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OF THE

RIO GRANDE VALLEY HORTICULTURAL SOCIETY

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The *Journal*, the official publication of the Rio Grande Valley Horitucltural Society, is published in January in one volume and one issue annually.

Aims and Objectives of the Society

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

At periodic meetings subjects of interest are presented by specialists in their field. These presentations are followed by forums. The *Newsletter* announces and discusses these programs and brings other news of interest to Society members.

The Society sponsors an annual Institute featuring outstanding speakers from all parts of the world who present new developments in the field of horticulture. Panel discussions, social get-togethers, and a barbecue complete the all-day program.

The *Journal of the Rio Grande Valley Horticultural Society*, provides a continuing record of horticultural progress. Along with research reports, talks given at the Institute are published in the *Journal.*

Anyone interested in horticulture can become a member of the Society. The annual dues of $7.50 include a subscription to the *Journal.* Subscriptions by institutions and libraries are $10.00 a year. Applications for membership or subscriptions should be sent to the Secretary, Rio Grande Valley Horticultural Society, Box 107, Weslaco, Texas 78596.

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President

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Rio Grande Valley Horticultural Society

Past Presidents

1946 W. H. Friend
1947 A. L. Ryall
1948 W. H. Hughes
1949 D. J. McAlexander
1950 William C. Cooper
1951 D. E. Kornegay
1952 E. B. Dubuisson
1953 Norman P. Maxwell
1954 R. H. Cintron
1955 E. O. Olson
1955 George P. Wene
1956 Stanley B. Crockett
1957 George Schulz
1958 Harry Foehner
1959 J. B. Corns
1960 Orval Stites
1961 Howard Wright
1962 Stanley B. Crockett, Jr.
1963 Bruce Lime
1964 Bailey Sleeth
1965 C. E. Davidson
1966 Noel E. Ryall
1967 Clay Everhard, II
1968 Richard A. Hensz
1969 Tom Longbrake
1970 Glenn White
1971 Arthur Hentz
1972 John Fucik
1973 Gilbert Ellis
1974 Roy E. McDonald
1975 Roger Albach
1976 Ben Villalon
1977 Andy Scott, Jr.
1978 Fred Karle
1979 J. Victor French
1980 Marvin Miller
1981 Cliff Hobbs
1982 Robert Rouse

History of the Arthur T. Potts Award

When the Rio Grande Valley Horticultural Society decided to establish an award recognizing outstanding horticultural work in this area there was little doubt as to who would be the first recipient. Arthur T. Potts of Harlingen was chosen and his name has been given to the award.

Arthur T. Potts worked in the field of citriculture in Texas long before the establishment of a commercial citrus industry. Born in Weatherford, Texas, he graduated from Texas A and M College with a Bachelor of Science degree in horticulture and went to the Beeville Experiment Station as superintendent in the early years of this century. At the Beeville station during the period 1909 - 1912 he determined that satsumas and kumquats could be grown in South Texas. Citrus in that area was grown on trifoliata rootstock which is susceptible to citrus canker. Citrus canker and freezes finally eliminated most of the citrus trees along the Gulf Coast. The citrus industry then moved southward and by 1921 most of the citrus trees in the state were located in the Lower Rio Grande Valley.

Meanwhile Potts joined the Extension Service and traveled over the state locating experiment substations including the one at Weslaco. By 1924 Potts had received master's degrees in horticulture from the University of California and Texas A and M. At that time he moved to the Lower Rio Grande Valley to become a partner with Sam Baker in the Baker-Potts Nursery Co. He later bought out his partner's share in the business and has been closely identified with the development of the citrus industry in the Valley ever since. He also helped in the development of several large citrus tracts including those at Bayview, Progreso and Adams Gardens. Mr. Potts was instrumental in formation of the Texsun Citrus Exchange and served in many civic capacities.

PREVIOUS POTTS AWARD RECIPIENTS

1955 Arthur T. Potts
1956 Wilson Popenoe
1957 E. M. Goodwin
1958 J. B. Webb
1959 G. H. Godfrey
1960 W. C. Cooper
1961 Lon C. Hill
1962 W. H. "Bill" Friend
1963 Paul W. Leeper
1964 Stanley B. Crockett
1965 Harry Foehner
1966 Sam D. Taylor
1967 O. F. Marrs
1968 P. W. Rohrbough
1969 Arthur V. Shull
1970 Frank J. Schuster
1971 Guy W. Adriance
1972 George R. Schulz
1973 Bailey Sleeth
1974 Raphael H. Cintron
1975 J. B. Corns
1976 Henry E. Link
1977 R. T. "Mayo" Correa
1978 A. H. "Dutch" Karcher, Jr.
1979 Charlie Rankin
1980 Glenn G. White
1981 Walter H. Baxter, Jr.
1982 Raymond Cowley

W. Raymond Cowley

1982 Recipient of the Arthur T. Potts Award

From his arrival in the Valley in 1947 as an associate soil scientist with the Texas Agricultural Experiment Station, thru his years as Resident Director of Research and until his retirement in 1974 to become a management consultant for the Rio Grande Valley Sugar Growers, Inc., the imprint of W. Raymond Cowley could be seen on most major Valley crops.

He is best known for establishment of a viable sugar industry in the area. The multi-million dollar sugar mill at Santa Rosa bears his name in tribute to that fact. Cowley did the initial work on sweet sorghum and sugarcane which led to the development of this new industry. In 1978, along with Ashby Smith, he was honored by the USDA for his pioneering sweet sorghum research.

His mark is on the Valley's cotton industry, also. In 1948 the station started a variety testing program and was able to identify the cotton varieties which would best counter the region's pernicious rootrot and insect problems. In 1951, when the "big freeze" took a heavy toll of citrus, cotton was ready as an alternative crop with improved varieties.

Seeing a growing market for cantaloupes if the proper varieties could be developed, Cowley encouraged R. T. Correa to pick up the earlier breeding work by G. H. Godfrey and try to fill this growing need. Practically all cantaloupe varieties grown in South Texas today came from this program.

Cowley gave leadership to the disease-free budwood indexing program, the freeze-protection program, an improved irrigation program, and was instrumental in establishing and supervising evaluation programs which steered optimistic producers away from endeavors unsuited to Valley conditions.

