications. To maintain 90% bare ground weed oil at the rate of 300-400 gallons an acre a year in 8 to 10 applications was required. However, weed oil is an important part of a chemical weed control program, as a supplement to the residual herbicides as a spot treatment for established grasses and resistant species.

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Chemical Weed Control With No Tillage: A Cultural Practice for Texas Citrus Orchards[1]

R. F. LEYDEN[2]

Cultural practices involving bare soil and no tillage are not new in citrus orchards. The "Hinkley" system, introduced in California in 1919 (Schoonover and Batchelor 1948), was a precursor of present techniques. By 1949 approximately 50,000 acres of California citrus were under a system of no tillage with weeds controlled by oil sprays (Johnston and Sullivan 1949). With the development of suitable residual herbicides in the 1950's the acreage under chemical weed control increased to more than 75,000 (McCarty, Day, and Russell 1960).

McCown and Kretchman (1961) reviewed chemical weed control in Florida citriculture. Experimental work has shown promise but as yet the system has not gained wide acceptance.

In Texas, cultural practices, including chemical weed control with no tillage, have been under investigation at the Citrus Center since 1953 (Leyden 1959). No adverse effects with respect to tree growth, fruit production, or soil condition have resulted from a system of chemical weed control with no tillage. One of the advantages found with chemical weed control and no tillage has been slightly warmer temperatures on night of radiation cooling (Leyden and Rohrbaugh 1963). Similar findings have been reported from other areas (Johnston and Sullivan 1949).

With equal amounts of fertilizer and irrigation water tree growth, during the first 3 years in the field has been significantly greater under chemical weed control with no tillage than under clean cultivation or sod culture.

Field-scale cost studies are not yet available in Texas. However, California data indicates that, once established, chemical weed control with no tillage is more economical than conventional systems (Johnson and Sullivan 1949).

Herbicides are required to have label registration for use on specific crops in specific areas. As of spring 1964 only one residual herbicide, Karmex[3], has registration for use in Texas citrus orchards. Another ma-

[1] Based on a talk given before the Rio Grande Valley Hort. Soc. Feb. 27, 1964. Co-operative citrus research of Texas College of Arts & Industries and Texas Agricultural Experiment Station of Texas A & M University, Weslaco.

[2] Assoc. Prof. of Agriculture, Texas College of Arts & Industries, Citrus Center, Weslaco, Texas.

[3] Karmex (diuron), 3-(3,4-dichlorophenyl)-1,1-dimethylurea, E. I. du Pont de Nemours & Co.

terial which has been successfully tested in Texas and which will likely be registered is Simazine[4].

Karmex and Simazine must be carried into the soil where they are absorbed by germinating seeds and seedlings. They can control most annual weeds and seedling grasses but not established perennial grasses. Established johnson grass or bermuda grass must be brought under control by cultivation, hoeing, or repeated spot spraying with weed oil.

Johnsongrass plants initiate rhizome production at approximately 3 weeks of age. One plant may produce more than 200 feet of rhizome in a growing season (McWhorter 1961), each segment of which can give rise to a new plant. A vigorous follow-up program is required in order to control such species.

At least one season of intensive clean cultivation, to reduce the population of established grasses, is advised before attempting chemical weed control. Application just before an irrigation early in the spring, to land that has been brought to a weed-free condition mechanically, should provide for maximum effectiveness of the residual herbicide.

The herbicides being considered are available as wettable powders. Constant agitation is required in the tank to keep the particles of powder in suspension. Agitation can be provided mechanically or, where sufficient pump capacity is available, by means of by-pass and the use of 1 or more jet devices. Satisfactory agitation can be maintained in a 200-gallon tank with 2 properly placed jets.

The particles of wettable powder are abrasive and subject gear, roller, and ordinary piston pumps to considerable wear, leading eventually to pump failure. Centrifugal pumps are least affected by abrasives.

The herbicide particles are relatively large. Strainers of 50-mesh screen should be used in the discharge line and at the nozzles. For herbicide spraying the flat fan-type nozzles are preferred. A comparatively large orifice is needed. The Tee-jet No. 8004 or equivalent has been found satisfactory. Nozzle openings are worn by abrasive materials. Calibration should be checked after periods of regular service.

Low pressure, from 20 to 40 p.s.i, gives comparatively large droplet size and minimizes drift, a desirable characteristic in herbicide spraying. An accurate pressure gauge and regulator is required in the line.

Until recently, suitable application equipment was not readily available. Fig. 1 illustrates an orchard weed spraying attachment developed by a local manufacturer. The boom, which is shielded, angled, and hinged can work up under trees and close to the trunks, without damage to limbs or trunks. A PTO-operated centrifugal pump provides sufficient capacity for by-pass agitation with 2 jet devices.

[4] Simazine, 2-Chloro-4,6,-bis(ethylamino)-s-triazine, Geigy Chemical Corp.

Figure 1. Orchard weed spray attachment developed by Frontier Industries, Raymondville, Texas.

Herbicides must be applied at controlled rates. In the case of Karmex the label allows 4 lbs. an acre a year. Careful calibration of the spray rig is required. This can be accomplished in various ways. A simple method of calibration is illustrated:

While operating at application speed and pressure over a measured distance the output of 1 nozzle is collected. The calculations are:

distance in feet x boom width in feet = sq. feet treated

$$\text{gals./acre} = \frac{(\text{gals./nozzle x no. of nozzles}) \text{ x } 43560}{\text{sq. feet treated}}$$

Gallons per acre can be varied by changing speed, pressure, or nozzle size.

To apply a herbicide at, for instance, 4 lbs. to an acre it is necessary to know the gallonage delivered per acre, as calculated above, and the capacity of the tank. Assume an output of 50 gallons an acre, and a tank capacity of 200 gallons. A tankful will cover 4 acres; and

4 lb./ac x 4 acres = 16 lb./tankful

Residual herbicides may be considered as another tool available to the grower. Growers considering chemical weed control with no tillage as an orchard cultural practice are advised to begin with a limited acreage until they become familiar with the use of this tool.

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Certain Post-Bloom Treatments for Control of Texas Citrus Mites and Their Effect on Chaff Scale Parasites[1]

H. A. Dean and Jack C. Bailey[2]

The Texas citrus mite, *Eutetranychus banksi* (McG.), was present in greater numbers than usual at the post-bloom period at many locations in the Lower Rio Grande Valley during 1963. Bailey and Dean (1962) reported protracted residual control of this mite with Tedion applied at post-bloom under conditions of relatively limited populations. Several selective formulations of miticides were investigated for their relative toxicity to this mite, particularly under heavier population pressures. Sevin was also investigated for its relative toxicity to chaff scale, *Parlatoria pergandii* Comstock, applied at a time when oil is not recommended.

MATERIALS AND METHODS[3]

Trees were sprayed with a foliage coverage application from a ground rig with a single nozzle (6/64 inch orifice size) guns using 550-600 psi pressure at the tank. The 4-tree plots at the Rio Farms grove and the single tree plots at Substation No. 15 were replicated four times.

Dosages of the various spray materials per 100 gallons of mixture were as follows:

a. Sevin^R (=carbaryl) – 1.25 lb. 80% WP.

b. Chlorobenzilate – 1 lb. 25% WP.

c. Kelthane^R, 1,1-bis (p-chlorophenyl)-2,2-,2-trichloroethanol-1 pint and 1 quart 18.5% EC.

d. Tedion^R (=tetradifon)-1 lb. 25% WP and 1 quart 12.3% EC.

e. Zineb – 1 lb. 75% WP.

f. All treatments contained 2 oz. Triton B-1956 spreader-sticker.

Mite populations were determined by collecting 40 leaves per plot, brushing the mites from the leaves with a mite-brushing machine onto a 5-inch plate and counting the mites on one-half the area under a stereoscopic microscope.

[1] Technical contribution No. TA 4718, Texas Agricultural Experiment Station, Texas A&M University, Weslaco.

[2] Associate Entomologist and Junior Entomologist (on leave), Lower Rio Grande Valley Research and Extension Center, Weslaco.

[3] Thanks are due Geigy Chemical Corporation, Niagara Chemical Division, Rohm and Haas Company and Union Carbide Chemicals Company for supplying various pesticides.

The degree of parasitism by the various parasites of chaff scale was determined by a method similar to that described by Dean (1961). Scales which showed a normal body configuration and no evidence of parasitism were considered alive. A "dead scale" figure considered scales which were dead from causes other than parasites, such as predator action, old age, etc. This figure can be found in the table by subtracting the live and parasitized scale percentages from 100. Scales which showed evidence of parasitism including those with immature forms of parasites were considered parasitized. Scales with a parasite egg, larva or pupa were recorded and grouped as scales with live parasites as an indication of parasite activity. Not more than 10 adult females were examined from each leaf under 18X magnification with a stereoscopic microscope. Two previous-flush leaves were selected at random from each quadrant of four trees in each plot for each 100 scale count.

RESULTS

Unusually great populations of Texas citrus mites were present in all plots prior to treatment on April 9, as shown in Table 1. Populations were reduced to small numbers 21 days after treatment; however, after 51 days differences in residual control were evident. In the Sevin plots, a somewhat smaller population occurred where 1 lb. 25% WP Chlorobenzilate was added to the Tedion but this was considerably less than commercial control. The addition of 1 pint 18.5% EC Kelthane increased the initial and residual control with Tedion. No difference was found in control with the two formulations of Tedion, although a slightly greater population occurred on May 30 in plots treated with the liquid formulation of Tedion. Smaller populations of Texas citrus mites occurred in plots following application with 1 quart 18.5% EC Kelthane. Citrus rust mites were not found in samples from any treatment plot following treatment of April 9. False spider mites, *Brevipalpus* spp., were of no concern.

Formulations of Tedion were compared on April 5, 1963 at Substation No. 15 with the addition of 1 lb. 25% WP Chlorobenzilate (principally for citrus rust mite control). Pre-treatment populations of the Texas citrus mite and eggs were 3.73 and 6.93 in plots sprayed with 1 lb. 25% WP Tedion and 0.60 and 2.10 in plots sprayed with 1 quart 12.3% EC Tedion. Counts on May 31 showed no mites and less than 0.1 Texas citrus mite egg per leaf. Tedion was applied to a smaller initial population of Texas citrus mites, and residual control persisted after 56 days.

Average percent live scale was 44.6 and the percentage of parasitism was small at the Rio Farms grove just prior to treatment, as shown in Table 1. The initial count comprised a large collection of scale-infested leaves from the entire grove. Live scale percentages increased in all plots 34 days after application, particularly in the selective miticide treatments D and E. The latter, however, showed an increasing trend of parasite activity. After 60 days, plots sprayed with Sevin had a much

Table 1. Spray treatments applied April 9, 1963 at the Rio Farms Valencia orange grove and their effect on Texas Citrus mite and citrus rust mite populations and on chaff scale and chaff scale parasite populations.

Treatment[1/]	*Materials per 100 gallons*	*Date*	*Average per leaf* *TCM*[2]	*TCME*[3]	*RM*[4]	*Percent Adult Female Scales* *Live Scale*	*Parasitized*	*with Immature parasites*
A	1.25 lb 80% WP Sevin	4/8/63	17.35	30.70	0.68			
	1 lb 25% WP Tedion	4/9				44.6	1.8	1.2
	1 lb 75% WP zineb	4/30	0.59	1.10	....			
		5/13				52.8	0.3	0.3
		5/30	17.80	33.10	....			
		6/10				66.0	0.8	....
B	1.25 lb 80% WP Sevin	4/8	23.02	40.55	0.05			
	1 lb 25% WP Tedion	4/9				44.6	1.8	1.2
	1 lb 25% WP chlorobenzilate	4/30	0.30	0.22	....			
		5/13				63.5	1.0	....
		5/30	10.80	16.10	....			
		6/10				67.0	0.8	....
C	1 quart 12.3% EC Tedion	4/8	16.85	33.25	0.05			
	1 pint 18.5% EC Kelthane	4/9				44.6	1.8	1.2
	1 lb 75% WP zineb	4/30	0.01	0.01	....			
		5/13				No Count Made		
		5/30	0.60	1.10	....			
		6/10				68.3	20.0	14.3
D	1 lb 25% WP Tedion	4/8	19.82	39.20	0.12			
	1 pint 18.5% EC Kelthane	4/9				44.6	1.8	1.2
	1 lb 75% WP zineb	4/30	0.01	0.05	....			
		5/13				84.3	5.0	3.5
		5/30	0.30	0.50	....			
		6/10				35.8	37.5	26.8
E	1 quart 18.5% EC Kelthane	4/8	20.68	35.52	0.12			
	1 lb 75% WP zineb	4/9				44.6	1.8	1.2
		4/30	0.02	0.05	....			
		5/13				85.5	4.3	3.0
		5/30	0.02	0.10	....			
		6/10				38.2	31.8	20.8

1/ All treatments contained 2 oz Triton B-1956.
2/ Texas citrus mites.
3/ Texas citrus mite eggs.
4/ Citrus rust mites.

greater percentage of live chaff scale with no indication of live parasite activity. The percentage parasitism figure is an accumulative figure and it is possible that the small percentage figure on June 10 might have occurred prior to treatment. Percentage parasitism cannot be considered a valid comparative figure on any date. The percentage forms with live immature parasites for treatment C, D and E were generally greater than normally found at that time of the year. The live chaff scale parasite population was absent in trees sprayed with Sevin 60 days after treatment. Also, results showed that Sevin produced little to no control of chaff scale.

SUMMARY

The unusually heavy populations of the Texas citrus mite at the post-bloom period of 1963 were difficult to control with certain miticides. Tedion gave control when applied under small population levels, but under great population levels failed to give control after 1½ months except where 1 pint 18.5% EC Kelthane was added. Of the formulations used, one quart 18.5% EC Kelthane gave the best control when applied to greater populations of this mite.

Sevin failed to give control of chaff scale after 60 days, at which time chaff scale parasites were not found in these plots. A very good parasite-chaff scale relationship developed in the selective miticide plots, thus indicating this relationship is upset by the use of Sevin.

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Brown Soft Scale Control With Oil[1]

Rex B. Reinking[2]

Spray oil is listed in the Florida Better Fruit Program 1964 as one of the materials for controlling brown soft scale, *Coccus hesperidum* L. In Texas oil plus Sevin (R), carbaryl, 1-Naphthyl N-Methyl carbamate, has been found to be more effective than oil alone for controlling the brown soft scale (Dean, et al. 1962).

Continual evaluation should be made of recommended brown soft scale control programs and variations from these recommendations. Furthermore, as new spray oils are developed it is important that their value in controlling brown soft scale be determined. This experiment was undertaken to compare the effectiveness of the recommended spray measures with oil alone in various concentrations, and also to determine the effectiveness of some new oils that are being developed.

MATERIALS AND METHODS

The experiment was conducted on 15-year-old grapefruit trees at the Jones & Collier Foundation at Weslaco. The trees were frozen back severely in the January freeze of 1962 but had grown to a height of approximately 8 feet.

Four oils sprays at various concentrations were compared with a check that consisted of no treatment. The oils used in the experiment were two commercially available oils, Ortho Volck Soluble and Ortho NP-90; and two newly developed numbered oils, CS 2888 and CS 2866. Specifications for these oils are outlined in Table 1. Plots were laid out in a completely randomized block design, one tree per plot and plots replicated four times.

Sprays were applied with a conventional John Bean Sprayer at 500 p.s.i. Approximately 7 gallons per tree as a full coverage spray was used. Counts of live scale on 1 foot of terminal growth on 12 locations per plot was the device for sampling. Counts were made pre-spray, and 17 and 72 days after spray.

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

[1] Cooperative citrus research of Texas College of Arts & Industries and Texas Agricultural Experiment Station of Texas A & M University, Weslaco.

[2] Instructor in entomology, Texas College of Arts & Industries, Citrus Center, Weslaco, Texas.

RESULTS AND DISCUSSION

All treatments gave significantly better control of brown soft scale than the check at the 17-day count, and all but one treatment at the 72-day count (Table 2). A mix of 1% oil plus 3/5 pound of 80% Sevin was the most effective for the control of brown soft scale. This complements the work by Dean, et al. 1962.

It was interesting to note that spray oils at rates as low as 0.5 percent showed statistically significant level of control when compared to the

Table 1. Specifications of spray oils involved in experiment.