In 1959 he was given special recognition by the Texas Vegetable and Citrus Growers and Shippers for research achievement and service to those industries. In 1971 he was presented the Oustanding Leadership and Service Award by Texas Citrus Mutual. He has also been named Weslaco Citizen of the Year and received the Community Council Citizen Award for service to his community.

Cowley, raised in Wise County of North Central Texas, holds two degrees from Texas A&M University.

He and his wife, Mildred, reside in Weslaco. They have two grown children, Betty Sue Smith of Austin and Raymond Allen Cowley of Chicago.

NORMAN P. MAXWELL

1983 Recipient of the Arthur T. Potts Award

While recovering, in the Veteran's hospital in Temple, from wounds sustained in WW II Norman Maxwell enrolled as a graduate student at Texas A&M. He already had a BS in Horticulture from the University of Delaware. A field trip to the Valley led him to state, "the Valley is the place for me". In 1946 he joined the staff of the experiment Station at Weslaco under Superintendent Bill Friend. Thus began Norman's long and distinguished career in which he made many important contributions to the horticultural industry.

His citrus research has stressed varietal improvement through the screening of existing varieties, nucellar lines, new bud sports and testing of tristeza tolerant rootstocks. He was instrumental in establishing a nursery at the Hoblitzelle Ranch for study of container grown citrus trees. His innovative grafting techniques and growing procedures have made container propagation of citrus trees practical.

Norman has the distinction of being the Valley's 'Mr. Avocado', the resident expert to a small but profitable avocado industry. His research showed the 'Lula' avocado well adapted to the Valley, with good consumer demand and high monetary return to the grower.

During his 35 plus years at Weslaco Norman worked with: Vitis vinifera grapes, several varieties of which produced well but didn't go into dormancy early enough in the fall and were winter killed; several Florida low chilling peach varieties were found adaptive to Valley climate and soils; and the propagation of amaryllis bulbs which, because of the longer growing season here, multiplied more rapidly and could be brought to bloom faster than under growing conditions elsewhere.

Largely through his tireless efforts to garner funds and nurseryman's support new greenhouses for ornamental research are under construction at the Weslaco facility. He will be the research leader of a program which should be of immense benefit to the Valley's ornamental nursery growers.

The Rio Grande Valley Horticultural Society has greatly benefited from Norman's support and more than 30 years membership. He has served in most offices of the Society, including the presidency in 1953. He has authoredsor coauthored more than 60 scientific and popular publications and currently is a member of the University graduate council, having served on the guidance committee for several graduate students. Norman's two children are following in the A & M tradition with Jani Ruth now a student and Norman Paul, a graduate in Entomology, currently working on campus.

GUIDELINES FOR SELECTING THE RECIPIENT OF THE ARTHUR T. POTTS AWARD

1. The Arthur T. Potts award is to be given to an individual for outstanding contributions to the Horticultural Industry of the Lower Rio Grande Valley. The recipient may be from Industry, State or Federal agencies and need not reside in the Rio Grande Valley nor have been a member of the Society.

2. The members of the selection committee are to be appointed by the President no later than 1 July. The committee will consist of at least four members from the membership of the Rio Grande Valley Horticultural Society. At least one representative from some phase of production horticulture, ie., chemical sales, consultant, producer or supplier, must be a member of the committee. In addition, one member must be a carryover from the previous year to insure continuity within the committee.

3. The committee is to select a candidate for the award and to submit the candidate's name to the Board of Directors for approval by 15 October so that pictures and biographical sketch of the recipient can appear in the Journal of the Rio Grande Valley Horticultural Society the same year the award is presented. In the event the Board of Directors rejects the candidate, the selection committee must then select another candidate and submit this selection to the Board.

4. The committee is to solicit names of candidates for the award from the membership each year. The newsletter may serve as a satisfactory agent of solicitation by including in it a statement indicating that the committee is accepting nominations for the award from the membership.

5. The committee is to keep records of all meetings; these records to include a list of candidates considered for the award and this list passed on to the selection committee the following year. These candidates may then be reconsidered for the award. The Secretary of the Society is responsible for maintaining a file of these records.

6. The committee is responsible for providing a biographical sketch of the recipient, determining the appropriate wording for the plaque and having it ready in time for the Annual Institute.

7. The committee is responsible for purchasing the plaque for the following year in order to insure that a plaque is always available for engraving. The Secretary shall be responsible for storing the plaque.

8. The Arthur T. Potts Award shall be presented to the recipient at the Annual Institute by the President or his appointed representative.

RIO GRANDE VALLEY HORTICULTURAL SOCIETY MEMBERSHIP, 1982

SPECIAL CONTRIBUTORS

Charlie Rankin, Voice of Valley Agriculture, KURV, Edinburg
F M C Corp.
Griffin and Brand, McAllen
Kinney Bonded Warehouse, Donna

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Southland Care Co., Edinburg
Stauffer Chemical Co., Weslaco
Waugh's Fruit Ranch, McAllen

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Leeper, P., Weslaco
Link, H., Weslaco
Linnard, E., McAllen
Rankin, C., Edinburg
Schulz, G. R., McAllen
Shull, A. V., Edcouch
Sleeth, G., Weslaco
White, Glen G., Donna

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Arnall, N., Weslaco
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Hefley, Ed, Weslaco
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Hentz, A. E., Harlingen
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Jones, Whitney, Mission
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Ledbetter, Floyd, Harlingen
Lee, Janie, Brownsville
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Lloyd, J. L., La Feria
Martinez, Joe, Weslaco
Masao, Nishuira, Japan
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Miller, Marvin, Weslaco
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Murray, Charles E., McAllen
McFarland, W., Edinburg
Neal, James R., Mission
Nightingale, A. E., College Station
Nixon, P. R., Weslaco
Orr, E. B., La Feria
Padron-Chavez, Juan, Gen. Teran, Mex.
Peynado, A., Weslaco
Pospishil, James, La Feria
Ramirez-Dias, Juan, Gen. Teran, Mex.
Reinking, R. B., Harlingen
Rice, H. E., La Feria

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Roeder, Judy, Weslaco
Rogers, J. L., Harlingen
Rouse, R., Weslaco
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Smith, K., Harlingen
Smith, L., Edinburg
Snider, B. B., Harlingen
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Steeno, D., Harlingen
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Stone, John, Weslaco
Taylor, J. L., McAllen
Thode, E., Harlingen
Timmer, Pete, Lake Alfred, FL
Villalon, G., Weslaco
Wallace, D. K., Weslaco
Wallace, Ed., Harlingen
Warren, D. G., Edinburg
Whitlock, Les, McAllen
Wiedenfeld, R., Weslaco
Wiegand, Craig, Weslaco
Wilhite, Howard, San Juan
Wiltbank, W., Gainsville, FL
Work, Alice, Harlingen
Wright, J., Weslaco
Wutscher, H., Orlando, FL

Guidelines for Authors

Submit two copies of manuscripts doubled-spaced, including tables, figures, table headings, and figure captions. All margins must be at least one inch. The last word at the bottom of each page must be complete.

Subjects: Previously unpublished scientific research and observations, review and technique articles, reports of new problems or pests, market evaluations, variety releases, etc., are acceptable for publication. Papers should relate to horticulture. Manuscripts dealing with non-horticultural crops are acceptable if some application to horticultural science exists. Popularized or new versions of previously published information are not acceptable.

All manuscripts are subject to peer review by two associate editors who may seek additional review by appropriate specialists. Where the associate editors disagree as to the merits of a paper the editor will seek the opinion of another specialist before a decision on acceptance is made. Acceptance of a manuscript may depend on some revision following review. Authors should subject their contributions to review within their organization prior to submission.

One author of the paper must be a member of the Rio Grande Valley Horticultural Society. There will be a page charge of $15.00 per printed page in the Journal.

When in doubt as to manuscript preparation or literature citation style, please consider that we attempt to follow the style of the Journal of the American Society for Horticultural Science where this does not conflict with specific guidelines as follows:

Title: Keep title brief, but let it reflect important aspects of the article. Capitalize only the first letter of important words.

Byline: Author's name follows the title, followed by author's affiliation (title and institution) and institutional address with zip code.

Additional index words: This heading with a list of additional key words not used in the title may follow the byline.

Abstract: An author-written abstract follows the index words separated with space. The abstract should be brief, concise, and informative. Do not exceed 5% of the length of the paper. Separate the abstract from the text with a solid line, use two to four spaces above and below the line.

Text: An "Introduction" heading is not used. Introductory statements should give the background and objectives of the research work reported, or purpose of the article. Use no footnotes, supplementary information should be included in the text and may be parenthesized.

The body of a research paper should be divided into sections such as MATERIALS AND METHODS, RESULTS, DISCUSSION, followed by ACKNOWLEDGEMENTS and LITERATURE CITED, or other appropriate headings. Subheadings with the first letter capitalized may be placed at the beginning of paragraphs and underlined.

Names of proprietary substances, materials, and special apparatuses should be followed by parenthesized named and addresses of the manufacturers.

Chemicals, fungicides, insecticides, herbicides, etc., should be listed by their approved common names. The chemical name should be parenthesized following the common name when it is first used in the text. Use the chemical name when the common name is not available. Use trade names only if no other name is available.

Tables and Figures: Indicate in the manuscript's margin where each table and figure should appear. Captions and headings should describe figures and tables so that they are understandable when considered apart from the text.

Each table should be typed on a separate page without crowding its columns.

Figures should be unmounted. On a separate page, type the figure numbers (Fig. 1) and captions for each figure. On the back of each unmounted photograph or graph, use a soft-lead pencil to carefully write the figure number and the paper's title and author.

Enumeration and Measurements: Use numerals whenever a number is followed by a standard unit of measurement; e.g., 2 g or 9 days, otherwise use words through nine and numerals for numbers larger than nine.

You may select either the metric or English system of measurements, but do not interchange them. However, equivalent measures of the non-selected system may be parenthesized: e.g., 908 g/500 liters (1.52 lb/100 gal).

Manuscripts for publication in the Journal, may be sent to:

Journal Editor
Rio Grande Valley Horticultural Society
P. O. Box 107
Weslaco, TX 78596

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 four classifications of annual active membership: Individual, Sustaining, Patron, Special Contributor. Upon payment of dues such members are entitled to vote and to receive publications of the Society for the calendar year.

3. *Dues.* Annual dues shall be:

Individual	$ 7.50
Sustaining	25.00
Patron	50.00
Special Contributor	100.00

Dues are payable at the time of application for membership and become due and payable in January 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 membership should not be terminated, prior to final action by the Board.

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

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

ARTICLE V. SECTIONS

1. The Society shall be divided into Sections representing the various 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 affirmative majority vote of the membership present when such has been approved and recommended by a majority of the entire Board of Directors.

ARTICLE VI. MEETINGS

1. An Annual Horticultural Society Institute shall be held, preferably in January, to present the latest developments in scientific and practical horticulture to all interested persons.

2. The schedule for other meetings shall be developed by the President and a majority of the Board of Directors.

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

4. The meetings of the Society and the Annual Horticultural Society Institute shall be devoted to horticultural topics from scientific and practical standpoints (ARTICLE II). The presiding officer shall rule out of order all

motions, resolutions, and discussions tending to commit the Society to partisan politics or commercial ventures.

5. 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, President-elect, a Vice-President and a Director from each Section and a Director-at-large for a total of eleven.

2. *Nomination.* The President, not less than thirty days before the Institute, 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-elect and the Directors shall be elected by a majority vote of the members present at the Annual Institute and shall assume duties following termination of the Institute.

4. *Term of Office.* The term of office of President shall be for one year. The President-elect shall serve for one year prior to assuming office as president. 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.* The Board of Directors shall apoint a line of succession of Vice-Presidents.

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 all 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 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 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 an 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 13 April 1978 by the Horticultural Society.

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Effects of Single Salt Solutions and pH on Seed Germination of Two Native Range Grasses

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ABSTRACT

The effects of six salts (NaCl, $CaCl_2$, $MgCl_2$, KCl, Na_2SO_4, and $MgSO_4$) and hydrogen ion concentration (pH) on the seed germination of big sacaton (*Sporobolus wrightii*) and green sprangletop (*Leptochloa dubia*) were investigated under laboratory conditions. Big sacaton germination was $\geq$ 60% in solutions of 20 mmhos/cm conductance of $CaCl_2$, KCL, Na_2SO_4, and $MgSO_4$, but was severely inhibited in NaCl and $MgCl_2$ concentrations of 20 mmhos/cm conductance. Green sprangletop germination was suppressed by low to moderate (6 to 12 mmhos/cm) concentrations of salts except $CaCl_2$. Germination of green sprangletop was severely reduced by $MgCl_2$ and $MgSO_4$ solutions with conductances of 8 mmhos/cm. Seeds of both species had the ability to germinate well over a wide pH range, but big sacaton seed germination was significantly decreased at both extreme acid (pH 3 and 4) and extreme basic (pH 12) pH values.