*Spray Oils**	*SSW @ 100 F Viscosity*	*U.R.*	*API 60°F Gravity*	*Distillation Range*
Volck Soluble 97% oil	75.0	92.0	34.5	5% @ 638°F 20% @ 650°F 90% @ 696°F
CS 2866 98% oil	67.6	94.0	35.4	5% @ 646°F 20% @ 658°F 90% @ 693°F
CS 2888 88.6% oil	82.0	86.0	29.7	5% @ 588°F 20% @ 625°F 90% @ 738°F
Ortho NP-90	85±	85.0	28.5	5% @ 627°F 20% @ 660°F± 90% @ 769°F±

*All oils are paraffinic.

Table 2. Total live brown soft scale count as affected by spray oils and Sevin.

Treatment (per 100 gal water)	*Pre-Spray Aug. 8, 1963*	*17 days Post-Spray Aug. 29, 1963*	*72 days Post-Spray Oct. 23, 1963*
1 gal oil + 3/5# 80% Sevin Ortho Volck Soluble	4489*a	179 a	101 a
1½ gal oil Ortho NP-90	3216 a	919 a	560 a
1 gal oil CS 2866	2361 a	573 a	908 a
1½ gal oil CS 2866	2854 a	627 a	916 a
½ gal oil Ortho Volck Soluble	4062 a	537 a	1762 a
¾ gal oil Ortho NP-90	2699 a	813 a	2804 ab
1 gal oil Ortho Volck Soluble	3370 a	1579 a	2848 ab
½ gal oil CS 2866	3385 a	1469 a	2955 ab
¾ gal oil CS 2888	2223 a	2029 a	5186 bc
Check	2540 a	5462 b	7305 c

* Values followed by the same letter are not significantly different at the 5% level.

check. Trees sprayed with the low percent of oil were able to hold their leaves and set a crop of fruit the following spring while the check trees were defoliated and did not set any fruit the following spring. This may be important when infestations are light. In this case oil alone was all that was required to obtain satisfactory control. Excluding Sevin from the spray mix would be an advantage because of the adverse effect it has on beneficial insect populations (Brooks and Thompson. 1961).

Texas citrus mites or rust mites were not present in the plots. Other scale insects were not present in sufficient numbers to secure any data on their control.

At the end of 72 days all plots were sprayed with an oil plus Sevin spray mixture to keep brown soft scale from completely destroying the check trees.

SUMMARY

An experiment was conducted to compare recommended spray measures for brown soft scale with variations in oil concentrations and to determine the effectiveness of two newly developed spray oils.

1. The most effective treatment was oil plus Sevin.
2. All treatments were significantly better than the unsprayed check.
3. Higher percentages of oil gave better control but rates as low as 0.5% gave some control of brown soft scale.
4. The two newly developed spray oils were as effective as two commercially available oils in controlling brown soft scale.

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ACKOWLEDGEMENTS

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Field and Laboratory Studies of *Chilocorus cacti* L. (Coleoptera: Coccinellidae), A Diaspine-Scale Predator on Citrus[1]

H. A. Thomas[2]

One of the predaceous insects often associated with diaspine scale infestations on citrus in the Lower Rio Grande Valley of Texas is the coccinellid *Chilocorus cacti* L. During the mid-1950's, the insect occurred commonly in the citrus-growing portions of the area.

Chilocorus cacti is a black, medium-sized coccinellid, (3.5 - 4 mm in length) with an irregular orange spot in the center of each elytron. The insect resembles the twice-stabbed ladybeetle *Chilocorus stigma* (Say), except that the venter of *C. cacti* is uniformly amber-colored, the thoracic sternites of *C. stigma* are dark brown or black (Muma, 1955).

C. cacti is a beneficial insect (Wolcott 1943, 1944), and while it prefers certain weed-inhabiting hosts, (Hunter 1912, Schilder *et al*, 1928; Gains 1933, Wolcott 1956), the host range of *C. cacti* as such has not been studied. The objectives of the present study were to gain information on the value of this insect as a predator, and its habits on citrus.

METHODS

To determine seasonal population trends and to establish certain details of the life history of *C. cacti* two types of periodic records were made. First, the insect was collected during an entire growing season at ten-day intervals using the fabric-covered tray technique (Lord 1949). These collections were made in an orange orchard moderately infested with *Parlatoria pergandii* Comst. and *Aonidiella aurantii* (Mask.), located immediately west of Texas A & I College Laboratory. In addition, counts were made during timed, five-minute visual observations on five randomly distributed trees in a three-acre block of mature grapefruit trees. The observer counted from beneath the trees, examining the inner foliage. Trees in this orchard were infested principally with *Lepidosaphes gloverii* (Pack.) and *A. aurantii*. A trace of *P. pergandii* was present.

Counts of the scale insect population taken in the latter orchard were made by counting the live scale of all species. The scale on 24 four-inch twigs, (six in each quadrant) were counted on five representative trees and expressed as average number of scale per twig. (Table 1)

In the laboratory, feeding tests, determination of instars, instar-duration, egg deposition and incubation period were recorded in a constant-temperature cabinet at 26° C. unless otherwise noted. No attempt was made to control cabinet humidity. The cabinet was illuminated within by two 15-watt flourescent lamps on a timer which provided approximately the same photoperiod as that occurring out-of-doors.

Feeding and fecundity tests were conducted with mated pairs of beetles collected in the field. Following capture, each mating pair was segregated to its own covered petri dish. Fresh food was supplied every other day. Half of the total number of pairs received one species of food and the other pairs received another species (see Laboratory Studies). Food consisted of scale-infested citrus leaves which had been washed thoroughly to remove dirt and loose scales. Each dish received sufficient infested leaves to insure an abundant food supply for the two-day period, after which the leaves were removed and new infested leaves added. At the time of changing the food, loose scales and other debris were dumped from the dish together with all old leaves. This material was then checked with a 3X magnifier for eggs. The total number of eggs for the two-day period per pair was recorded for thirty days and the data analyzed by comparison of means to determine the relationship of diet to fecundity.

The duration of the instars was determined from specimens isolated in Petri dishes and fed as above.

RESULTS AND DISCUSSION

Field Studies

The average number of ladybeetles per tree, counted in five minutes, is presented in Plates I and II, which show that maximum numbers occurred in late spring or summer. The build-up of scale insects in the area usually commences in early April and the scale population is likewise most numerous in late summer (Table I; Clark, 1930). Thus, in general, the trend of the predator population tended to follow that of the host in these two years.

The peak numbers of ladybeetles in 1958 and 1959 occurred at different times (Plates I and II), perhaps caused by differences in numbers of adult bettles which survived the winter and differences in the amount of scale available as food early in the season. In 1959, the first larvae of the season were found on March 25th.

Table 1. Average no. live scale on 24 twigs, grapefruit, 1959.

April	*May*	*June*	*July*	*August*
37	39	24	33	87

[1] The work reported here was supported in part by a Sigma-Xi-R.E.S.A. Research Grant. Cooperative citrus research of Texas College of Arts & Industries and Texas Agricultural Experiment Station of Texas A & M University, Weslaco.

[2] Present address: Maine Forest Service, Augusta, Maine. Formerly: Asst. Prof. of Agriculture, Texas College of Arts & Industries, Citrus Center, Weslaco.

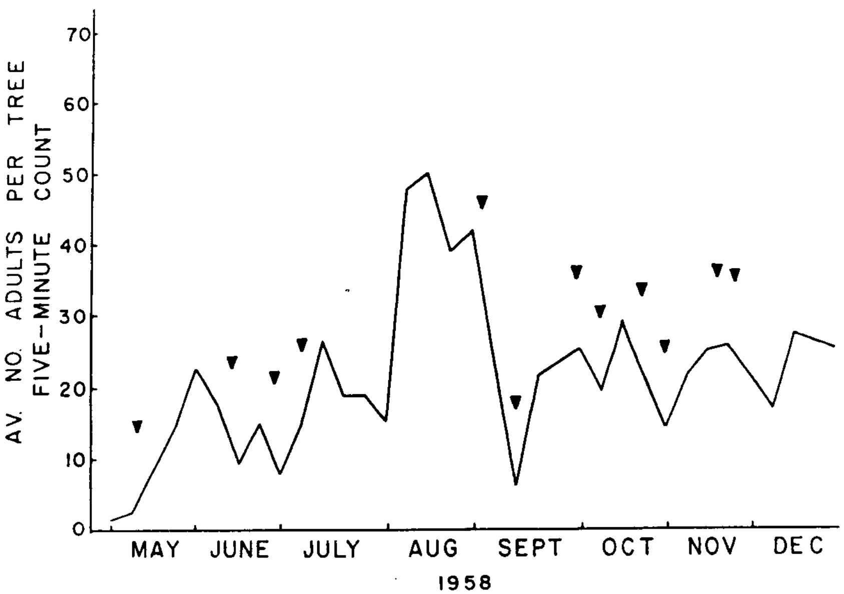

Plate I. Field population trend, *Chilocorus cacti.* on Grapefruit, Weslaco, Texas. Symbol indicates rainfall, 2 in. or more.

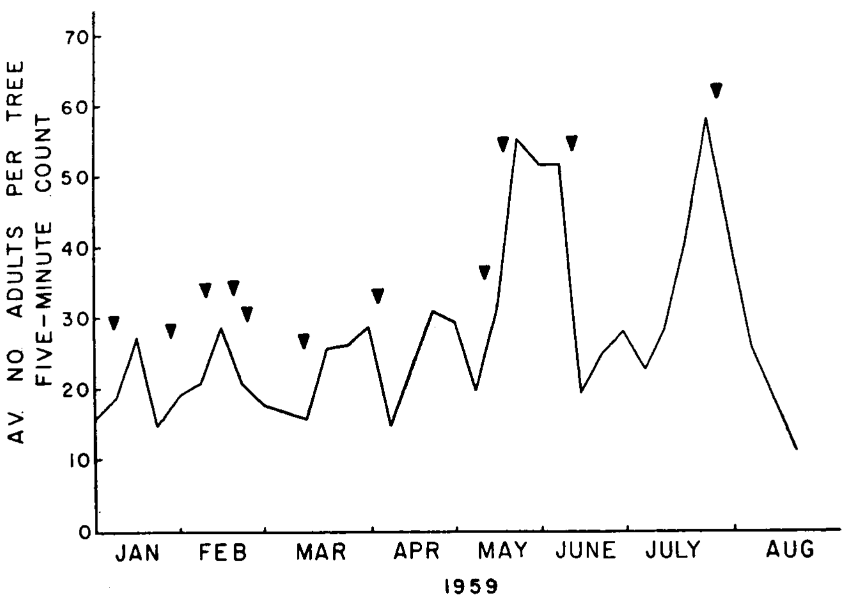

Plate II. Field population trend, *Chilocorus cacti.* on Grapefruit, Weslaco, Texas. Symbol indicates rainfall, 2 in. or more.

The wedge-shaped symbol used in Plates I and II indicates occurrence of two inches or more of rainfall. Rainfall was measured in a standard Weather Bureau rain guage at Texas Agricultural Experiment Station, Substation 15, 1½ miles distant from the orchard studied.

From Plates I and II, it will be noted that in many instances, there was a decline in the average number of beetles following rain. Immediately following heavy showers, live beetles were found occasionally on the ground beneath the study-plot trees, apparently having been washed off the branches and foliage. These beetles appeared sluggish and in many instances were mired in the mud. Muma (1955) stated, "During rain storms adults seem to disappear from the trees."

During cool weather the adults remain active to a minimum of 55° F. After several hours at this temperature, the beetles become entirely quiescent.

Generally the beetles did not reproduce from December to March. Mating pairs were observed in January and some egg deposition was noted in February, but only after periods of above-average temperatures.

In contrast with certain other members of the genus *Chilocorus* which lay eggs in bark crevices or under scale armor (Girault, 1908; Marlatt, 1906; Muma, 1955), a site favored by *C. cacti* for egg deposition is within its own exuviae. At the end of the last larval instar *C. cacti* larvae usually congregate and transform to pupae and adults. Exuviae often form patches on the trunk and larger limbs of the tree and the gravid females use these exuviae for oviposition, favoring the exuviae on twigs. Another favored site for egg deposition is in single exuvia which are found occasionally on protected leaves. In many such sites, the exuvia is located over one or more live scale adults. The exuvia in this case provides some protection for the scale beneath and the lady-beetle larva hatches near a potential food source.

An additional site for egg deposition is on old fruit spurs, in the crevices such as occur between the base of the stem and the sepals. On April 6, 1959, fifty-seven randomly collected grapefruit spurs were examined for eggs. Seventeen percent of the spurs had one or more eggs attached.

From beetles collected at ten-day intervals and stored in alcohol (see Methods), dissection showed that the sex ratio of males to females averaged .49 to 1 for the season. In May the ratio averaged 1.4 males to females but for the remainder of the season females predominated.

Dissections did not reveal any internal parasites. However, a mite hypopus of the family Saproglyphidae was often found beneath the elytra of *C. cacti* specimens (Thomas, 1961).

Dissections of the alimentary canal of the beetles showed that much of the diet in the field consisted of chaff and purple scale. Examination of gut contents also showed that meconia, such as are commonly associated with *Aphytis* pupae, were present. The origin of such meconia in the gut is not known.

Laboratory Studies

With the exception of work by Muma (1955) on *C. stigma,* studies of food habits and host range of members of the genus *Chilocorus* have been fragmentary. Gaines (1933) reported *C. cacti* "feeding on scale on citrus trees", in the area of the present study. Another observation reads, "Weslaco. Very abundant on trees infested with *Chrysomphalus aonidum.*" (Gaines, 1959).

To gain information on the host range of *C. cacti,* confined larvae and adults were provided with various species of insect food. Schilder and Schilder (1928) noted that most species of the Chilocorini feed on coccids and aphids. Accordingly, the following were offered: *Icerya purchasi* Mask.; *Aphis spiraecola* Patch; *Aonidiella aurantii* Mask.; *Lepidosaphes gloverii* (Pack.); *Palatoria pergandii* Comst.; and *Chrysomphalus aonidum* (Linn.). The preferred prey were of the diaspine scale group. The first two, non-diaspine members of the foregoing list were rejected while the latter four species, all diaspine scales, were fed upon.

Confined females of *C. cacti* freely consumed their own eggs, evidently a behavior pattern common among the Coccinellidae, Balduf (1935), Nicholson (1933).

Observations were made of *C. cacti* adults feeding on a laboratory colony of *Aonodiella aurantii* comprised of all developmental stages. The predator preferred nipple-stage scales, ignored crawlers entirely, and only occasionally fed on an adult scale. When nipple-stage scales were attacked, both the scales and their wax coverings were consumed. By contrast, when *A. aurantii* adults were attacked, either a slit was chewed in the scale armor or the armor was raised and the body of the scale withdrawn.

The feeding habits of larval *C. cacti* were not studied in detail. However, in the rearing work, the diet supplied the adults was sufficient for larval development. First instar larvae readily feed on the white cap state of *A. aurantii* and made no attempt to attack mature specimens, perhaps due to the inability of the larvae to penetrate mature scale armor.

To determine what relationship existed between diet and fecundity, a test was set up to determine egg deposition from *C. cacti* females on two separate hosts, *viz. Chrysomphalus aonidum* and *Lepidosaphes beckii.* Comparison tests were run for thirty days (see Methods). The mean number of eggs deposited during the 30-day period by the group (seven pairs) fed *C. aonidum* was significantly greater than the mean for the group fed *L. beckii,* at the 99% level of confidence. It should be pointed out however, that in the citrus-producing area of the Lower Rio Grande Valley, *C. aonidum* was limited in its distribution at the time of this study while *C. cacti* was found generally in the area.

Plate III illustrates the trend of egg deposition by beetles on the two diets. Those beetles fed on the *C. aonidum* not only produced more eggs but attained a high rate of egg deposition much sooner after mating than did those fed on *L. beckii.*

The preoviposition period, at 26° C. averaged five days.

Two females, maintained for 65 days after mating, produced 285 eggs for the period, an average of 142 eggs per female. After 65 days the pair were still producing a few eggs.

Eggs collected from the dishes were used in incubation tests. At a constant temperature of 26.6° C., the eggs of *C. cacti* hatched in 6.2 days, with a range of from four to seven days, as determined from 333 eggs.