Many factors influence the processes of germination and seedling establishment, particularly soil salinity and hydrogen ion concentration (pH). In the American Southwest and elsewhere worldwide, saline soil reclamation is a major environmental-conservation concern. One important facet of this problem is the screening of seed stocks for salinity tolerance to identify salt tolerant species. Dewey (2) has suggested that germination is a fair measure of salt tolerance. Donovan and Day (3) noted that germination is affected by type of salt as well as concentration.

Soil pH has been found to alter plant distribution by affecting seed germination (5). Species of woody plants and grasses also responded differently to varying pH of the germination substratum in laboratory tests (8, 10, 6). Thus, pH may be another useful criterion for selection of plant materials.

This paper presents the effects of six salts (NaCl, $CaCl_2$, $MgCl_2$, KCl, Na_2SO_4 and $MgSO_4$) and pH on the germination of two perennial grass species under laboratory conditions. Big sacaton and green sprangletop were selected for germination experiments because they are palatable and are used for range reseeding on Texas rangelands. A knowledge of their seed germination tolerance to salinity and pH would be useful to those who select species for seeding range sites.

MATERIALS AND METHODS

Big sacaton seeds were supplied by the Plant Materials Center of the Soil Conservation Service, Knox City, Texas. Green sprangletop seeds were obtained from a commercial source. The mean germination given for big sacaton and green sprangletop by each seed supplier was 90 and 61%, respectively. Seeds were stored at room conditions (20 to 27 °C and 50 to 75% relative humidity) in cloth bags. Most germination experiments were conducted when the seeds were less than one year old.

All germination experiments were conducted in growth chambers with automatic temperature and flourescent light controls at alternating temperatures of 20-30°C (16 hr low temperature, 8 hr high temperature with light). An experimental unit in a randomized complete block design was 100 seeds in a 9-cm petri dish containing two filter papers wetted with 10 ml of distilled water or other test solution. Treatments were replicated four times, and each experiment was conducted at least twice. A seed was considered to be germinated when both the radicle and plumule were visible. The number of germinated seeds was recorded 14 days after initiation of each experiment.

The effect of salinity on seed germination was evaluated in aqueous solutions of six salts (NaCl, $CaCl_2$, $MgCl_2$, KCl, Na_2SO_4, and $MgSO_4$) with electrical conductances of 0, 4, 6, 8, 12, 16, and 20 mmhos/cm. The influence of pH on seed germination was investigated by adding HCl and/or KOH to distilled water to give pH values of 2, 3, 4, 5, 6, 7, 8, 9, 11, and 12 (6).

Percentage germination data were transformed (Arcsin $\sqrt{\%}$) before statistical analyses, and means were compared with Duncan's multiple range test (9).

RESULTS AND DISCUSSION

Germination of big sacaton and green sprangletop generally decreased with increasing salt concentrations; however, the degree of reduction varied with the kind of salt and grass species (Table 1). Big sacaton seed germination was invariably greater than that of green sprangletop, regardless of salt or concentration. Big sacaton seed germination was poorest in NaCl and $MgCl_2$; the percentage germination was significantly reduced to 35 and 43%, respectively, when the salt concentration was increased to a conductance of 20 mmhos/cm. Although big sacaton seed germination was significantly reduced by increasing the conductances of the $CaCl_2$, KCl, Na_2SO_4, and $MgSO_4$ solutions, it was ≥ 60% in solutions of all four salts with conductance of 20 mmhos/cm. Big sacaton seeds were most tolerant of KCl and Na_2SO_4 solutions.

Green sprangletop seed germination was most restricted by Mg salts ($MgSO_4$ and $MgCl_2$) and $MgSO_4$ was more damaging than $MgCl_2$. Increasing $MgSO_4$ concentrations to give conductances ranging from 4 mmhos/cm to 6, 8, and 12 mmhos/cm progressively reduced germination from 53% to 39, 6, and 2%, respectively (Table 1). Germination was significantly reduced to 29% by $MgCl_2$ when the conductance of the salt solution was 8 mmhos/cm, and only 2% of the seeds germinated at the 12 mmhos/cm conductance level. These results agree with those of Hyder and Yasmin (4), and Ryan et al. (7), who reported that Mg salts inhibited the germination of several grass species. Green sprangletop seed germination was not reduced significantly by $CaCl_2$ until the solution's conductance

Table 1. Percentage germination of big sacaton and green sprangletop seeds after a 14 day exposure to various salt solutions.[1]

Species	Conductance[2] (mmhos/cm)	NaCl	$CaCl_2$	$MgCl_2$	KCl	Na_2SO_4	$MgSO_4$
Big Sacaton	0	87 ab	90 ab	94 a	92 a	91 a	94 a
	4	90 a	91 ab	91 ab	89 a	91 a	93 a
	6	87 ab	92 a	92 a	89 ab	92 a	93 a
	8	83 ab	84 b	91 ab	87 abc	91 a	84 b
	12	78 b	85 ab	84 bc	81 bc	80 b	70 c
	16	61 c	65 c	76 c	80 c	81 b	62 c
	20	35 d	61 c	43 d	69 d	72 b	60 c
Green Sprangletop	0	63 a	63 a	64 a	62 a	62 a	62 a
	4	60 ab	59 a	58 ab	58 ab	57 a	53 b
	6	57 ab	58 a	52 b	55 b	59 ab	39 c
	8	55 b	62 a	29 c	52 b	52 b	6 d
	12	38 c	57 a	2 d	38 c	33 c	2 e
	16	12 d	58 a	0 e	8 d	5 d	1 e
	20	1 e	42 b	0 e	4 e	1 e	0 f

[1] Means within a column followed by the same letter do not differ significantly at the 95% confidence level.

[2] Approximate salt concentrations for the various conductances are:
4 mmhos/cm = 45 meq/l, 6 mmhos/cm = 70 meq/l, 8 mmhos/cm = 95 meq/l,
12 mmhos/cm = 160 meq/l, 16 mmhos/cm = 200 meq/l, 20 mmhos/cm = 260 meq/l.

was increased to 20 mmhos/cm. This finding supports that of Ryan et al. (7). The germination of green sprangletop seeds in aqueous salt solutions of NaCl, KCl, and Na_2SO_4 followed the same trend with significantly lower germination occurring at the 12 mmhos/cm conductances level. Germination of green sprangletop was reduced to 12% or less by NaCl, KCl, and Na_2SO_4 at concentrations with conductances of 16 mmhos/cm.