Average duration of instars at 26.5° C. were:

1st instar	4.5 days
2nd "	4.0 "
3rd "	4.5 "
4th "	5.0 "
pupa	7.8 "

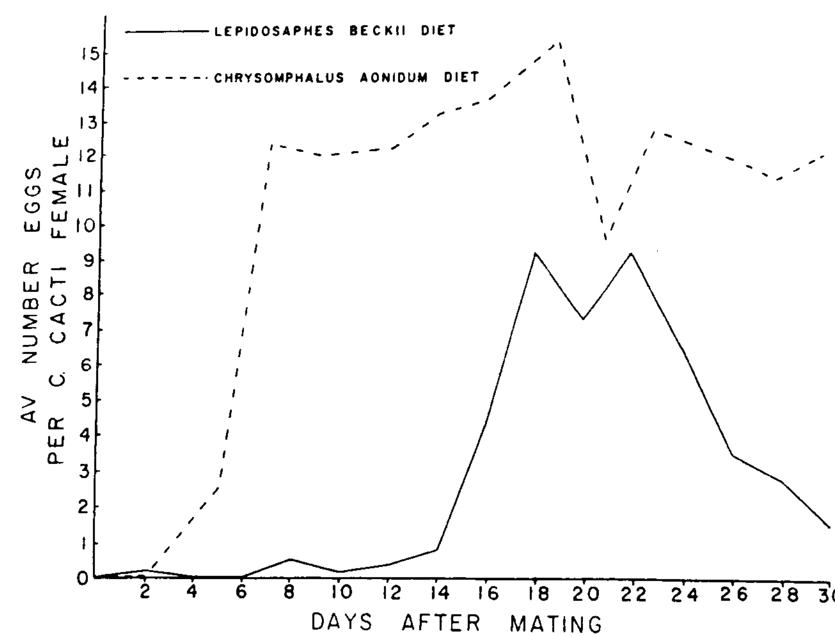

Plate III. Egg deposition by *Chilocorus cacti* fed on different Scale hosts.

SUMMARY

The field data showed that the seasonal population trend of *C. cacti* corresponds approximately with the known seasonal pattern of the principal host in the area.

In the laboratory, the beetle had good reproductive potential which varied depending on the species of host provided as food.

Chilocorus cacti plays a useful part in the biological control of scale on citrus in the Lower Rio Grande Valley through its ability to exist on several scale species. Its biotic activity appears to be limited largely to the growing season. The primary restriction to the citrus environment would subject this predator to the effects of pesticide programs used for other citrus insects. This factor would be quite limiting where intensive spraying or dusting were practiced.

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Tangerine and Tangerine-Hybrid Varieties for Texas

E. O. OLSON and NORMAN MAXWELL[1]

Citrus in the Lower Rio Grande Valley is comprised mostly of red grapefruit (*Citrus paradisi* Macf.) and sweet oranges (*C. sinensis* [Linn.] Osbeck). Trees of tangerine (*C. reticulata* Blanco) and tangerine-hybrid varieties occur as occasional small commercial plantings, or as backyard trees for household use. Probably less than 3% of Texas citrus is tangerines, even if one includes backyard plantings of satsumas (*C. reticulata*) along the entire Gulf Coast.

There is, however, still a place for tangerine and tangerine-hybrid varieties in the Texas citrus industry. The cold hardiness of tangerine trees is an extremely important asset after Texas' freezes in 1949, 1951, and 1962. The excellent quality and characteristic rich flavor of some tangerines, tangelos, and tangors are prized by many as being superior to that of sweet oranges and grapefruit. Most tangerines, like frozen orange concentrate, are convenient to prepare for use. Small children can peel loose-skinned tangerines but have difficulty peeling sweet oranges. In the Valley, some tangerine varieties are adapted to commercial plantings. Some are suited only for backyard culture, whereas others are best suited to areas too cold for standard varieties of sweet orange and grapefruit. Varied seasons of maturity add to their usefulness.

Tangerines and their hybrids show even better peel color in the Winter Garden district near Crystal City, Texas. The more intense red and orange peel colors of Winter Garden tangerines is probably caused by cooler nights, and warmer days than in the Lower Rio Grande Valley. The freeze hazard is greater in Winter Garden than in the Valley, therefore, the cold tolerance possessed by many tangerine varieties is essential for them to be grown there. The attractive peel color of tangerines in the Winter Garden gives the area a favored position as a source of fancy tangerines.

The original tangerine trees are believed to have come from China. They probably grew far enough north or at high enough elevation that resistance to cold was necessary.

CHARACTERISTICS OF TANGERINE VARIETIES

Characteristics of different tangerines and tangerine hybrids presently available in Texas are shown in Tables 1 and 2. These vary in maturity season, fruit size, ease of peeling, cold hardiness, and recommended use. Some are especially noteworthy for excellence of fruit flavor.

'Clementine' trees proved very cold hardy in Valley freezes in 1949, 1951, and 1962. Its fruit is mellow and mild flavored, and small children love its easy-to-peel sweet fruit.

'Dancy' trees are less cold hardy, and its loose-skin fruit has a redder peel, more tartness, and matures later than the Clementine.

'Ponkan' has big fruit, easy to peel. The Ponkan is a highly respected variety in the Far East.

'Owari' (Owari satsuma) trees have great cold hardiness, especially when grown on *Poncirus trifoliata* rootstock in the Upper Gulf Coast and Winter Garden areas. The pulp is very tender. Few satsumas are raised in the Valley because other tangerine varieties with superior flavor do well there.

CHARACTERISTICS OF TANGOR VARIETIES

The tangors are hybrids between tangerine and sweet orange. One of the parents in many of the tangor varieties is the 'King' orange. The 'King' is a prolific bearer, is cold hardy, has quality fruit and has a rough bumpy rind. According to Swingle (1946) the 'King' is probably a natural hybrid of tangerine and sweet orange and thus is considered a tangor.

'Kara', a hybrid of 'Owari' x 'King', was produced by H. B. Frost at the California Agricultural Experiment Station. It is tart, large in size, and late in maturity. When mature, the fruit has a rich flavor. It has loose pebbled skin.

'Kinnow' is hybrid of 'King' x 'Willow-leaf' tangerine and was produced by Frost. The fruit is smaller than that of 'Kara', is juicy, tight skinned and has an aromatic flavor. The fruit is of very high quality.

'Wilking' is a hybrid of *'Willow-leaf' x King'*. It has an excellent flavor.

'Murcott' (Murcott Honey orange) is of unknown origin but it probably is one of Swingle's hybrids from breeding trials at Little River, Florida. It is believed to be a hybrid of sweet orange x tangerine. It ripens midseason (February in Florida) and is very popular in Florida. It has high quality and a pleasing aromatic odor. The 1962 freeze in Texas killed 'Murcott' trees to the ground, while 'Kara' and 'Clementine' trees showed only twig injury.

'Temple' (Temple orange) is considered to be a tangerine hybrid and probably originated as a natural hybrid in Jamaica. The 'Temple' is a high quality fruit and is very widely planted in Florida. It is commonly grown in dooryards in the Lower Rio Grande Valley but it is very tender to cold.

[1] Research Plant Pathologist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and Horticulturist, Texas Agricultural Experiment Station, Weslaco, respectively.

CHARACTERISTICS OF TANGELO VARIETIES

The tangelos are hybrids between tangerine and grapefruit. Many of the tangelo varieties have the sprightly acid taste of grapefruit without the characteristic bitterness of the grapefruit.

'Minneola' is a hybrid of 'Duncan' (Bowen) grapefruit x 'Dancy' tangerine. It ripens at midseason, has an attractive orange-red color, and excellent flavor. It does not peel readily by hand.

'Thornton' has the same parentage as 'Minneola'. In appearance, the fruit is rather coarse and when ripe it becomes soft and puffy. It has excellent flavor and has been the most commonly grown tangelo variety in the Lower Rio Grande Valley.

'Wekiwa' is hybrid of grapefruit x 'Sampson' tangelo. It has a pinkish tinge to the flesh and ripens early.

'Pearl' is a hybrid of the 'Imperial' grapefruit x 'Willow-leaf' tangerine. It has a yellow rind and is smooth skinned. It ripens early in the Rio Grande Valley of Texas.

'Orlando' has the same parentage of the 'Minneola'. It is the most promising tangerine hybrid for commercial planting in Texas. It ripens in late November and December and has good flavor. 'Orlando' trees are productive and vigorous. The fruit has orange-red peel color and orange flesh with tenderness typical of tangerines. It has the shape of a flattened orange. It peels easily by hand but it does not have the typical loose skin of the tangerine.

PROBLEMS IN THE CULTURE OF THE TANGERINE AND ITS HYBRIDS IN TEXAS

Most tangerines and tangelos are sensitive to xyloporosis virus. Since most commercial grapefruit trees in Texas are infected with xyloporosis without visible symptoms, any trees which were once grapefruit or have had grapefruit budded on them should not be topworked to tangerines. Nurserymen should use only previously unbudded seedlings for rootstock to avoid virus contamination. Xyloporosis causes severe stunting and death of affected 'Orlando' trees, therefore, budwood of the variety to be grown should be taken only from trees known to be virus-free.

'Orlando' tangelo is sometimes self-sterile, therefore, a pollinator is required to get a commercial set of fruit with regularity.

Many tangerine varieties are objectionably seedy. The varieties with rough, loose rinds (Tables 1 and 2) are more perishable and more difficult to handle in transit than sweet oranges and grapefruit. Varieties with smooth, tight rinds, such as 'Clementine' and 'Kinnow', are easily bruised and need care in handling to avoid injury during picking, packing and shipping. Fruits should be harvested by cutting stems with blunt-pointed shears, rather than twisting the fruit from the stem.

'Clementine' tangerine is self-sterile and the 'Orlando' tangelo is sometimes self-sterile. Therefore, these varieties should be interplanted with pollinator varieties. One method is to plant one row of pollinator variety to every 6 rows of trees. The 'Temple' orange is a good pollinator variety but most any seedy sweet orange or tangerine variety will do.

'Murcott' fruits are often borne on erect, stiff twigs and sometimes the foliage does not shade the fruit. Such fruit, often up to 50% of the crop, is granulated or sunburned. Some hybrids such as 'Wilking' tend to overbear one year, carrying a multitude of small fruit, and then have few fruit the next year.

While tangerine trees are cold hardy, their fruit is not. Loose-skinned fruit seems to be especially sensitive to cold injury. However, early maturing tangerines are harvested before Thanksgiving and before frost danger is great. Varieties which mature in mid- or late winter are more subject to freeze hazard. For this reason, early maturing tangerines have the best promise for areas north of the Valley, whereas varieties maturing in all seasons can be grown in the Lower Rio Grande Valley.

BREEDING TRIALS FOR TANGERINES

Breeding for the production of tangerine hybrids has been in progress for many years. The U. S. Department of Agriculture in 1960 released 3 early, large, sweet tangerines in Florida. In 1963, the U.S.D.A. announced the release of 'Page', an early orange resulting from a cross of tangerine parents, in Florida. U.S.D.A. hybrids released in California in 1964 includes 'Fairchild', 'Fremont', and 'Fortune'. These hybrids have been propagated in Texas but most have not yet fruited. Also under test in Texas are numerous other mandarin hybrids from state and federal breeding studies in Florida and California. Tangerine is being used as one parent to add greater cold hardiness to sweet orange and grapefruit hybrids. Testing of the progeny of these crosses is underway at Rio Farms and other locations.

CONCLUSION

There is a promising place for tangerines and tangerine hybrids in the Lower Rio Grande Valley. Some are more cold hardy than grapefruit or oranges. Some provide an excellence of flavor unmatched by oranges, and their ease of peeling makes them desirable for home use.

Most varieties have weaknesses which restrict their use to dooryard plantings. However, the 'Orlando' tangelo has real possibilities as a commercial variety.

An intensive effort is underway to find or produce even better tangerine hybrids for Valley use. Citrus breeders expect to produce varieties which combine rich flavor, good size, attractive fruit peel and color, and good shipping character with cold hardiness, high productivity, and

Table 1. Fruit characteristics of Texas' tangerine, tangelo and tangor varieties.

Group and Variety	*Season*	*Fruit size*[1]	*Rind color*	*Rind texture*	*Ease of peeling*[2]	*Mature fruit flavor*
Mandarins:						
Clementine	Nov.-Dec.	M	red-orange	pebbled	W	sweet
Dancy	Dec.-Jan.	M	red-orange	pebbled	W	tartly sweet
Owari Satsuma	Oct.-Nov.	M	orange	pebbled	W	mild sweet
Ponkan	Nov.-Dec.	L	orange	pebbled	W	rich sweet
Tangelos:						
Minneola	Jan.-Feb.	L	red-orange	smooth	W	rich tart
Orlando	Dec.-Jan.	M	orange	pebbled	P	mild sweet
Pearl	Nov.-Dec.	M	yellow	smooth	P	mild sweet
Thornton	Nov.-Jan.	L	orange	pebbled	FW	mild sweet
Wekiwa	Nov.-Jan.	S	yellow	smooth	P	mild sweet
Tangors:						
Kara	Feb.	M	orange	rough	FW	rich
Kinnow	Dec.-Feb.	M	yellow-orange	smooth	P	rich sweet
Murcott	Mar.-April	M	orange	pebbled	P	sweet
Temple	Feb.-Mar.	L	red-orange	rough	FW	tart sweet
Wilking	Jan.-Mar.	S	orange	pebbled	FW	rich

1 Fruit size: S = small; M = medium; L = large.
2 Ease of peeling: W = Well; FW = fairly well; P = poorly.

Table 2. Origin, cold hardiness, limitations and recommended use of Texas' tangerine, tangelo and tangor varieties.

Group and Variety	*Cold hardiness of trees*	*Limitations of variety*	*Recommended use*
Mandarins:			
Clementine	very good	small fruit, needs pollinator, carries exocortis virus.	dooryard
Dancy	poor	old-line trees carry psorosis virus, trees short-lived.	dooryard
Owari Satsuma	very good	poor holding quality on tree.	Gulf Coast and Winter Garden
Ponkan	poor	puffy fruit, coarse and dry fruit.	dooryard
Tangelos:			
Minneola	good	necked-fruit shape is hard to pack, low yields, needs pollinator.	semi-commercial
Orlando	good	sensitive to xyloporosis virus, needs pollinator.	commercial
Pearl	good	unattractive appearance, big seeds.	dooryard
Thornton	good	old-line trees have psorosis virus, puffy when overripe, necked.	not recommended
Wekiwa	good	unpleasant flavor late in season.	dooryard
Tangors:			
Kara	very good	fruit not tolerant to cold.	dooryard
Kinnow	good	alternate bearer, thin peel.	dooryard
Murcott	poor	fruit sunburns, granulates.	not recommended
Temple	poor	carries exocortis virus, sensitive to cold.	Semi-commercial
Wilking	good	alternate bearer, small fruit, some granulation.	dooryard

freedom from disease. Such selections will be better suited than oranges and grapefruit to survive recurrent freezes in the Valley.

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Soil Chemical and Physical Properties Associated with Depressional Saline and Adjacent Areas in Two Grapefruit Groves[1]

David L. Carter and Victor I. Myers[2]

Soil salinity and high, fluctuating water tables limit citrus production in many areas of the Lower Rio Grande Valley (Kroth et al., 1952). Injurious effects of salinity may be manifested as toxicity of specific ions such as boron, chloride and sodium, (Cooper, 1950; 1953; Cooper et al., 1958; Pearson and Goss, 1953; Pearson et al., 1957) or as the overall effects of total salt concentration (U. S. Salinity Lab. Staff, 1954). Some citrus groves have saline, nonproductive areas that are usually lower in surface elevation than surrounding areas.

This paper presents soil chemical and physical properties of saline, nonproductive areas and adjacent soils in two grapefruit groves in relation to surface elevation and water table depths.

METHODS AND MATERIALS

Two study sites each including three soil sampling locations were selected on the basis of observed tree growth. Both sites were on Rio Farms property. Site 1 was approximately one mile west of farm road 88 and one-half mile north of Delta Lake. Site 2 was approximately one mile east of farm road 88 and 300 yards north of the large open drain north of Delta Lake. At each study site, soil samples were taken in the center of a bare area where trees had died, near the margin of the bare area where trees were stunted by salinity effects, and adjacent to the bare area where trees appeared healthy and productive. The three sampling locations at each site will be referred to as saline, transitional and unaffected, respectively. The saline and transitional locations at both sites were Rio fine sandy loams (slightly wet). The unaffected soils were Willacy fine sandy loams. The two sampling sites are shown in Fig. 1 and 2. The marking stake in the foreground indicates the saline sampling location, and the stake in the background marks the transitional sampling location. Soils were sampled during June 1961 by depth increments of 0 to 3, 3 to 6, 6 to 12, 12 to 18, 18 to 24, 24 to 36, 36 to 48, and 48 to 60 inches except that samples from the 48- to 60-inch depth were not obtained from saline and transitional locations at site 1.

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

[2] Research Soil Scientist and Research Agricultural Engineer, respectively, USDA, Weslaco, Texas.

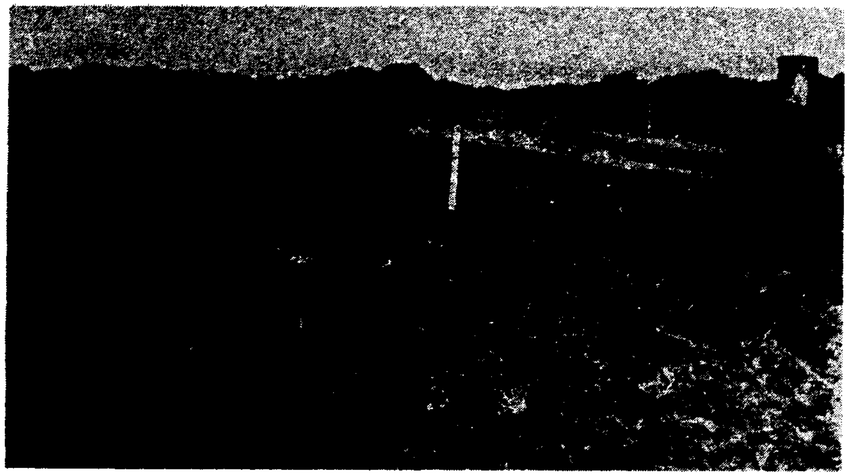

Figure 1.—Site 1. The stake in the foreground marks the saline sampling location and the stake in the background marks the transitional sampling location.

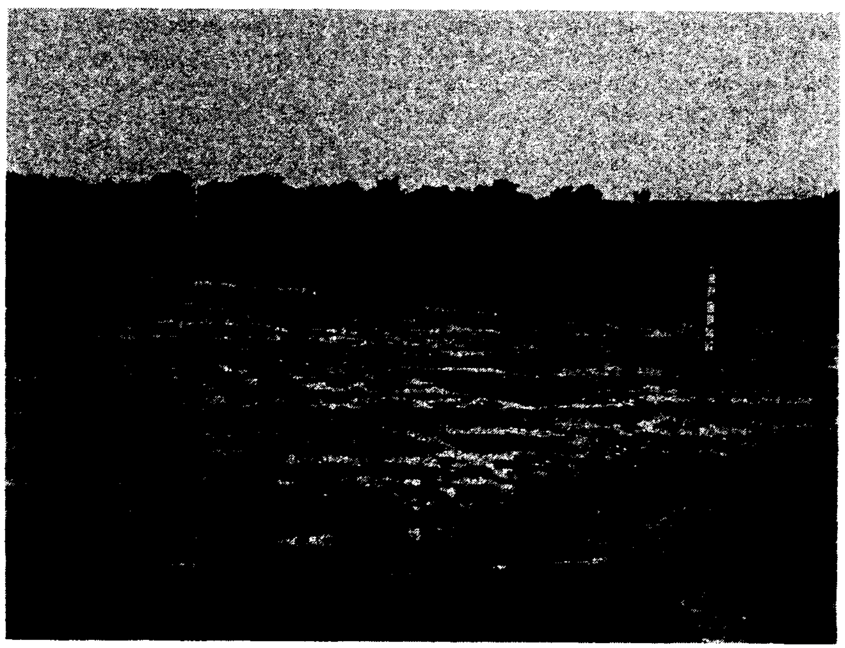

Figure 2.—Site 2. The stake in the foreground marks the saline sampling location and the stake in the background marks the transitional sampling location.

All soil samples were analyzed for the following chemical and physical properties:

a. ECe, the electrical conductivity of the water extracted from saturated soil which is a measure of total salts (U. S. Salinity Lab. Staff, 1954).

b. Water-soluble ions: Ca^{++} + Mg^{++}, calcium plus magnesium; Na^{+}, sodium; K^{+}, potassium; Cl^{-}, chloride; HCO_3^{-}, bicarbonate; $CO_3^{=}$, carbonate; (U. S. Salinity Lab. 1954) and $SO_4^{=}$, sulfate (Jackson, 1958).

c. ESP, the exchangeable sodium percentage (U. S. Salinity Lab. Staff, 1954).

d. CEC, cation exchange capacity, (U. S. Salinity Lab. Staff, 1954).

e. Particle size distribution or soil texture determination (Bouyoucos, 1962).

In addition to the soil samples, water samples were collected from auger holes left open for one day. The water samples were analyzed for ECe and the same water-soluble ions listed for soil samples. The water table was deeper than 6 feet at the unaffected location at site 2, and a water sample was not obtained.

Depth to the water table was measured continuously at site 1 for one year beginning in May 1961. Precipitation was measured and dates of irrigation recorded during the same year.

A core drill was used to drill to a depth of 50 feet in the saline area of site 1.

RESULTS AND DISCUSSION

The surface soil was extremely saline at both sampling sites where trees had died (Table 1). The salt concentration decreased sharply with depth indicating that salts had accumulated by evaporation of water from the soil surface. Transitional soils varied in salinity with depth over a narrow ECe range of 1.5 to 3.5 mmhos./cm. (Table 1). That this salinity range was near the critical concentration for the grapefruit trees growing on the sampling locations was evidenced by their exhibited salt toxicity symptoms and stunted growth. The salinity of unaffected sampling locations was low throughout the sampling depth. The maximum ECe measured in unaffected soil was 1.28 mmhos./cm. in the 36- to 48-inch depth at site 1. Most values measured were below 1 mmho./cm. (Table 1).

The soluble salts contained in the soil solution were mostly calcium, magnesium and sodium chlorides (Table 2). Only small concentrations of K^{+}, and $SO_4^{=}$ were detected. Approximately two-thirds of the soluble cations were Ca^{++} + Mg^{++}. Na^{+} composed the other one-

Table 1. ECe of soils at three locations at each of two sampling sites.

	Saline		Transition		Unaffected	
Site	1	2	1	2	1	2
Depth, inches	*ECe, mmhos./cm.*					
0.3	56.9	71.0	1.73	2.28	0.59	0.77
3-6	30.5	38.0	2.55	2.51	0.63	0.64
6-12	16.1	19.1	3.06	1.98	0.55	0.73
12-18	12.6	11.2	1.84	1.68	0.80	0.60
18-24	12.2	10.6	1.45	2.40	0.66	0.93
24-36	9.4	8.8	2.50	2.40	1.08	0.55
36-48	7.8	9.6	3.15	3.40	1.28	0.76
48-60	....	8.2	......	3.50	1.12	0.61

third. Cl^- accounted for over 90 percent of the soluble anions in saline soils, but only small quantities of Cl^- were found in transitional and nonsaline soils. HCO_3^- was the predominant anion in unaffected soil solutions, but concentrations were low (Table 2).

Highest CEC values were found for the saline soils at both sites. Lowest values were found in unaffected soils. CEC increased with depth at all sampling locations (Table 3).

ESP levels were highest in saline soils and lowest in unaffected soils (Table 3). No values were excessive in relation to the soluble salt concentrations found. Leaching of soluble salts from saline soils would also decrease the ESP.

The highest sand and the lowest clay percentages were found in unaffected soils. The converse was true for saline soils (Table 3). Clay content increases and sand content decreases with depth at all sampling locations. The increase in CEC with depth is associated with the increase in clay content.

The relative surface elevation at the saline, transitional and unaffected locations at site 1 is illustrated in Fig. 3. A similar relation existed between locations at site 2. The minimum and maximum depth to the water table during the year May 1961 to May 1962 are also shown in Fig. 3. The water table was always considerably nearer the surface of the saline locations than at the unaffected locations. Consequently, more water moves upward from the water table, evaporates, and deposits salts in the surface soil in the depressional areas. As a result the depressional areas become saline.

Both irrigations and rainfall influence the water table depth in the depressional area (Fig. 4). Irrigations at mid-June and late July 1961 caused water table rises at the saline and transitional locations at site 1 but had little effect on the water table at the unaffected location. The

irrigations were not applied to the saline location. Nevertheless, irrigating the transitional and unaffected locations caused a water table rise in the saline location. September 1961 rainfall raised the water table at all locations of site 1, where detailed measurements were made. A similar

Table 2. Ionic composition of the soil solution at all sampling locations.

	Saline		Transition		Unaffected	
Site	1	2	1	2	1	2
Depth, inches	*Water soluble Na^+, me./100 g.*					
0-3	8.72	10.88	0.21	0.26	0.04	0.10
3-6	5.20	5.05	0.30	0.28	0.04	0.10
6-12	2.02	3.66	0.24	0.25	0.07	0.11
12-18	0.89	2.23	0.20	0.21	0.12	0.09
18-24	0.91	2.16	0.20	0.26	0.11	0.09
24-36	1.52	2.01	0.37	0.48	0.17	0.12
36-48	1.19	2.19	0.58	0.49	0.18	0.14
48-60	......	2.05	......	0.44	0.12	0.15
	Water soluble Ca^{++} + Mg^{++}, me./100 g.					
0-3	12.67	18.11	0.32	0.29	0.01	0.14
3-6	7.91	8.61	0.48	0.34	0.08	0.08
6-12	3.90	5.99	0.57	0.19	0.10	0.08
12-18	3.10	3.00	1.15	0.14	0.10	0.07
18-24	3.11	3.28	0.22	0.32	0.11	0.16
24-36	2.40	1.77	0.33	0.70	0.21	0.19
36-48	1.76	1.82	0.54	1.08	0.27	0.22
48-60	......	1.67	......	1.15	0.26	0.16
	Water soluble Cl^-, me./100 g.					
0-3	20.12	28.61	0.15	0.25	0.03	0.02
3-6	11.28	11.91	0.33	0.34	0.03	0.02
6-12	5.71	9.67	0.44	0.21	0.04	0.04
12-18	3.94	4.75	0.19	0.17	0.06	0.02
18-24	4.03	4.20	0.18	0.19	0.02	0.06
24-36	3.03	2.44	0.33	0.61	0.06	0.06
36-48	2.01	2.98	0.61	0.84	0.12	0.08
48-60	......	2.79	......	1.13	0.07	0.05
	Water soluble HCO_3^-, me./100 g.					
0-3	0.24	0.17	0.10	0.29	0.13	0.28
3-6	0.20	0.13	0.22	0.26	0.13	0.24
6-12	0.26	0.27	0.16	0.19	0.16	0.22
12-18	0.21	0.12	0.19	0.18	0.37	0.10
18-24	0.26	0.14	0.20	0.19	0.30	0.13
24-36	0.26	0.19	0.21	0.05	0.28	0.15
36-48	0.20	0.12	0.22	0.03	0.27	0.13
48-60	......	0.13	......	0.04	0.25	0.13

water table depth pattern likely occurs at most depressional areas in the Lower Rio Grande Valley.

The saline location at site 1 is underlain by clay to a depth of 50

Table 3. Cation exchange capacity, exchangeable sodium percentage, percent clay and percent sand of soils at all sampling locations.

	Saline		Transition		Unaffected	
Site	1	2	1	2	1	2
Depth, inches	*CEC, Cation exchange capacity me./100 g.*					
0-3	17.6	11.4	9.8	9.0	6.8	8.7
3-6	17.6	11.6	10.1	8.5	6.8	7.9
6-12	15.1	21.7	9.5	7.1	8.2	8.4
12-18	20.0	25.7	11.5	6.6	13.7	9.0
18-24	19.3	20.6	13.6	16.4	15.0	13.1
24-36	22.6	18.8	17.7	32.4	15.3	16.2
36-48	21.9	18.0	18.1	22.4	14.6	20.7
48-60	......	17.7	......	22.4	14.6	21.5
	ESP, Exchangeable sodium percentage %					
0-3	10.6	13.0	7.8	11.1	8.4	3.6
3-6	18.3	19.8	6.3	12.1	7.6	5.1
6-12	13.9	11.6	7.9	13.5	2.8	4.8
12-18	17.8	17.8	6.4	11.7	6.8	8.7
18-24	14.1	18.1	7.5	11.0	6.9	4.5
24-36	15.5	14.0	6.1	6.2	7.0	4.8
36-48	13.2	16.8	14.0	7.3	6.6	4.8
48-60	......	22.6	......	5.2	7.7	6.0
	Clay, %					
0-3	16.4	18.4	10.4	11.4	9.4	9.4
3-6	20.6	17.4	10.4	11.4	8.4	9.4
6-12	19.0	35.4	10.8	9.4	11.4	10.4
12-18	23.4	41.4	14.0	9.4	21.4	11.4
18-24	30.4	37.4	16.0	28.4	22.4	16.4
24-36	33.0	29.4	26.4	32.4	22.4	19.4
36-48	37.0	31.4	28.4	29.4	21.4	27.4
48-60	......	32.4	......	29.4	21.4	27.4
	Sand, %					
0-3	65.6	68.6	79.6	81.6	85.6	83.6
3-6	60.6	71.6	79.0	81.6	88.6	84.6
6-12	61.2	57.6	79.4	83.6	82.6	84.6
12-18	61.6	51.6	73.6	83.6	69.6	82.6
18-24	59.6	54.6	72.0	66.6	67.6	77.6
24-36	56.0	63.6	62.6	63.6	68.6	73.6
36-48	50.6	61.6	60.6	64.6	69.6	66.6
48-60	......	59.6	.....	64.6	69.6	66.6

feet except for a thin sand lens at about 18 to 19 feet. No artesian pressure or sources of water to supply the water table were found except irrigation and rainfall.

Moderate water table rises that have little or no effect on evaporation and do not enter the tree rooting zone of high, unaffected soils can

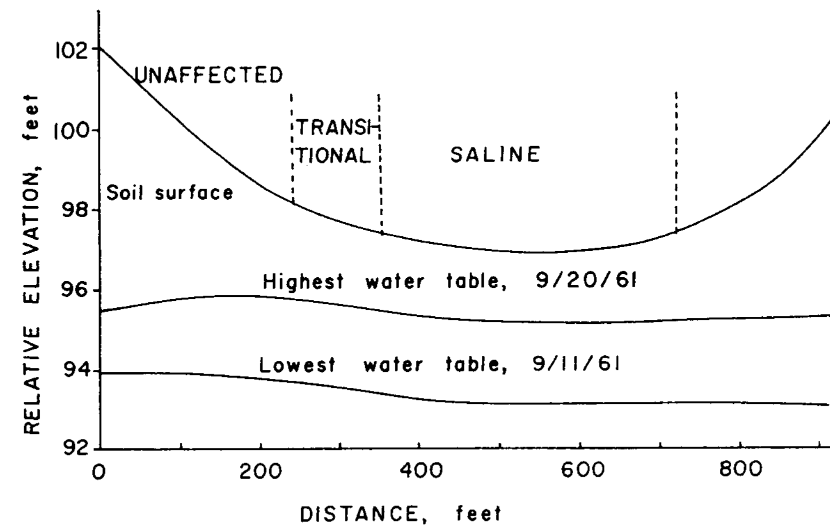

Figure 3. Relative ground surface in relation to the maximum and minimum water table depths during the year May 1961 to May 1962.

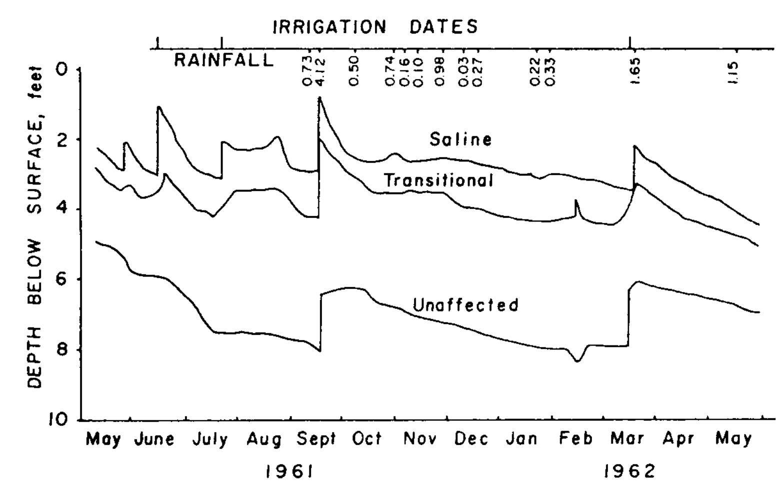

Figure 4. Water table fluctuations at site 1 during the year May 1961 to May 1962.

result in greatly increased evaporation and almost completely fill the plant root zone of low, saline soils. Therefore, the fluctuating water table not only is conducive to salt accumulation, but it limits the tree rooting zone. A high water table in the rooting zone for a few weeks may retard or kill citrus trees.