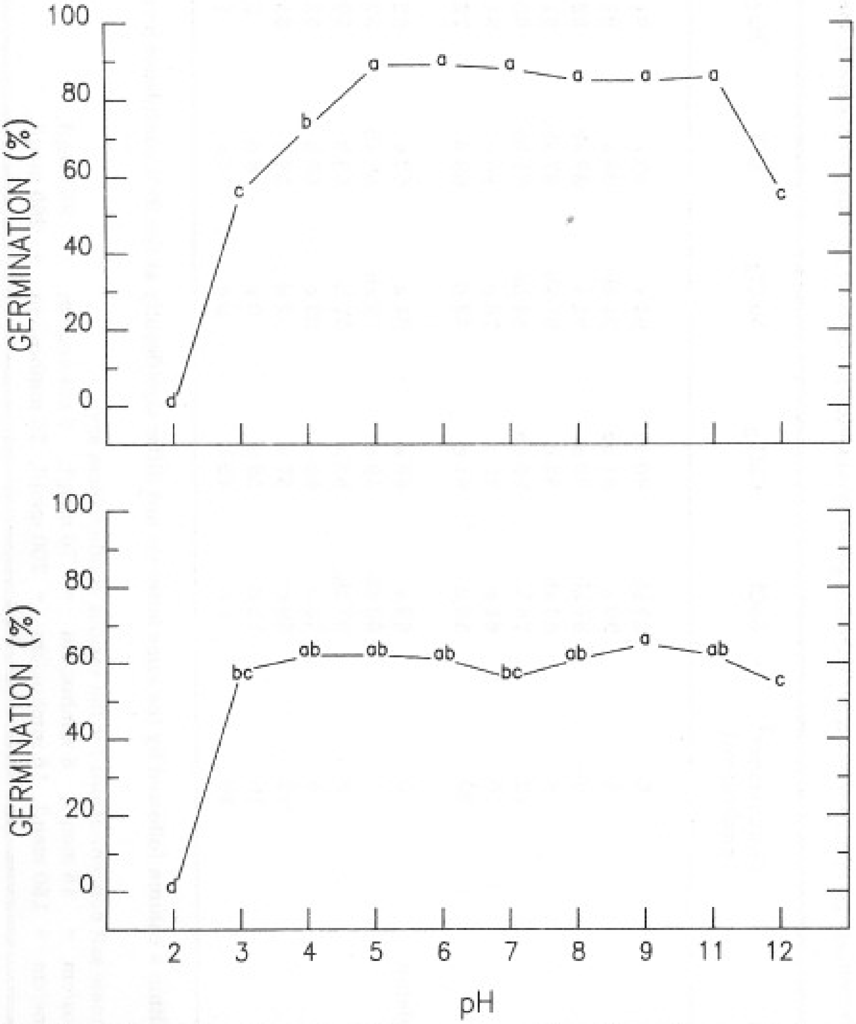

Fig. 1. Big sacaton (upper) and green sprangletop (lower) percentage seed germination after 14 days exposure to solutions of various pH. Means within an attribute with similar lower case letters are not significantly different at the 95% confidence level.

No germination of either species occurred in solutions adjusted to pH 2 (Fig. 1). Green sprangletop germination did not differ significantly in media whose pH ranged from 3 to 12, but its highest germination occurred at pH 9. Green sprangletop seed germination appeared to be mildly depressed at both extremes and pH 7. Stubbendieck (10) also reported a depression in germination of two grass species in pH media at or near neutrality. Big sacaton seed germination was significantly reduced at pH values of 3, 4, and 12, compared with its germination in pH media ranging from 5 to 11. Germination percentages of this species at pH 3 and 12 were significantly lower than at pH 4. The highest germination percentages of big sacaton seeds occurred at pH 5 and 6. Apparently big sacaton seed germination is more sensitive to pH than that of green sprangletop.

CONCLUSIONS

Seed germination of these two grass species responded differently to salinity. With the exception of NaCl and $MgCl_2$ solutions with electrical conductances of 20 mmhos/cm, big sacaton germination was not severely restricted by moderate to high concentrations of the six salts. Except for $CaCl_2$, green sprangletop germination was severely reduced by low to moderate salt concentrations, particularly by $MgCl_2$ and $MgSO_4$. Both concentration and specific ion effects were important for germination and varied with the species of grass being tested. The field establishment of green sprangletop might depend more on the salt concentration and ionic composition of the soil than big sacaton. Soil rich in Mg and low in Ca might not favor the germination of green sprangletop seed. Seed germination in saline soils is not only affected by direct ion effects, but also by osmotic interference with imbibition. This parameter should be considered before seeds of these grasses are planted in the field. Both big sacaton and green sprangletop germinated well over a wide range of pH levels; however, big sacaton germination was less tolerant of both extremely acid and extremely alkaline pH levels.

ACKNOWLEDGEMENTS

I thank Mario Alaniz and Oscar Garcia for their laboratory assistance.

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Market and Storage Diseases of Jicama

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Additional Key Words: *Pachyrrhizus erosus*, *Cladosporium*, *Penicillium*, *Rhizopus stolonifer*, hypochlorite.

ABSTRACT

Of 126 jicama roots examined at retail food stores, 40% had blemishes of which 31% were incited by *Cladosporium* sp., 8% by *Penicillium* spp. and 1% by *Rhizopus stolonifer* (Ehrenb. ex Link) Lind. *Cladosporium* and *Penicillium* were primarily superficial colonizers; whereas, *Rhizopus* caused internal decay. Mechanical injury during the harvesting and marketing of jicama roots [*Pachyrrhizus erosus* (L.) Urb.] was prerequisite for infection by *Cladosporium*, *Penicillium*, and *Rhizopus*. Inoculation of fungi either alone or in combination on non-wounded roots resulted in no infection. Serious losses have been observed of jicama stored at 6-9°C and 80-85% RH for 28 days. Effective control measures include postharvest dip of roots in 2000 ppm sodium hypochlorite solution at room temperature for 1 min, followed by drying and storage or retail display at 20-25° and 65-70% RH.

Jicama [*Pachyrrhizus erosus* (L.) Urb.] is a tropical root crop grown primarily in Mexico and to a limited extent in the Lower Rio Grande Valley of Texas. Extensive cultivation occurs in the Mexican states of Jalisco, Michoacan and Yucatan (2). Porterfield (3) stated that the jicama plant has a tropical distribution throughout the world. The edible tuberous root has a light brown skin, white flesh, and a shape somewhat like a large flat turnip. The root attains a maximum size of about 30 cm in diameter although they are normally harvested after attaining a size of 12-20 cm. Jicama roots are served in restaurants and sold as a specialty vegetable which has created an interest in their culture and use in Texas. Information on the proper storage and marketing conditions to prevent postharvest losses is not available. The purpose of this study was to 1) identify the pathogens causing postharvest losses, 2) make a survey of local stores to determine the extent of losses, and 3) determine the conditions and treatment necessary to control postharvest losses. A preliminary report has been published (1).

MATERIALS AND METHODS

During February of 1982, jicama roots were examined for postharvest blemishes and decays at a local packinghouse. Data was taken on the various types of decay with subsequent isolation on potato dextrose agar and identification of the fungi.

To determine the effect of wounding on susceptibility, 250 healthy jicama roots were washed in 2000 ppm sodium hypochlorite (ClO^-) with 1% surfactant (Triton X-100) and allowed to dry. A 10 mm diameter disk about 2 mm deep was then removed from 3 areas on each of 125 jicama with a sterilized cork borer. Each fungus alone or in combination was inoculated to 3 areas on each of 125 wounded and 125 non-wounded roots. The jicama roots were then stored for 2 weeks at 20°C and 80% RH.

A survey of 5 retail grocery markets in the Lower Rio Grande Valley was made to determine the approximate temperature and relative humidity at which jicama roots were displayed. In addition, data on disease incidence and disease ratings were obtained.

Solutions of ClO^- at various concentrations were tested as a postharvest dip to determine their efficacy against postharvest decay in jicama. Sixty fresh jicama roots with no apparent disease were selected at random and separated into 5 groups of 12 each. The treatments were: 1) control; 2) control; 3) 1 min dip, 1000 ppm ClO^-; 4) 1 min dip, 2000 ppm ClO^-; 5) 1 min dip, 4000 ppm ClO^-. The jicama roots were subsequently dried and stored for 4 weeks at 20-25°C and 65-70% RH with the exception of control 1 which was stored at 6-9°C and 80-85% RH. Disease was rated on a scale of 1 to 5 as follows: 1 = excellent: no decay or surface fungal growth; 2 = good: jicama salable, with trace decay or surface fungal growth: 3 = fair: jicama salable, with trace decay and/or moderate surface fungal growth; 4 = poor: jicama marginally salable, with moderate decay and/or severe surface fungal growth; 5 = unsalable because of excessive decay and/or surface fungal growth.

RESULTS AND DISCUSSION

Of 50 jicama roots examined at one packinghouse, 9 had 1 or more blemishes of which 87% were incited by *Cladosporium* sp. 10% by *Penicillium* spp. and 3% by *Rhizopus stolonifer*. Decays caused by *Cladosporium* sp. and *Penicillium* spp. were mainly superficial and normally extended no more than 2-3mm deep (Fig. 1). However, *R. stolonifer* caused an internal decay.

Wounding was a prerequisite for infection to occur by *Cladosporium*, *Penicillium*, and *Rhizopus* (Table 1). *R. stolonifer* was the most aggressive colonizer of the 3 fungi whether inoculated alone or in combination.

In a survey of 5 retail food stores, percentage of diseased jicama roots at individual stores ranged from 14 to 81% (Table 2). *Cladosporium* rot was the predominant disease accounting for 31% followed by *Penicillium* rot with 8%, and *Rhizopus* rot with 1%. The display conditions varied from store to store supporting the fact that information on proper storage and marketing conditions is lacking. Normally, jicama roots were displayed in refrigerated vegetable racks and stacked 3 to 4 deep.

Hypochlorite at the concentrations studied significantly reduced decay caused by *Cladosporium* (Table 3). Even though 1000 ppm ClO^- provided good control, 2000 ppm is recommended for additional protection since many stores will continue to refrigerate the roots. The incidence of *Rhizopus stolonifer* was infrequent so that control may not be necessary. When jicama roots were stored at about 22°C and 65-70% RH, *Penicillium* incidence was insignificant. However, when jicama roots were stored at 6-9°C and 80-85% RH for 4 weeks serious

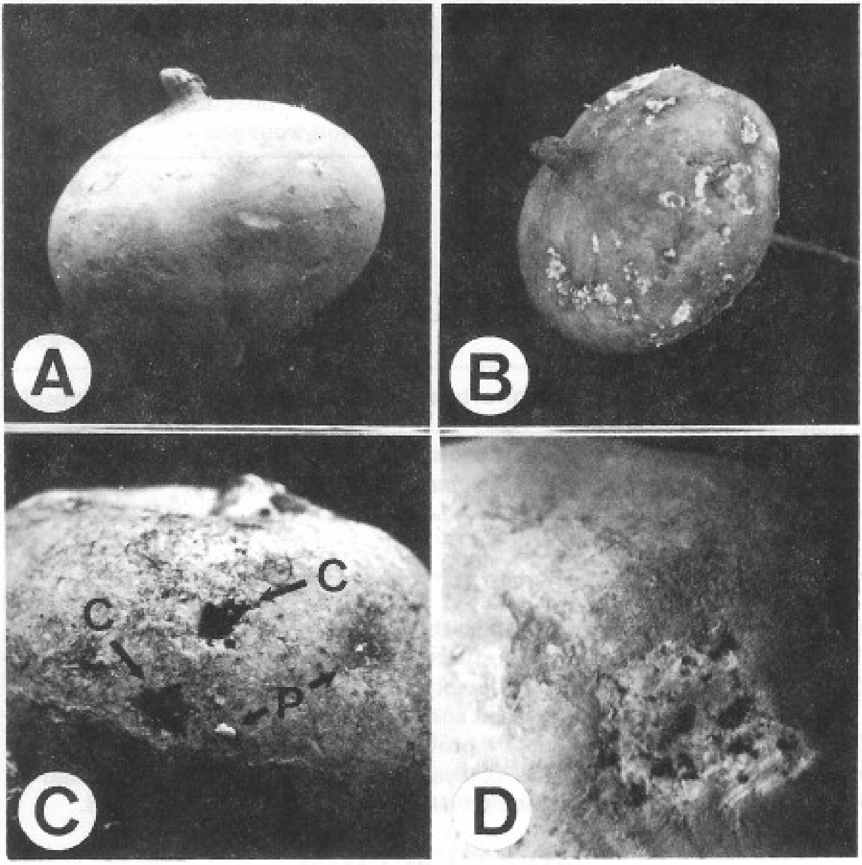

Fig. 1. (A) Healthy jicama root, (B) jicama root stored at 6-9°C and 80-85% RH for 28 days with extensive areas infected by *Penicillium* spp., (C) comparison of lesions caused by *Penicillium* spp. [P] and *Cladosporium* sp. [C], (D) injured jicama root with initial infection by *Cladosporium* sp.