The water table was saline beneath the saline and transitional soils and moderately saline beneath the unaffected soil at site 1, (Table 4). The ionic composition of the water table had approximately the same proportion of various ions as the saline soil extracts, except that the water table contained a higher proportion of $SO_4^{=}$.

The depth to the water table and water table fluctuations should be considered before planting any area, particularly low areas, to citrus. Wherever the water table is near enough to the soil surface for large quantities of water to move upward and evaporate from the soil surface, a salinity problem may develop that will be injurious to citrus. Even where the water table is 4 feet below the soil surface, some injurious salinity effects may occur as evidenced by the poor growth of trees on transitional soils. Furthermore, since salts accumulate rapidly, a water table near the soil surface for even a few weeks may result in saline soils.

To assure that citrus will grow in an area, adequate artificial or natural drainage is required. Unaffected soils apparently have adequate natural drainage for citrus production, but transitional and saline soils do not. In order to produce citrus on low, saline areas, where the water table is near the soil surface, artificial drainage must be installed and the soils must be leached free of excess soluble salts.

Table 4. ECe and ionic composition of the water table at the sampling locations.

	ECe	Na^+	$Ca^{++} + Mg^{++}$	Cl^-	HCO_3^-	$SO_4^{=}$
	mmhos./cm.			me./1		
			Site 1			
Saline	15.5	62.6	102.0	140.0	4.4	35.2
Transitional	8.9	48.7	52.0	74.0	7.6	34.4
Unaffected	5.9	20.2	46.0	45.0	6.2	19.4
			Site 2			
Saline	19.1	101.3	110.0	194.0	3.8	37.2
Transitional	10.6	26.5	92.0	104.0	6.4	15.6
Unaffected			No Sample			

SUMMARY

Some chemical and physical properties of saline, transitional and unaffected soils in two grapefruit groves were studied in relation to tree growth, surface elevation, and depth to the water table. Saline areas where trees had died, transitional areas where tree growth was stunted and salt toxicity symptoms were exhibited, and unaffected areas where trees appeared healthy and productive were sampled.

The saline soils contained extremely high salt concentrations in the surface few inches but salt concentration decreased sharply with depth. Transitional soils contained salt concentrations near the critical level for grapefruit trees. Unaffected soils were low in salt.

The saline soils contained mostly calcium, magnesium and sodium chlorides. About two-thirds of the cations were $Ca^{++} + Mg^{++}$, and the other one-third, Na^+. Cl^- composed over 90 percent of the soluble anions in saline soils, whereas only very small quantities of Cl^- were found in transitional and unaffected soils. HCO_3^- was the predominant anion in unaffected soils where total salt concentration was low.

Unaffected soils were higher in surface elevation than saline soils. Transitional soils were a little higher than saline soils. The water table was always nearer the surface of saline, depressional locations than at the other locations sampled. Irrigation and heavy rainfall cause high water table conditions in depressional areas. During and following high water table periods, more salt accumulates in the low saline areas because of more evaporation.

Soluble salts accumulate in the surface few inches of soil where the water table is near enough to the soil surface to allow continuous upward water movement and evaporation. Such soils will not produce citrus without intensive management practices. Only soils with adequate drainage should be planted to citrus. It is important to study the water table conditions of any area, particularly low areas, where citrus planting is anticipated. A high water table encompassing the root zone for a few weeks may retard or kill citrus trees. Because of the proximity to the water table, fluctuations that have little or no effect in unaffected soils with deep water tables may have severe adverse effects in depressional areas.

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A Thermometer Shelter Designed for Citrus Orchards and Vegetable Fields

Donald J. Haddock[1]

Reliable temperature measurements are essential when cold protection equipment is being operated in citrus orchards and vegetable fields. Unwarranted anxiety and crop loss can result from inaccurate temperature measurements. An unsheltered but accurate thermometer may register several degrees colder or warmer than the air, depending upon weather conditions and exposure of the thermometer. A calibrated or accurate thermometer properly exposed within a suitable shelter will give a satisfactory and representative temperature measurement of the immediate area.

A newly designed thermometer shelter shows promise of being well suited for temperature measurements in orchards and fields. The shelter is relatively accurate, simple and economical. It was designed, constructed and preliminarily evaluated at the Weather Bureau Agricultural Service Office at Weslaco in February and March 1964. However, it has not been thoroughly tested and is not necessarily approved as an official Weather Bureau shelter.

Tests conducted during eight selected nights indicated that the shelter shown in Fig. 1 was more suitable than 12 other types, including some that are commonly used in orchards. Suitability was based upon accuracy (correction factor), cost and simplicity. Minimum temperatures recorded in each shelter were compared to those obtained in a cotton region shelter (CRS). Positive corrections were given to those shelters having lower minimum temperatures than the CRS. The CRS was selected as a standard for this test because of its widespread use.

Test results for the shelter shown in Fig. 1 are listed in Table 1. The average correction was +.1 degree F. for the eight nights with weather conditions ranging from clear skies and calm winds to cloudy skies and a gentle breeze. The largest corrections, +.3 and +.2 degree, occurred during the clear calm nights and the least under cloudy skies, except for one case of clear skies and light air.

A thermometer shelter is most critically needed in citrus orchards and vegetable fields on clear calm nights when the corrections are relatively large (Table 1). Under cloudy or windy conditions, an unsheltered but accurate thermometer will generally give a satisfactory measurement.

The shelter in Fig. 1 was constructed from redwood boards; a cedar

[1] Advisory Agricultural Meteorologist, Weather Bureau Agricultural Service Office, Weslaco, Texas.

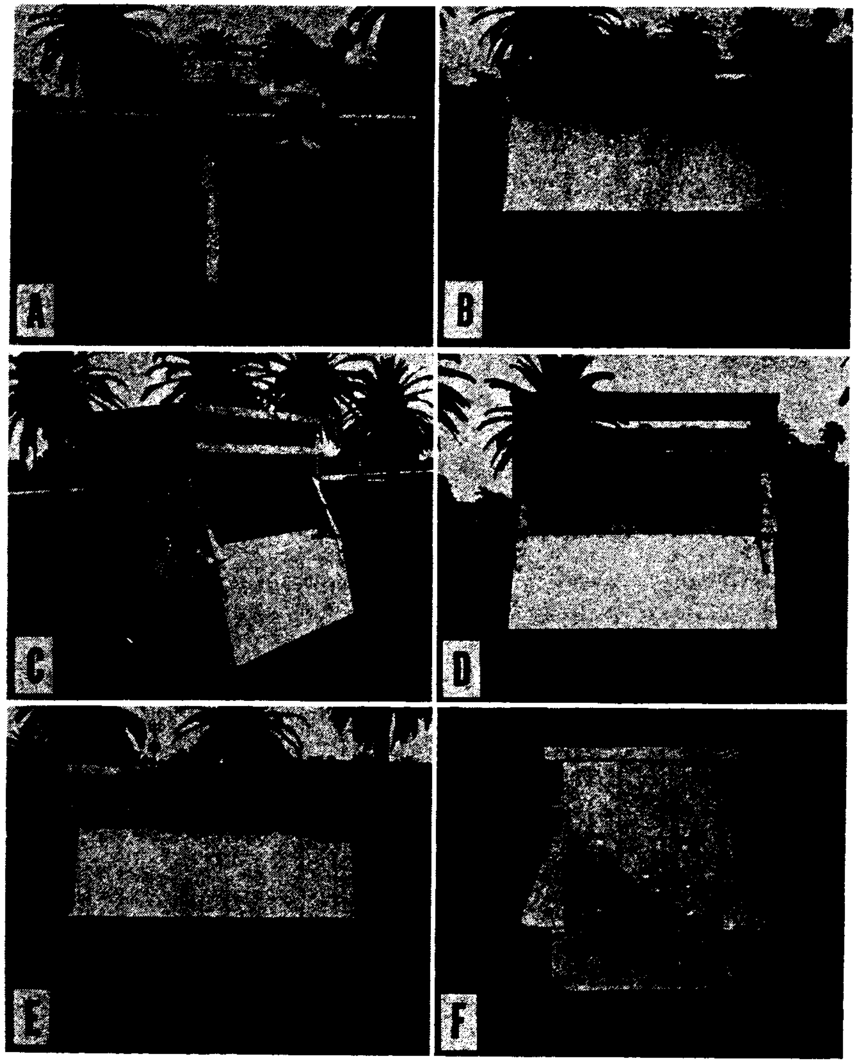

Figure 1. Views of the thermometer shelter. (A) Shelter being evaluated by the author following a test night. The midheight of the shelter is five feet above the ground and the door faces north. (B) Front view of shelter in service (door closed) showing double roof, ventilation opening between lower roof and top of door, and slatted floor. (C) Oblique view showing hinged open door, ventilation holes through the end sections, and ventilation opening between the door and the lower base board. (D) Front view with open door showing thermometer exposure and attachment of supporting post to back interior of the shelter. (E) Back view showing double roof, ventilation opening between lower roof and back side (similar to door), and slatted floor. (F) Side view depicting door hinged to the right side of the shelter and end ventilation holes sloping downward toward the ground.

post; galvanized nails, hinges and a hasp; and white paint. The outside dimensions are: 21½ inches long, 15½ inches wide and 15 inches deep. The cedar post is seven feet long and supports the shelter at five feet above the ground (4½ to 5½ feet is a proper height for the center of the shelter). It has many desirable features for minimizing the terrestial and even solar radiation effects. The shelter was constructed with a double roof; well-ventilated front, back and floor; and a white glossy exterior finish.

Construction material and cost are shown in Table 2. Total cost, excluding labor, was $4.98, which is approximately four to five percent of the retail cost for a standard CRS.

Table 1. Eight minimum temperature correction factors (degree F.) for the shelter shown in Figure 1, February and March 1964.

	Sky Condition and Cloud Cover		
Wind Speed	*Clear* 0/10-3/10	*Partly Cloudy* 4/10-7/10	*Cloudy* 8/10-10/10
Calm (0 mph)	+.3 & +.2	+.1 & +.1	
Light air (1-3 mph)	+.2 & ±.0		±.0
Light breeze (4-7 mph)			
Gentle breeze (8-12 mph)			±.0

Table 2. Material and cost for the shelter.

Redwood lumber		$1.80
	1 – 1"x12" – 21½"	
	1 – 1"x12" – 20"	
	2 – 1"x10" – 14"	
	2 – 1"x8" – 20"	
	2 – 1"x4" – 21½"	
	4 – 1"x4" – 11"	
	2 – 1"x8" – 14"	
Cedar post		1.53
	1 – 4"x4" – 7'	
Nails		.20
	1 lb #8 box galvanized	
Hinges		.35
	1 pair 1"x3" strap galvanized	
Hasp		.30
	1 – 1"x3" galvanized	
Paint		.80
	½ pint glossy white exterior	
	Total cost	$4.98

Pecans in the Lower Rio Grande Valley[1]

F. R. Brison[2]

Successful pecan growing is closely related to four important factors: climate, soil, varieties and management.

CLIMATE

Climate includes principally temperature, humidity, rainfall, and wind.

Temperature – The pecan grows best with a long warm growing season, and a cold dormant season. The best pecan growing areas have mean monthly temperatures of from 75 to 85°F. during the main months of the growing season. It is important that day and night temperatures be warm during the growing period. Cool nights are not considered favorable.

Pecans grow best in areas where there is sufficient cold weather during the winter to provide a definite dormant period. Early investigators mention 750 hours below 45°F. as being a minimum number of hours during the winter for good continued growth and bearing of pecan trees. There are areas in northern Florida where pecans grow successfully with much less annual cold weather than this. Pecan trees here in the Lower Rio Grande Valley grow and produce well with winters that probably have less than 200 hours below 40°F.

Humidity – Humidity is related to successful pecan growing because of its influence on diseases that affect leaves, nuts, and limbs of the tree, and also by its influence on pollination. Briefly, high humidity encourages pecan scab, vein spot, mildew, and several other disease pests. Also, the pecan is wind pollinated and when the relative atmospheric humidity is above 85 percent, no pollination occurs. This is because high humidity prevents *shedding* of pollen from the anthers, and also the distribution of it by the wind. Excessively high humidity and accompanying rain, dew, and fog during the early harvest season may cause sprouting of the pecans. This difficulty is more likely to occur with some varieties than others. The Schley and Burkett are two varieties in which sprouting frequently occurs.

Rainfall – Abundant soil moisture is necessary for successful pecan growing. In many areas this is supplied by rainfall directly. In the West Cross Timber Belt of Texas, pecans are grown on many sites where moisture during certain seasons is supplied largely by natural sub-irrigation.

[1] A portion of a talk presented at the annual Institute of the Rio Grande Valley Horticultural Society, January 21, 1964.

[2] Professor of Horticulture, Texas A and M University, College Station.

In parts of west Texas and notably in New Mexico, pecans are grown under systems of management that provide for regular irrigation.

SOIL

Good soil is necessary for successful pecan growing. These are important factors:

Depth – Great depth provides a deep basin for moisture. The best pecan soils of Texas have a depth of from 2 to 10 and more feet of soil that can be readily penetrated.

Moisture-holding capacity – Moisture in the soil is important to supply requirements for good annual growth and for the proper development of size and maturity of nuts. Without adequate soil moisture, pecan fail.

Fertility – The pecan kernel is a concentrated source of food. The energy for this food comes from the soil. It is necessary that the soil be generously fertile to provide for the vigorous growth and fruiting necessary for good production of nuts.

Salt tolerance – The pecan tree is sensitive to excesses of salt in the soil. Tests in Oklahoma have shown that pecan trees were affected adversely where elm and other native trees were apparently unaffected. Pecan tree growth is noticeably retarded where total salt accumulation is as much as 900 p.p.m. This consideration would be of concern to prospective pecan growers in the Lower Rio Grande Valley of Texas.

VARIETIES

There are many varieties of pecans. Our experience is that there are specific geographical areas where different varieties can be grown. No decision is more important in pecan growing than the selection of proper varieties. Recommendations for any area are based on experience and performance in that area. Unfortunately, we have only limited information on varieties for the Valley. These are suggested: Success, Stuart, Mahan, Desirable, and Choctaw.

MANAGEMENT

Successful pecan growing depends upon good management in the establishment of the trees and in their care during early growth and during their productive years. Important operations in management are cultivation, fertilizing, cover crops, insect pest and disease control, and the harvesting and marketing of the crop.

A pecan orchard should have sufficient size and potential producing capacity to justify the equipment necessary to provide proper management. Generally, we think that a unit capable of producing 30 or more thousand pounds of pecans annually is sufficient to justify equipment to provide proper management.

VEGETABLE SECTION

Living with Pesticides[1]

Parke C. Brinkley[2]

I have entitled my talk "Living With Pesticides". I have selected this title for several reasons:

(a) We can't live without them.

(b) They are capable of doing a great deal of good and they are also capable of doing a great deal of harm.

(c) There has been some conflict between the various commodity producers over the use, or more precisely, the misuse of pesticides.

(d) Millions of people are living today only because of pesticides.

Pesticides have been used to a limited extent for thousands of years. They really came into commercial use about the turn of the century. The modern era of chemical control began with the introduction of DDT in the early forties as the forerunner of hundreds of compounds which have followed.

Plants in the United States are attacked by some 3,000 species of insects, and equally this many disease agents. Livestock are not directly attacked by nearly so many, but they are seriously attacked by numerous ones including heel fly, horn fly, face fly, botts, lice, mites, mange and screw worms. Add to this list weeds affecting crops and livestock and, as Assistant Secretary of Agriculture John Baker recently told a committee of Congress, it totals a loss to American farmers of some thirteen billion dollars annually, or more than one-third of their total income. This loss occurs even with the widespread use of pesticides.

Now add to this list some fifteen billion board feet of saw timber lost because of the attack by the 160 destructive forest insects. This is a loss, by the way, ten times as great as the total loss from forest fires. As this list mounts, you begin to get the story of the importance of pesticides, the contribution they are making to our economy, and the potential benefit to mankind from their wider use.

I have been talking only about the United States and only about agricultural production. World-wide food losses are astronomical from pests of various sorts.

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1 Presented at Annual meeting of Rio Grande Valley Horticultural Society, January 21, 1964.

2 President, National Agricultural Chemicals Association, Washington, D.C.

The Public Health Service has credited pesticides with saving the lives of five million people and preventing 100 million illnesses a year.

Hunger and disease make people ripe for Communism.

Let us never forget that the really big fight today is between Christian Democracy and Godless Communism. In this fight no nation is doing more on our side than the United States, and no industry is doing more than the industry of agriculture.