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losses occurred. Jicama roots at the retail food stores did not have the incidence of *Penicillium* spp. that would be expected from this study. However, information was not available on the period of time they had been on display. In addition, the RH was not controlled and could vary from that approximated thus affecting disease incidence.

Hypochlorite dip can effectively reduce postharvest decay of jicama roots. Maintaining a relative humidity of 65-70% may be as important as the $C1O^-$ dip. This study demonstrated that refrigeration should be avoided. Mehanical injury during harvest, storage, and marketing should also be avoided. Jicama

Table 1. Effect of wounding and non-wounding on the susceptibility of jicama to postharvest decay.

Inoculum	Infection (%) [z] Non-wounded	Wounded
Control	0	0
Cladosporium sp.	0	62
Penicillium spp.	0	51
Rhizopus stolonifer	0	78
Combination	0	84
(Clad.-Pen.-Rhiz.)	0	(16-9-59) [y]

[z] Based on symptomology from a total of 75 inoculations for each inoculation treatment.

[y] Percentage infection by each fungus inoculated in combination - *Cladosporium* sp., *Penicillium* spp., *Rhizopus* sp., respectively.

roots are easily bruised and injured, such that, subsequent control measures are a necessity. Effective control of postharvest decays include a postharvest dip in at least 1000 ppm $C10^{-}$ and preferably 2000 ppm at room temperature for 1 minute. The roots should be dried and stored in mesh sacks at 20-25°C with 65-70% RH. If sprouting becomes a problem in prolonged storage, the temperature should be reduced to 15-18°C. Jicama roots at the retail outlet should be displayed in an area with good air circulation at 20-25°C with 65-70% RH.

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Table 2. Display conditions and disease incidence of jicama roots at 5 retail food stores.

				Cladosporium		*Penicillium*		*Rhizopus*		*Total*
Retail Store	Temp (C)	Approx. % RH	Number of jicama	Diseased jicama	Disease rating ($\overline{x}$)[z]	Diseased jicama	Disease rating ($\overline{x}$)	Diseased jicama	Disease rating ($\overline{x}$)	disease (%)
W-1	7-10	60-80	21	3	2.7	0	1.0	0	1.0	14
W-2	21-24	40-60	25	4	2.5	2	2.0	0	1.0	24
W-3	9-10	60-80	18	5	2.0	1	2.0	1	4.0	39
M-1	7-10	60-80	36	20	2.3	9	2.2	0	1.0	81
M-2	7-10	60-80	26	11	3.1	0	1.0	0	1.0	42
$\overline{X}$	-	-	25.2	8.6	2.5	2.4	1.6	0.2	1.6	40

[z] 1 = excellent: no decay or surface fungal growth; 2 = good: jicama salable, with trace decay or surface fungal growth; 3 = fair: jicama salable, with trace decay and/or moderate surface fungal growth; 4 = poor: jicama marginally salable, with moderate decay and/or severe surface fungal growth; 5 = unsalable because of excessive decay and/or surface fungal growth.

Table 3. Effectiveness of various treatments in controlling postharvest decays on jicama.

Treatment	Hypochlorite conc. (ppm)	Storage condition Temp. (C)	Storage condition R H (%)	Disease rating[z] *Cladosporium*	Disease rating[z] *Penicillium*	Disease rating[z] *Rhizopus*
Control	..	6-9	80-85	1.4 b[y]	5.0 a	1.0 a
Control	..	20-25	65-70	2.5 a	1.1 b	1.1 a
Hypochlorite	1000	20-25	65-70	1.6 b	1.0 b	1.0 a
Hypochlorite	2000	20-25	65-70	1.3 b	1.1 b	1.0 a
Hypochlorite	4000	20-25	65-70	1.4 b	1.0 b	1.0 a

[z] 1 = excellent: no decay or surface fungal growth; 2 = good: jicama salable, with trace decay or surface fungal growth; 3 = fair: jicama salable, with trace decay and/or moderate surface fungal growth; 4 = poor: jicama marginally salable, with moderate decay and/or severe surface fungal growth; 5 = unsalable because of excessive decay and/or surface fungal growth.

[y] Mean disease rating of 12 jicama roots dipped for 1 min. Means within a column followed by the same letter are not significantly different (P=0.05) according to Duncan's Multiple Range.

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Remote Sensing Survey of Palms with Respect to Suspected Lethal Decline in South Texas

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ABSTRACT

Color infrared aerial photography was used to determine the density and distribution of Canary Island date palm (*Phoenix canariensis* Chaub.), true date palm (*P. dactylifera* L.), and Washington palm (*Washingtonia* spp.) and to identify palms with lethal decline (LD) in the Lower Rio Grande Valley (LRGV) of Texas. The eastern portion of the LRGV, the area with infected date palms, contains 27% of the LRGV's date palms while 73% are located in the western portion. The survey indicates there are 136,151 palms of which 80.6% are Washington and 19.4% are date palms.

In the early development of the Lower Rio Grande Valley (LRGV) of Texas, many palms were planted for their aesthetic value along road ways, in parks, and at commercial and home sites. Most of the trees were either Washington palms, Canary Island date palms, or true date palms. These trees add to the tropical image of the LRGV, and their beauty lures many tourists to this area annually.