The industry of agriculture is, of course, composed of three separate groups working together – (1) those who furnish the farmer with production supplies such as automobiles, trucks, tractors, fertilizers, pesticides, containers and a thousand other things that farmers use in producing a crop; (2) the producers themselves; and (3) the people who take the farmers' raw products and process, pack and distribute them to the comsumers.

The pesticide industry is proud of the part that it plays in helping to provide the American people with the most wholesome, most abundant, most attractive and the cheapest food on earth.

The average hour's industrial wage in this nation today will buy more food than a similar hour's wage has ever bought in this country at any time. It will also buy more food than a similar hour's labor will buy in any other nation on earth.

All of us involved can take just pride in this accomplishment, but none of us can take more than partial credit for it. This is equally true in most affairs.

Pesticides are not a productive agent but rather a protective force that, working with other segments of agriculture, contributes to the total production.

Pesticides don't cure diseases, but they do prevent insects from spreading diseases from one person to another.

Pesticides don't make crops grow, but they keep weeds out and let the crops grow.

Pesticides don't make cattle gain weight, but they keep the lice and flies and mites off of them so they can gain weight.

Yes, we work along with plant breeders, animal breeders, soil conservationalists, fertilizer people, farm machinery people, the land-grant colleges, the Departments of Agriculture, and numerous others in trying to help the farmer produce and market more efficiently and more abundantly.

To do our share we are spending more than 10% of our gross income on research and development. Yes, more than 10% of our gross income at the technical level goes back into producing new materials which are better, more effective and cheaper. This is more than any other

industry I know with the single exception of the pharmaceutical industry.

The reason that we spend this kind of money and take this big gamble is the potential profit that we see. Were it for not for this potential profit you can rest assured that we would not be interested in spending the four to seven years' time required or the one to three million dollars in money required to produce each new chemical.

In order to be competitive with other areas of the country and with other areas of the world, the growers here in this Valley are going to have to continue to have newer and better and safer and cheaper pesticide chemicals. If you get them it will be because we are continually encouraged to produce them, because frankly, if we don't produce them, nobody is going to.

The thing that will discourage us more than anything else is unnecessary or unduly restrictive laws, rules, regulations and requirements. This you must consistently help us to guard against.

We are a very highly regulated industry at both the federal and state levels. We are regulated by the United States Department of Agriculture and by the State Departments of Agriculture. We are regulated by the federal Food and Drug officials and by the state Food and Drug officials. This is right and proper. We feel that a good strong regulatory program, wisely administered, is of great good to the public, to you, and to our industry. We want to see this at the federal level and in every state.

There are many people, however, who feel that a great many additional requirements need to be put on the industry, many of which are completely unnecessary yet at the same time would be costly both in money and in additional time required to bring out a new product.

Pesticide chemicals have been and will probably continue to be a prime subject for controversial discussions because of their very nature. Being chemicals, therefore intimately connected with science in the public minds, these products represent one of the tangible things of which the public can become afraid. The public lacks the knowledge needed to understand them and consequently they are easily influenced by sensational stories and articles. This has been well illustrated more recently when the wildlife people could not generate enough "scare" on their own so they brought in many alleged human health hazards. The results speak for themselves. Seldom has this nation been rendered such a disservice.

The opinion of the public is a force to respect, for when it is marshaled for a purpose it can restrict or encourage business growth. It can elect or topple a government and it can change laws and regulations for better or for worse.

Thus in any major controversy involving the general public, an official investigation is invariably scheduled and an official report prepared and publicized. The recommendations of the investigating body are acted upon as promptly as feasible, and the complete report, with supporting data and action taken, filed for further reference and guidance the next time a controversy develops on a similar or related subject.

Over the years pesticides have been officially investigated by the U. S. Public Health Service, by the Federal Food and Drug Administration, by the National Academy of Sciences, by the U. S. Department of Agriculture, by both the House and the Senate of the U. S. Congress, and by special committees appointed by the Governors of a number of states including Connecticut, Wisconsin, North Dakota, and California.

In all of these investigations and studies, pesticides have not been found wanting. In general terms, the conclusions have been that pesticides are essential to maintain and improve our food supplies and our public health, and that they must be, and are thoroughly pre-tested before use and carefully and wisely handled and applied.

Following these investigations, President Kennedy's Science Advisory Committee last year made a study and released a report in May on the use of pesticides. It is said that this study was triggered by Miss Carson's book *Silent Spring*. Following issuance of the President's Report and as a direct result of it, Senator Ribicoff is chairmanning a Subcommittee which has been investigating pesticides since last May, and the end does not seem to be in sight.

A whole string of witnesses, thirty-two so far, including Dr. Jerome Wiesner, the then Science Advisor to the President, three cabinet officers, Miss Carson, several representatives of the industry, and numerous scientists of international reputation have appeared before Senator Ribicoff's Committee at his request to discuss the various aspects of the use of pesticides as well as their impression of the proper role of government in the production, distribution and use of pesticides.

At the beginning of these hearings, the emphasis appeared to be on the effects of the use of pesticides on wildlife. The emphasis quickly changed, however, to the effects of pesticides on the public health, especially in terms of the ingestion of pesticides as residues either in or on food as well as the effect of the use of pesticides in our environment.

At the present time most of the recommendations of the President's Science Advisory Committee are being carried out, many of them by administrative action of the various agencies of the federal government and others by federal legislation.

The four recommendations of the President's report dealing with legislation have been or are being carried out by actions initiated by Senator Ribicoff.

The first two of these recommendations were that legislation be enacted to eliminate the registration of pesticides "under protest" and to require that every pesticide formulation carry its federal registration number on the label. These two are encompassed in Senate Bill 1605

which has passed the Senate and been approved by the Subcommittee of the House Agriculture Committee. It is expected to be approved by the full House Agriculture Committee and the House of Representatives in early February.

The third recommendation was that the intent of the Federal Insecticide, Fungicide, and Rodenticide Act be clarified to specifically protect fish and wildlife by including them as useful vertebrates and invertebrates. Senator Ribicoff requested that Secretary Freeman and Secretary Udall get together and work this out administratively, which they did to the satisfaction of both departments.

The fourth recommendation was that funds be provided the U. S. Department of Agriculture to evaluate the efficiency of each of the Federal-State eradication and control programs for both efficiency of the program and the effect of the program on non-target organisms in the environment that is, if a fire ant eradication program was carried on in an area, a study be made to see what happened to other things in the area other than the fire ant as a result of this program. Senator Ribicoff, a member of the Senate Finance Committee, sponsored the inclusion of $125,000 in the Department of Agriculture's budget for this year for this specific purpose.

You people in this Valley are and must continue to be extremely interested in what happens to pesticides because your livelihood really depends upon their proper use. You must live with pesticides as must the people of Texas as a whole.

As an indication of the important position held by Texas in the use-pattern of pesticide chemicals, a look at the figures may be of considerable interest to you. Based on the latest available statistics, 12% of all of the acres in the U. S. sprayed or dusted with pesticides for insect, plant disease and weed control, are in Texas. Using this statistic as a guideline and applying it to the recently announced estimate of the 1963 market for pesticides, the quantity and basic value of pesticides used in Texas in the year 1963 is almost seventy-eight million pounds worth over forty-five million dollars at the level of the basic manufacturer of the goods. Of these totals, some fifty per cent is roughly estimated to be insecticides, fifteen per cent fungicides, fifteen per cent herbicides, and the balance defoliants, desiccants, rodenticides and like materials.

I don't know that is going to happen during the coming months. I assure you, however, that we in the industry will do what we can and what we feel to be right in trying to protect our ability to furnish you the materials that you want and need. We solicit your understanding and your help.

Resistance in Sweet Corn Hybrids to the Corn Earworm in the Lower Rio Grande Valley[1]

MICHAEL F. SCHUSTER[2]

The corn earworm, *Heliothis zea* (Boddie), is the most important insect pest of sweet corn in the Lower Rio Grande Valley. Sweet corn varieties have been tested for resistance to the corn earworm at Weslaco since 1958. In 1958 and 1962, the better hybrids were tested for horticultural characteristics as well as earworm resistance. This paper reports the results obtained in those two years.

METHODS: – The experimental varieties of sweet corn were planted on March 15 in four randomized complete blocks. Fertility was maintained by a preplanting application of 60 pounds nitrogen per acre and a sidedress application of 40 pounds nitrogen five weeks later. Irrigation water was applied after the corn was sidedressed and again when corn began tasseling. The ears were harvested in one picking during the last week of May.

The ears were evaluated for appearance (husked and unhusked) and quality (flavor and tenderness). Weight of husked ears in 1958 and unhusked ears in 1962 and number of marketable ears per acre were recorded at harvest. Quality and appearance were scored by comparing with the check variety Aristogold Bantam Evergreen. Characters were given the score: 1 – inferior to check, 2 – slightly inferior to check, 3 – equal to check, 4 – slightly better than check, and 5 – superior to check. In 1962, this system of rating was used to evaluate seedling vigor.

Earworm damage was estimated by an injury index similar to that of Walters (1948). The injury index consisted of the number of ears in each injury category multiplied by the category number. The products were added and divided by the total number of ears. Injury categories used in 1958 were: O – no injury; 1 – injury to tip only; 2 – injury to kernels to 2/5 inch below the tip; 3 – injury to 1 inch below the tip; 4 – injury to 2 inches below the tip; 5 – injury exceeding 2 inches below the tip. Injury categories in 1962 were: 0 – no injury; 1 – tip only; 2 – injury to kernels to ½ inch below the tip of the ear; 3 – injury to 1¼ inch below the tip; 4 – injury to 2½ inches below the tip; 5 – injury exceeding 2½ inches below the tip.

Seed of most hybrids were obtained through the Southern Sweet Corn Trials Chairman. However, seed were obtained locally for stand-

[1] Technical contribution No. 4717, Texas A & M University.
[2] Entomologist, Texas Agricultural Experiment Station, Weslaco.

Table 1. Summary of plant characteristics of sweetcorn grown at Weslaco, 1958.

Variety	Worm Damage1/4/	Yield-doz. ears/acre/4	Appearance unhusked	Appearance husked2/4/	Weight lb./ear4/	Quality2/4/	Days to Harvest	Seed Source3/
Long Chief	4.05 a	768.5 c	1.5 d	1.0 d	.640 a	4.0	70	1
Goldenyield	3.69 ab	1151.0 ab	2.0 cd	3.0 cd	.525 bc	3.75	72	4
Golden Security	3.57 abc	1387.3 a	2.0 cd	2.25 bc	.387 f	3.25	70	1
Florigold	3.56 abcd	1228.0 ab	2.0 cd	2.5 abc	.481 bcd	3.0	68	3
25776	3.26 bcd	1300.8 ab	2.75 ab	2.75 abc	.489 bc	3.25	70	3
VC 3952	3.22 bcd	1181.0 ab	2.25 bc	2.25 bc	.374 f	3.0	70	1
25778	3.19 bcd	1312.3 ab	2.75 ab	3.25 a	.418 def	3.75	72	3
Arist. Ban.E'green	3.02 cd	1059.0 b	3.0 a	3.0 ab	.458 cd	3.0	73	8
Golden hybrid #5	2.99 d	1040.3 b	2.75 ab	2.0 c	.450 cde	3.5	69	1

1/ See text for worm damage rating.
2/ See text for rating score.
3/ See text for seed source.
4/ Means bounded by the same letter do not differ significantly at the 5% level according to Duncan's multiple range test.

Table 2. Summary of plant characteristics of sweetcorn grown at Weslaco, 1962.

Variety	*Worm Damage*[1/4/]	*Yield-doz. ears/acre*[4/]	*Appearance unhusked*	*Appearance husked*[2/4/]	*Weight lb./ear*[4/]	*Quality*[2/4/]	*Seedling Vigor*[2/4/]	*Days to Harvest*	*Seed Source*
Merit	3.72 a	1139.8 abc	3.5 ab	3.0 ab	.706 ab	3.0 ab	2.38 abc	74	1
Arist.Ban.E'green	3.48 ab	1389.8 a	3.0 bcd	3.0 ab	.640 ab	3.0 ab	3.00 ab	72	8
NK1304	3.46 ab	875.8 bc	3.25 bc	2.25 cde	.536 b	2.25 abc	3.38 a	72	5
XP 195	3.38 b	861.8 bc	2.5 dc	1.75 e	.621 ab	1.63 c	2.63 abc	76	1
Seneca LV7	3.30 bc	1125.8 abc	2.75 cde	2.0 de	.638 ab	2.13 bc	2.63 abc	74	6
Cr. 955-1	3.25 bc	1125.8 abc	3.0 bcd	2.25 cde	.727 ab	3.25 a	2.38 bc	77	2
Florigold 107	3.23 bc	1195.5 ab	3.0 bcd	2.5 bcd	.572 ab	2.25 abc	2.50 bc	72	3
R 8	3.15 bc	10.28.8 abc	3.13 bcd	2.38 cd	.768 a	2.00 bc	2.38 bc	72	7
Staygold	3.14 bc	861.5 bc	2.25 e	2.13 cde	.641 ab	1.75 c	2.00 c	76	8
Calumet	2.93 cd	1042.8 abc	3.13 bcd	2.63 bc	.735 ab	2.63 abc	2.63 abc	72	1
Texsweet	2.60 d	792.3 c	4.00 a	3.0 ab	.728 ab	3.00 ab	3.00 ab	81	9

1/ See text for worm damage rating.
2/ See text for rating score.
3/ See text for seed source.
4/ Means bounded by the same letter do not differ significantly at the 5% level according to Duncan's multiple range test.

ard varieties and for varieties normally grown in this area. Seed were supplied by the following firms:

1. Associated Seed Growers, Inc. — New Haven 2, Connecticut
2. Crookham Company — Caldwell, Idaho
3. Ferry-Morse Seed Company — Detroit 3, Michigan
4. Michael-Leonard Company — Ames, Iowa
5. Northrup, King and Company — Minneapolis 13, Minnesota
6. Robson Seed Farms — Hall, New York
7. Rogers Brothers Seed Company, Inc. — Caldwell, Idaho
8. Sweet Corn Research — Ames, Iowa
9. Bockholt, A. J. — Texas A&M, College Station, Texas

RESULTS: —None of the hybrids tested in 1958 (Table 1) had significantly less earworm damage than the standard, Aristogold Bantam Evergreen. In fact, only one variety, Golden Hybrid 5 had a lower injury index. However, in 1962 (Table 2) the standard was one of the most damaged varieties although only Calumet and Texsweet 2 had significantly less earworm damage. This indicated that some progress is being made in incorporating earworm resistance into acceptable trade varieties.

Long Chief yielded significantly less dozens of ears per acre than any other variety in 1958. There was no yield difference found for the other varieties. In 1962, the highest yielding varieties were Aristogold Bantam Evergreen, Seneca LV7, Cr 955-1, Florigold 107, R8 and Calumet. Yields of Texsweet 2 were probably reduced as a result of its late maturity. The second irrigation was too early for maximum benefit.

No variety was found with ear appearance superior to Aristogold Bantam Evergreen in 1958. In 1962, Texsweet 2 appearance rating of unhusked ears was superior to Aristogold Bantam Evergreen while husked appearance was equal. No other variety had appearance superior to the standard.

Long Chief was the only variety which had significantly greater ear weight than Aristogold Bantam Evergreen, but were considered too large for the fresh market. The rest of the varieties were of acceptable size.

None of the varieties had better quality than Aristogold Bantam Evergreen in either year. Staygold and XP195 were found to have the poorest quality of the varieties tested in 1962.

Seedling vigor during 1962 did not differ greatly and none had greater vigor than the standard. Staygold had poorer vigor than the standard.

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Occurrence of an Unknown Virus Infecting Spinach in South Texas

D. M. McLean[1]

Two virus diseases of spinach (*Spinacia oleracea* L.) have been reported in spinach growing areas of Texas. Beet curly top occurred on spinach in the Winter Garden area and the casual virus was transmitted by beet leafhoppers, *Circulifer tennellus* (Baker) (Jones, 1936; Richardson and Raabe, 1956). Aster yellows also occurred on spinach in South Texas (Ivanhoff and Ewart, 1944). Tobacco ringspot virus has not been reported previously in South Texas, but it occurs naturally and frequently on spinach, sometimes alone and sometimes associated with other viruses.

This paper describes symptoms on spinach of another naturally-occurring virus disease, in the Lower Rio Grande Valley. Symptoms and preliminary studies of physical properties of the casual virus indicate it is the same, or closely related to, the virus causing spinach yellow dwarf, although its appearance cannot be accounted for in South Texas.

Spinach yellow dwarf was reported by Severin and Little (1947) from California where it occurred in experimental plots near San Pablo. Since symptoms on spinach may be confused with other virus disease symptoms, the disease may have been present in South Texas for a long time but was not recognized.

Symptoms similar to those induced by the yellow dwarf virus in spinach have occurred near Weslaco during several recent seasons in widely separated spinach plantings. The disease usually occurs in February and March, possibly coincidental with the buildup of migratory aphid-vector populations.

SYMPTOMS AND ETIOLOGY

The most conspicuous symptoms of the apparent yellow dwarf disease on aphid-inoculated spinach, after approximately 4 weeks, were yellowing of older leaves which developed a brown necrosis and eventually died. Young leaves usually were small, distorted, leathery to rugose, eventually becoming yellowed and died. Advanced symptoms might be confused with those of curly top virus infections.

Initial symptoms, 12 to 14 days after mechanical inoculation, were systemic vein-clearing in young leaves followed by yellow blotches in the outer or oldest leaves, often pronounced only on one side, causing curva-

[1] Plant Pathologist, Crops Research Division, Agricultural Research Service, United States Department of Agriculture, in cooperation with the Texas Agricultural Experiment Station, Weslaco.

Figure 1. *Upper*—Leaf from naturally-infected spinach showing vein-clearing and yellow blotches. Note curvature of mid-rib. *Lower*—Naturally-infected spinach plant showing distortion and chlorosis.

ture of the mid-veins (Figure 1). Chlorosis was not pronounced at first but yellow blotches coalesced into a general chlorosis and affected plants finally succumbed. Crown leaves were stunded, with shortened petioles, and often curved (Figure 1).

So far as known, the virus infects only spinach. Severin and Little (1947) listed 26 species in 13 families which failed to manifest symptoms after mechanical inoculations. Each of 10 spinach varieties tested by Severin and Little (1947) were susceptible.

In studies at Weslaco, all spinach varieties and hybrids, including those listed as resistant to "blight" (cucumber mosaic virus 1), were susceptible to spinach yellow dwarf virus after mechanical inoculations.

At Weslaco, the following plants failed to express symptoms in the greenhouse after mechanical inoculations: corn, cowpea, cucumber, zinnia, petunia, *Solanum incanum* L., *S. elaeagnifolium* Cav., *Chenopodium amaranticolor* Coste and Reyn., tomato, lambsquarter, sugar beet, *Gomphrena globosa* L., *Nicotiana repanda* Willd., *N. tabacum* L., *Amaranthus retroflexus* L., and sunflower.

According to Severin and Little (1947), physical properties of the virus had these characteristics: thermal inactivation 55°C in 10-minute exposure inactivation *in vitro* after 8 days exposure to air at room temperature; dilution tolerance of virus juice extract 1:20,000.

The green peach aphid, *Myzus persicae* (Sulz.), was demonstrated by Severin and Little (1947) to be a vector of the virus. Greenhouse tests at Weslaco using 5 viruliferous green peach apterae per plant successfully transmitted the virus from spinach to spinach.

Tobacco ringspot virus did not protect against a challenge mechnicaly inoculation of the unknown virus in spinach.

A search for weed hosts as reservoirs of the virus has been unsuccessful.

SUMMARY

Symptoms of an unknown virus infecting spinach in South Texas is described. Symptoms and preliminary studies of physical properties of the causal virus indicate it is the same, or closely related to, the virus causing spinach yellow dwarf. So far as known, the virus infects only spinach. The virus failed to infect 16 plant species commonly used as test plants in certain other spinach viruses after mechanical inoculations. The green peach aphid is a vector.

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The Influence of Irrigation and Spacing Treatments on the Production of Rio Grande Valley Tomatoes[1]

C. J. Gerard and W. R. Cowley[2]

The area in tomato production in the Lower Rio Grande Valley has varied from year to year depending upon a number of factors such as anticipated supply and demand for Valley tomatoes, irrigation water supply and increasing production costs. However, the release of improved tomato varieties by Leeper (1957, 1958, 1961) has provided needed stimulus to the tomato industry. In 1963, about 15,000 acres of tomatoes were planted in the Valley. Annually, the tomato crop contributes about 3 to 4 million dollars to the Valley economy.

The importance of determining the most efficient use of a limited water supply for tomato production was responsible for the initiation of irrigation management studies on this crop in 1958. Studies were conducted on green-wrap tomato varieties, Rio Grande and Homestead, from 1958-60, and on a processing variety, Chico, in 1962-63.

The objectives of these studies varied from year to year but generally were: (1) to evaluate the influence of irrigation and spacing treatments on yield and quality, (2) to determine the water requirement for optimum and economical production, and (3) to determine the influence of irrigation and plant spacing treatments on plant growth characteristics.

LOCATIONS AND SOILS

Irrigation studies in 1958 were conducted on Laredo clay loam soil 2 miles southeast of Progreso, Texas, near the Rio Grande River. Since 1958, irrigation experiments were conducted on Willacy loam soil on Substation 15 at Weslaco, Texas.

Many soils near the Rio Grande River including the site near Progreso are extremely variable. The soil is classified as Laredo clay loam but certain areas in the experimental site probably could be classified as Cameron clay loam. The clay loam surface which varies in depth from 2 to 5 feet is underlain by sand usually at depths of 2 to 3 feet but varies from 1 foot to 5 feet at this location. The Laredo soil has slow surface but excellent internal drainage and potentially hold a moderate to good reserve of soil moisture. The Cameron soils, in contrast to those of the Laredo, have poor surface and internal drainage.

[1] Presented before the Rio Grande Valley Horticultural Society January 21, 1964, at Weslaco, Texas.

[2] Respectively, Associate Soil Physicist and Superintendent, Lower Rio Grande Valley Research and Extension Center, Texas A & M University, Weslaco.

The Willacy loam is a deep, medium-textured, moderately permeable soil. Moderate to good drainage and a deep clay loam subsoil enables this soil to hold a good reserve of soil moisture.

Research studies with other annuals makes it possible to formulate irrigation management practice for tomatoes on the Harlingen clay soil. This soil has high water holding capacity, poor surface and internal drainage, high swelling, and is subject to severe cracking.

METHODS AND PROCEDURES

The irrigation experiments in 1958-59 consisted of 3 moisture level treatments replicated 4 times. Irrigation treatments described in Table 1 were based on the available moisture content of the top 2 or 3 feet. Homestead and Rio Grande (green-wrap varieties) were planted on 76 inch beds in January of 1958 and 1959, respectively. Tomatoes were thinned to 12 inch spacings in March.

Descriptions of irrigation treatments in 1960, 1962 and 1963 are indicated in Table 2. Plots were 38 feet wide and 50 feet long. Moisture treatments which were initiated at bloom stage were based on the available moisture remaining in the top 2 feet of soil. The experimental design was a randomized block consisting of 4 replications.

Chico, a processing tomato, was planted in January, 1962 and 1963. In 1962 and 1963, the main plots (irrigation treatments) were split to include spacing treatments which are described in Table 2. Spacing treatments were established in March. In 1962, plants were spaced 12 inches apart on single rows on 38 inch beds and on double rows on 76-inch beds. Plants on companion rows on the 76-inch bed were staggered. The companion rows were 12 inches apart. In 1963, plants were spaced 2, 6 and 12 inches apart on 38 inch beds as indicated in Table 2.

Rio Grande Variety tomatoes which were planted on 76 inch beds were lost due to frost in 1960. Transplants (Homestead) were obtained in March, planted 12 inches apart and irrigated.

The time to irrigate the different irrigation treatments, 1958-63, was determined by evaluating the soil moisture by one foot increments to a

Table 1. Description of irrigation treatments on Laredo clay loam, 1958, and Willacy loam, 1959.

Irrigation treatment	*Available moisture in top 2 or 3 feet at time of irrigation*	*Percentage of soil moisture at maximum allowable stress*	
		1958	*1959*
Wet	60%	20.3	15.5
Medium	40%	17.6	14.0
Dry	20%	15.5	12.6

depth of 5 feet. Soil moisture was determined periodically by sampling the soil to a depth of 5 feet from 1958-60 and was determined periodically to a depth of 5 feet with a neutron probe[3] in 1962 and 1963. The various plots were irrigated when the average soil moisture of the top 2 or 3 feet was reduced to the percentages indicated in Tables 1 and 2. Sufficient water was applied to each irrigation treatment to increase the soil moisture content to field capacity to a depth of 5 feet. Water was applied by level furrow irrigation and was measured onto each plot with a 6 inch Sparling flow meter. Seven inch portable aluminum gated pipes were used to convey water to individual plots.

After maturation of fruits, green-wrap tomatoes (1958-60) were harvested weekly, graded into different sizes and graded as to quality. The processing tomatoes were picked 3 times in 1962 and twice in 1963.

Tomatoes were seeded, fertilized and cultivated with tractor-operated equipment. Generally, the plot area was uniformly fertilized with 40 to 80 pounds of nitrogen per acre. Insects were controlled by application of recommended insecticides.

Table 2. Description of irrigation and spacing treatments on Willacy loam, 1960, 1962 and 1963.

Irrigation treatment	*Available moisture remaining in top 2 feet at time of irrigation*[1/]	*Percentage of soil moisture at maximum allowable stress* 1960	1962	1963
Wet	60%	15.5	16.3	16.3
Medium	40%	14.0	14.2	14.2
Dry	20%	12.4	12.1	12.1
Very dry	0	10.8	10.0	10.0
Not irrigated	----	----	----	----

Spacing treatment No. (Subplots)	*1962* *Description*
1	Single row on top of 38 inch beds. Tomatoes were spaced 12 inches apart.
2	Double row (12 inches apart) on top of 76 inch beds. Plants were 12 inches apart. Plants on companion rows were staggered.[2/]
	1963
1	Plants were spaced 2 inches apart on 38 inch beds.
2	Plants were spaced 6 inches apart on 38 inch beds.
3	Plants were spaced 12 inches apart on 38 inch beds.

1/ Irrigation treatments were initiated after appearance of first bloom.
2/ Staggered means plants on one row on top of 76 inch bed were spaced between plants on the other row.

[3] Instrument manufactured by Nuclear Chicago Corp., Des Plaines, Illinois.

RESULTS AND DISCUSSION

Results of experiments conducted in 1958 and 1959 on Laredo clay loam and Willacy loam, respectively, are indicated in Table 3.

In 1958, the wet and medium moisture treatments caused a slight increase in yield of marketable tomatoes (green wrap). In 1959, the wet and medium moisture treatments caused a slight decrease in yield of marketable tomatoes (green wrap). Marketable tomatoes in the different sizes followed the same trend as total yields in 1958 and 1959.

Yields of green wrap tomatoes in 1960 were low, possibly due to climatic factors and a late crop. Rains in 1960 prevented the evaluations of described treatments. The tomato plots in 1960 and 1962 were irrigated after planting but not in 1963. Irrigation treatments did not have a significant influence on yields of Chico tomatoes in 1962 as indicated in Table 4. Even though rainfall was low in 1962, it was well distributed in March, April, May and June. The supply of soil moisture at planting was also at a maximum because the tomatoes were irrigated at planting time.

In 1963, the wet and medium moisture treatments increased yields of Chico tomatoes as indicated in Table 4. The available soil moisture at planting time was low in 1963. As indicated in Table 4, rainfall in 1963 was higher than rainfall in 1962, but the rainfall was unevenly distributed in 1963. The first significant rain (0.40 inch) did not occur until May 2. This was followed by 2.0 and 2.4 inches on May 5 and 6, respectively. These rains were probably responsible for yields of about 11 tons on the non-irrigated plots. The yields of tomatoes on the dry and very dry treat-

Table 3. Yield, moisture use and irrigation data of moisture level treatments on Laredo clay loam, 1958, and Willacy loam, 1959.

Irrigation treatments	*Yield (Marketable) Ton/Ac.*	*No. of irrigations*[1/] *during growing season*	*Water applied inches*	*Rainfall inches*	*Soil moisture depletion inches*[4/]	*Total water used inches*
			1958 [2/]			
Wet	6.1	5	15.1	5.4	0.9	21.4
Medium	5.7	3	13.0	5.4	0.9	19.3
Dry	5.3	2	9.3	5.4	0.9	15.6
			1959 [3/]			
Wet	5.1	4	11.7	5.7	4.8	22.2
Medium	6.1	2	8.9	5.7	5.2	19.8
Dry	7.4	1	6.0	5.7	4.8	16.5

1/ All plots were irrigated at planting time in 1958 but not in 1959. Plants were spaced 12 inches apart.
2/ Homestead No. 24 (variety).
3/ Rio Grande W-219 (variety).
4/ In 1958, soil moisture on February 19 minus soil moisture on July 1, in 1959, soil moisture on February 17 minus soil moisture on June 15.

ments were not significantly different from the yields on the non-irrigated treatments. The reason for this response is not known, but it is possible that the plants potentials to produce higher yields were reduced when the plants were exposed to high soil moisture tension for extended period of time prior to irrigation. Many plants showed symptoms of severe moisture stress in 1963. The dry treatment was irrigated on April 9; the very dry treatment was irrigated on April 24.

In 1962, the yields of tomatoes planted on single rows on 38 inch beds were about 12 tons per acre higher than the yields of tomatoes planted on double rows on 76 inch beds. Tomatoes spaced 6 and 12 inches apart produced significantly higher yields than tomatoes 2 inches apart in 1963. However, tomatoes spaced 12 inches apart did not yield any

Table 4. Yield, moisture use and irrigation data of irrigation and spacing treatments on Willacy loam, 1960, 1962 and 1963.

Irrigation treatment	*Yield (Marketable) Ton/Ac.*	*No. of irri-gations*	*Water applied inches*	*Rainfall inches*	*Soil moisture depletion inches*	*Total water used inches*
			1960[1]			
Wet	3.0	1	2.5	7.4	6.6[3]	16.5
Medium	3.3	1	2.5	7.4	6.8	16.7
Dry	2.9	1	4.0	7.4	5.1	16.5
Very dry	3.7	0	none	7.4	7.9	15.3
Not irrigated	3.6	0	none	7.4	6.8	14.2
	Spacing treatments		*1962*[2]			
	1 2					
Wet	32.0 21.7	5	16.9	3.4	4.9[3]	25.2
Medium	30.6 19.1	3	10.7	3.4	4.4	18.5
Dry	34.1 21.7	2	11.5	3.4	5.3	20.2
Very dry	31.9 20.7	1	7.0	3.4	5.1	15.5
Not irrigated	37.8 22.0	0	0	3.4	5.7	9.1
	Spacing treatments		*1963*[2]			
	1 2 3					
Wet	15.9 20.3 20.3	6	14.7	6.6	2.4[3]	23.7
Medium	11.7 14.2 13.4	3	10.1	6.6	3.3	20.0
Dry	7.7 9.6 12.0	1	3.6	6.6	3.8	14.0
Very dry	8.1 9.5 8.8	1	5.4	6.6	4.8	16.8
Not irrigated	9.9 10.9 12.6	0	0	6.6	3.4	10.0

1/ Homestead No. 24 were irrigated when transplanted on 3/10/60 because January planted Rio Grande W-219 were killed by frost. Plants were spaced 12 inches apart.

2/ Chico tomatoes were irrigated at planting time in 1962 but not in 1963.

3/ In 1960, soil moisture on March 16 minus soil moisture in June 22; in 1962 soil moisture on March 6 minus soil moisture on June 21; in 1963 soil moisture on March 4 minus soil moisture on June 25.

higher than tomatoes spaced 6 inches apart. Yield data in 1962 and 1963 indicate that close-spacing of tomatoes, even under a high level of moisture, reduced fruit size and caused substantial reductions in yields. The reduction in yield due to close-spacing of tomatoes are not explainable at this time.

Moisture level treatments influenced blossom-end rot in Chico tomatoes in 1963. Tomatoes which were subjected to severe moisture stress for extended periods of time had higher incidence of blossom-end rot. Wilson (1963), Schroeder (1949) and others have attributed blossom-end rot to moisture stress. However, moisture stress conditions probably cause reduction in available soil calcium. Geraldson (1957), Maynard, et al. (1957) and Evans and Troxler (1953) proved that calcium deficiency caused blossom-end rot in tomatoes. Geraldson (1957) mentions the evaluations of the influence of soil moisture levels on blossom-end rot; however, no evidence of the results are presented in his paper. It is possible that moisture stress may be a direct and/or an indirect influence on blossom-end rot.

Moisture use increased sharply during April and May when available soil moisture was high as indicated in Table 5. Potential evapotranspiration is higher during these months because of increased solar radiation, increased numbers of transpiring surfaces, and blooming and fruiting of the tomato plants. Moisture use in March was higher in 1962 than in 1963 probably because the plots received a pre-planting irrigation in 1962. Maturation of fruits and plants, and lack of available moisture caused decreases in soil moisture use in June.

Root distribution for tomatoes and cotton on Laredo and Willacy soils is indicated in Table 6. The root distribution and moisture use data

Table 5. Typical soil moisture use in inches per day by tomatoes as influenced by irrigation treatments on Willacy loam, 1962 and 1963.

Irrigation treatment	*No. of irrigations after blooming*	*Ave. use of water - inches/day*			
		March	*April*	*May*	*June*
		1962			
Wet	5	0.08	0.26	0.33	0.16
Medium	3	0.08	0.23	0.17	0.13
Dry	2	0.08	0.15	0.31	0.13
Very dry	1	0.07	0.10	0.17	0.12
Not irrigated	0	0.05	0.08	0.16	0.08
		1963			
Wet	6	0.03	0.37	0.36	0.14
Medium	3	0.03	0.28	0.25	0.13
Dry	1	0.03	0.17	0.20	0.10
Very dry	1	0.03	0.15	0.26	0.13
Not irrigated	0	0.03	0.05	0.12	0.13

for tomatoes and cotton indicate maximum use of soil moisture on these soils is from the top 2 feet, but the plants are able to extract significant amounts of soil moisture from the 3rd and 4th feet.

Yields, root distribution and moisture use data on Willacy and Laredo soils indicate that often 12 to 20 tons per acre of Chico tomatoes[4] can be produced with about 10 to 12 inches of water when the water is properly distributed during the growing season. In four out of five years of research studies, irrigations failed to cause substantial increases in tomato yields. Maximum response from irrigation can be expected when (1) the available moisture of top 2 feet and especially the top foot of soil is low at planting time and (2) when rainfall is not adequate to supply available moisture at or just after the appearance of first blooms. Under these conditions on the Willacy and Laredo type soils, there is a critical need to irrigate at planting time and during the blooming and fruiting of the tomato plants.

Irrigation research with cotton on Harlingen clay indicates: (1) that maximum demand for water by plants occurs during the blooming and fruiting period and (2) that root distribution of annuals as indicated in Table 6 is restricted to the top foot of soil (Gerard and Namken, 1961). The maximum demand period for water by plants[5] is not markedly influenced by soil type. However, a comparison of root distribution data in Table 6 quickly suggests that irrigation management on Harlingen clay must be different than on the Willacy and Laredo soils. Irrigation of Harlingen clay is often necessary in the spring prior to or at planting time because rainfall during the fall and winter is insufficient to supply adequate moisture to insure good germination and stands. Irrigation studies with cotton on this soil indicate that during the growing season an irrigation is needed about every 15 days after the appearance of first blooms. This type of irrigation schedule should meet the water requirement for shallow rooted tomato plants during the high moisture demand period (blooming and fruiting). Four to 5 irrigations (12-15 inches of water) would probably insure satisfactory yields provided other factors do not limit production.[6]

Table 6. Root distribution of tomatoes and cotton as influenced by soil type.[1]

		Soil depth - feet				
		0-1	*1-2*	*2-3*	*3-4*	*4-5*
Soil	*Crop*		*Percent*	*by weight*		
Laredo clay loam	tomatoes	91.2	4.5	2.4	1.3	0.6
Willacy loam	cotton	62.1	22.8	7.9	4.9	2.3
Harlingen clay	cotton	99.0	0.7	0.2	0.1	0.0

1/ Average of 4 replications and 3 to 5 moisture level treatments. Moisture caused small differences in root distribution.

4 Marketable yields of green wrap tomatoes would be about 5 to 7 tons per acre.
5 This was certainly true of cotton.

SUMMARY

On the moderately permeable soils (Laredo and Willacy) 10 to more than 20 tons of tomatoes were produced with about 10 to 12 inches of water. Irrigation treatments failed to increase yields in 4 out of 5 years. A preplanting irrigation and an irrigation at about bloom stage in dry years is needed to supply the 10 to 12 inches of water required to produce satisfactory yields.

The root distribution of tomatoes are restricted to the top foot on the Harlingen clay which is a soil of very low permeability. Tomatoes must be irrigated more frequently on the Harlingen than on the Willacy or Laredo soils. On this soil, tomatoes usually require an irrigation at planting time and 3 to 4 irrigations beginning at bloom stage (12-15 inches of water). Irrigations should be about 15 days apart during the blooming and fruiting period.

Closer-spacing of tomatoes caused substantial reduction in yields because close-spacing apparently modifies the fruiting ability of the tomato plants.

Maximum demand for water by tomatoes starts during the bloom stage and increases during the fruiting period. However, an adequate supply of soil moisture at planting time is most critical. An understanding of critical moisture demand periods and of the influence of soil type on irrigation management can mean increased yields and conservation and efficient use of water.

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6 Marketable yields of green wrap tomatoes would be about 5 to 7 tons per acre. Marketable yields of Chico tomatoes would be about 10 to 20 tons per acre.

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South Texas Marketing Orders . . . Before and After[1]

BILL CREMMINS[2]

A little boy once asked his daddy . . . "Why is a man only allowed *one* wife?" And his daddy replied . . . "Son, when you grow older you will understand that the law *protects* those who are unable to protect themselves." And I suppose that's why we have marketing orders, too!

Why are they in the Valley?

First, maybe we better look at our fruit and vegetable industry BEFORE marketing orders . . . and then AFTER Texas growers voted several into existence. "Before and after" comparisons with marketing orders are not as simple or dramatic as the dieting or razor blade advertisements we see on TV. Marketing orders and advertising do have much in common, though. When it comes to measuring effects, how much can we attribute to a program? This usually means different things to different people.

For many years "rugged individualism" pervaded the past South Texas vegetable deals. Maybe "dog-eat-dog" is more adequate . . . by local definition.

Let's begin with one of the "luxuries" of World War II . . . *built-in profits.* Growers and handlers could hardly miss. Almost any supply courted even greater demand. The incentive . . . ship anything. And many did. Profits attracted more acreage and more handlers. Texas had available and relatively inexpensive labor . . . a factor not equally enjoyed by competitive areas in the war years.

But the honeymoon ended. Elements of competition quickly reclaimed sacrificed ground in post-war years. The large military orders diminished. Fixed-prices were abandoned to seek their own level. Competitive items appeared. Competition reappeared. Buyers began to disappear. Sellers once again had to seek buyers . . . and there were *many* sellers.

If these were problems, more were to come. *Cotton allotments* and reduced cotton acreages. Vegetables took up much of the slack. *Falcon Dam.* More water, many more acres . . . more vegetables. *New varieties.* Higher yields. Labor continued relatively cheap . . . and plentiful. Plant the seed catalogue and hope enough deals hit to keep finances in the black . . . in local jargon they began to grow things "wild."

[1] Comments to the Rio Grande Valley Horticultural Society at Weslaco, Texas, February 27, 1964.

[2] Agricultural Marketing Service, McAllen, Texas.

From an *oversupply* of commodities AND sellers evolved an assortment of practices. And maybe, here and there, a short supply of ethics . . . inducements to make a sale. There were deceptive, cheaper, or overweight packs and containers . . . oversizing . . . delivery of poorer qualities than sellers and buyers agreed upon . . . chiseling on freight, brokerage, or the volume harvested or packed from a grower's field.

Of primary interest, make the sale . . . adjust the price later. Adjust back to the grower. And the seller's argument, "If I don't give him a quarter, I'll lose a good customer." And he also said, we can't afford to lose a "good" customer.

After a series of distressing years, growers began to react. Lower Valley tomato growers, among the hardest hit, sought and *obtained* a Federal marketing order in 1959. Growers requested it . . . growers approved it. Or, at least 9 out of 10 did!

Opposition was militant . . . to quote a few: "We don't want the Government in our business" . . . "to many regulations already" . . . "*Dictatorship.*" But a marketing order was voted in anyway. The Tomato Committee went to work and established sizing requirements to obtain uniform packs . . . an important point in a mature-green tomato deal since buyers are mostly repackers. They introduced minimum grades to prevent less desirable fruit from being marketed . . . to plug less distant markets and substitute for profitable fruit.

The result: the trade enthusiastically expressed pleasure with the uniform pack and grading. They could depend on making volume orders and *repeat* orders and get virtually the same qualities each time, almost regardless of handler source. More uniform ripening was obtained . . . very important in this business. And the mature-green is the Valley's business.

Culls in years past were sold to peddlers for whatever they would bring . . . generally only $15-20 a truck load . . . often less. With cull sales prohibited, markets formerly plugged *by* them opened up for No. 2 tomatoes. Some No. 2 markets opened up for No. 1's. The grower gets something back from this fruit . . . not from the culls.

Major markets like Houston, San Antonio, Dallas-Ft. Worth began to make volume purchases. Even smaller markets, unheard from in years, re-entered for carlot business. The 10 million or so population of Texas returned as a market . . . indeed, handlers were able to penetrate a 20 million population radius heretofore relegated, in whole or in part, to poorer qualities, or to tomatoes from competitive areas.

Receivers throughout the country and Canada began to look with confidence to Texas for their supplies. They no longer looked to Texas as merely a last resort . . . a place to go when Florida, California, *even Mexico,* could not supply the merchandise. Texas began to achieve a goal set by its growers . . . to command respect in the market place.

But did the marketing order raise or stabilize farm income? Maybe! This issue becomes confused . . . there *are* extenuating circumstances. Other factors have had a profound impact on tomato prices. The mature-green has lost ground to the rapidly expanding vine-ripe industry. And tests show consumers prefer a tomato picked at a greater degree of maturity than the mature-green. You and I do . . . at least I think you do. Acreage did not diminish at a rate commensurate with this change.

Florida continued to extend her season into a period Texas once enjoyed with relative freedom. Also, weather conditions for several seasons tended to aggravate the situation. Cold spells in Florida made her spring deal tardy, bunching shipments from the two areas beyond the ability of the trade to absorb. And often, cool weather in major markets during this deal has not aroused tomato appetites.

No, tomato prices as a whole have not always been good. But now that acreage has become more realistic, prices have improved.

What would prices have been without the program? Worse, say many in the trade. Handlers, by now endorsing the program with guarded enthusiasm, say that limiting shipments to preferred grades and sizes allowed more of the fruit to be marketed. Fruit that did return something to the grower.

When fruit can't be marketed, sheds close and many growers are unable to find a home for it. The marketing order is credited with reducing abandonment. Many handlers claim it has brought them their only profitable seasons in years.

Growers, waiting for profits to trickle through to them, had some doubts. Doubts now have tempered . . . better returns have begun to filter through.

Handlers joined ranks with growers to obtain marketing orders on citrus, carrots, onions, and lettuce. The citrus and lettuce programs, like tomatoes, are confined to the Valley. Carrot and onion proponents were more ambitious. They took in all of South Texas where these commodities are produced commercially.

Seasons of distress prices, plus the success of the tomato order, prompted support for carrot and onion programs. Both commodities needed some cleaning up.

The carrot industry had drifted into much "wild" acreage since it is a *relatively* inexpensive crop to produce. The acreage was often earmarked for cotton, promoting or necessitating many growers to sacrifice the crop in February or March just to get the land cleared.

Oversupply became a regular burden. Packs were often little more than "field run, topped, washed, and packed." Supplies typically exceeded demand during such periods.

To quote Bill Whetstone of Mutual Vegetable Sales, Salinas . . .

"Selling 75 cars is a lot more than 3 times the work of selling 25 cars."

Prices characteristically fell to levels that discouraged many handlers from putting extra expense in a more acceptable pack. Like tomatoes, overweight packages were used as an inducement to attract and hold buyers.

The Carrot Committee tackled its problem aggressively. Weight limits were placed on containers to guard against handlers giving away unreasonable amounts of carrots at the *grower's* expense. Packs were limited to better grades . . . and size ranges were defined for the various packs. These size ranges limited carrots to certain minimum and maximum diameters and minimum lengths. Offgrade or off-size carrots went to canners or for livestock feed.

The industry expressed delight in the improved quality and uniformity of pack of South Texas carrots. The Texas image of poor and unreliable packs changed immediately. Discounting of South Texas carrots diminished as buyer confidence was restored. Texas is now getting a bigger share of the market . . . and California IS losing ground.

This committee at times has handled its operations with remarkable success. There are two main reasons: 1) South Texas enjoys being the dog, rather than the tail, with most of the winter supply originating here . . . what they do *does* have an impact on the market; and 2) aggressive grower leadership has kept grower interests paramount. The group is determined to move carrots at a profit even if it means diverting large quantities of them to non-fresh uses.

Handlers have been obligated to carefully grade and size carrots, hence slowing down output. By manipulating grade and size requirements, the committee has made more carrots available in periods of short supply and less available when there is an oversupply.

They managed to sustain rather stable and profitable prices in their first two seasons of operation. Gross overproduction plagued growers last year but even so prices averaged materially above 1959-60, a year of comparable supplies, yet no marketing order. The South Texas carrot production in 1959-60, unregulated, was valued at less than $3 million for 5¼ million cwt. Regulated in 1960-61, the crop was valued at more than $7 million for only 3¼ million cwt. More than twice the income for about 3/5 as many carrots.

Results in 1961-62 were similar.

In 1959-60, the grower not only furnished the carrots in each pack, often, willingly or not, he threw in some change out of his pocket too!

The Onion Committee inherited about every problem known to the industry. The trade had lost confidence in the deal. No one had nerve to buy FOB, at least at a confirmed price. What price tomorrow? Packs lacked uniform grading and sizing. And there was the overweight container inducement again.

Some handlers, interested primarily in packing charges, were concerned with only volume, not maximum return to the grower. Early shipments, seeking the offtimes higher prices at a deal's beginning, too often were junk merchandise. Markets plugged with this merchandise left consumers, retailers, and wholesalers reluctant to purchase . . . good merchandise could not displace it until it was given, or *rotted*, away. How many good cars could have moved for each bad one?

First, the committee standardized containers, packs, and established minimum grades. Uniformity brought favorable trade reactions. Buyer confidence was restored in South Texas quality.

But other factors crippled what was otherwise expected to be a successful 1961 season . . . their first under the marketing order. No matter what efforts the committee made by manipulating grade and size, they were handicapped. Their actions generally brought favorable market response . . . but not enough and of too short duration. There were "growing pains."

A long storage crop was made even longer by an unprecedented cold spring in storage areas and increased use of sprout inhibitors. Many onions were shipped from Michigan, New York, and other northern growing areas that under ordinary circumstances would have deteriorated and been discarded. The cold was a two-bladed ax. It dulled demand . . . especially demand for sweet onions, the type South Texas grows. South Texas profits from "hamburger weather" in the markets.

But the onion program has potential. The South Texas onion industry has several things going for it that lend themselves to a successful marketing order. The area is relatively compact; it has a unique commodity; and it usually enjoys an extended shipping period unencumbered by competitive onions.

If INDUSTRY interests receive proper priority, it should work.

And it has during the past 2 years! With the delicate balance between supply and demand, would they have been profitable with culls running loose?

The lettuce program grew out of pressures from *without* as well as *within*. A volume pro-rate program on California winter lettuce led interests there to bring competitive areas under similar controls. Texas agreed . . . Arizona did not.

The pro-rate program sought to tailor shipments to fit demand and to stabilize the flow to market. Violently oscillating shipping patterns excite similar price patterns. Many receivers, especially the smaller ones, could not afford the risk of purchasing lettuce. Too often $2 at time of purchase was worth $1 on arrival. And how do you sell lettuce "short"?

The pro-rate activities are now dormant since Arizona would not go along with California and Texas. The Order in Texas is used to regulate grade, size, pack, and container.

One of its main successes has been elimination of the "gunny sacker" and his practice of plugging markets with poor qualities of lettuce. His source of supply was most often an abandoned field. For a few dollars it was his and he would pack anything he could out of it. Having little investment, he could sell cheap. He operated out of his hip pocket. His near extinction has returned the major Texas markets as a profitable outlet for growers.

The trade has responded to the improved Texas pack. Indeed, Texas now moves lettuce into Midwestern, Southern, even Eastern markets once given to the desert valleys by default. Texas need no longer grow lettuce with a market dependent upon the hope and necessity of calamity befalling its competitors.

One of the less heralded but maybe the most important asset of any marketing order is the assembly of growers, shippers, and allied industry men. Gone is the waste, frustration, and pity of isolated, opposing groups. Men with many common problems and objectives, and sometimes conflicting problems and objectives, get together, discuss, and try to solve their problems and obtain their objectives to their *mutual* advantage. The industry profits from working together and becoming better informed.