The eastern half of the LRGV, (from the coastal area to Mercedes) is undergoing an environmental change with the death of a large number of date palms. The death of these trees is suspected to be caused by mycoplasmalike organisms (MLO's), which cause a disease identical or very similar to a disease of palms in Florida known as lethal yellowing or lethal decline (6). The vector of MLO's is unknown, but a plant hopper, *Myndus crudus* Van Duzee has been strongly implicated (3) and is reported to be in South Texas (4). In 1971, LD was first noticed on mainland Florida and has been found in over 26 species of palms (6). The change it has caused in the urban environment of South Florida has been compared to that of northeastern American cities and their encounter with Dutch Elm disease (1). The Texas LD is estimated to have been in the Brownsville, Texas area of the LRGV since 1978 and is symptomatically identical to Florida's lethal decline. It has spread about 64 km inland since then (Report on Date Palm Disease of the LRGV by Randolph E. McCoy, January 1980, unpublished data). At this dispersal rate, it could disperse throughout the entire LRGV by 1983.

Because of its rapid spread and the environmental change it is causing, scientific studies have been initiated in the LRGV to develop methods of LD control or eradication. Included in these studies is a survey method of palms using remote sensing techniques that are similar to those used for citrus (2). Evaluation of these techniques and results of a survey taken in February 1980 are reported here.

MATERIALS AND METHODS

The area surveyed was the LRGV of Texas, which is comprised of 559,581 ha. One hundred and forty sample sites, each containing 20.9 ha., were selected from this area by a course line computer. Each site was photographed with Kodak Aerochrome 2443 film (color infrared) at a scale of 1:2000 with a modified Fairchild K-37 camera, equipped with a 30-cm focal length lens and Wratten 15 and CC50B filters. The aerial platform was an Aero Commander 680 modified for vertical photography.

Photo interpretation was acquired visually from the color infrared (CIR) photography with the aid of a magnifier. Each sample site was covered by one CIR photograph (Fig. 1). Black-and-white contact prints were made of each photograph and were used for locating the sites and gathering ground truth on individual trees. Each CIR photograph was examined to count the number of trees present and evaluate their physical condition. This information was recorded on the black-and-white prints by color coding each tree according to tree species and physical condition.

Characteristics that were used to identify date palms on the photography are: crown geometric pattern, (which is composed of long slender fronds); dark-green colored fronds; and tree shadows, which provides lateral view of the tree. Date palms infected with MLO's are characterized by loss of green color from fronds, excessive drooping of fronds, decay of growing tip, and toppling of the crown leaving only the trunk standing (5).

Washington palms, although they have not been found susceptible to LD, were included in the survey because of the lack of information concerning their distribution and abundance. They are characterized by long slender trunks and dark-green fan-shaped fronds.

Photo interpretation verification was accomplished by on-site-inspections of 10 randomly selected sites. The boundaries of each site were established from the black-and-white prints. Each date palm and Washington palm was counted and its physical condition determined. This ground truth data were then compared with photo interpretated data recorded on the black-and-white print.

For photo interpretation accuracy of identifying trees infected with MLO's, an area in the eastern portion of the LRGV containing 72 date palms was photographed. The interpretation results were verified with on-site-inspections and the determination of each tree's condition.

RESULTS

Survey results are given in Table 1. From the 141 sample sites, 116 date palms were identified of which 95% were determined healthy, 2% diseased and 3% dead. On-site-inspection indicated a photo interpretation omission error of 21.3% and commission error of 2.7%, resulting in 18.6% more trees being present than determined from the CIR photography.

Date palms normally have a gradual loss of lower fronds and many trees exhibit chlorosis due to causes other than LD. These symptoms are similar to early infection of LD and can be detected on CIR photography but determination of the specific cause of the symptom was not possible. Latter symptoms of infected palm trees, which are a color change and excessive drooping of fronds, could be accurately identified on CIR photography. Excessive drooping of fronds

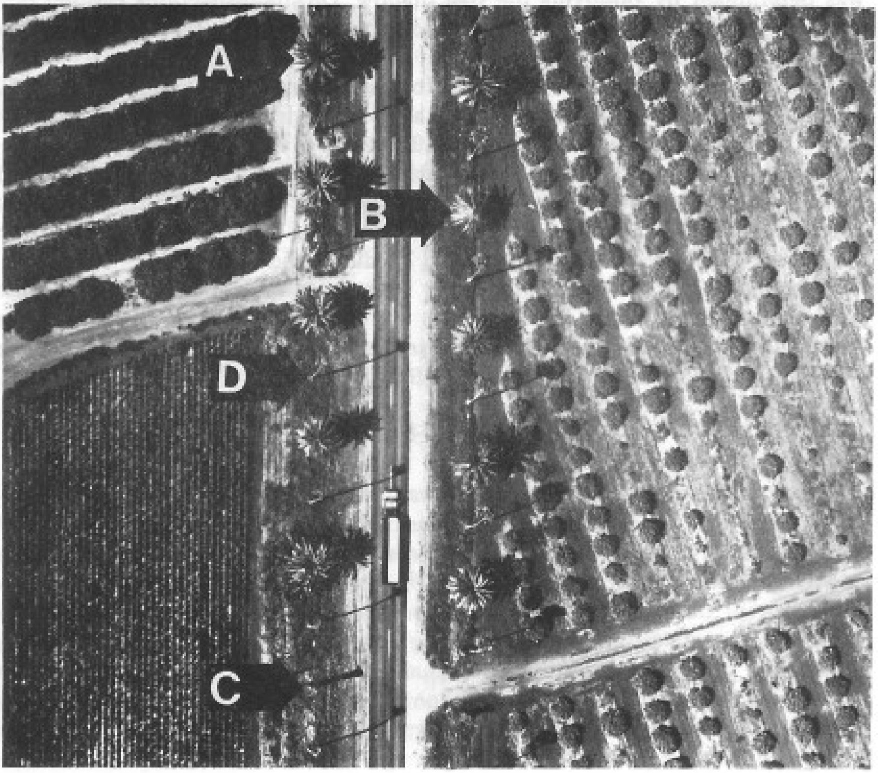

Fig. 1. Aerial photography exhibiting *Phoenix canariensis* (A) healthy, (B) final symptoms of lethal decline, (C) trunk, void of fronds; and (D) Washingtonia spp.

Table 1. The population of Washington and date palms in the LRGV and the percentage of date palms with lethal decline.[z]

Area	Date Palms No.	Date Palms %	Infected/Dead No.	Infected/Dead %	Washington palms No.
Rio Grande Valley, Eastern	7126	27	1140	16	- -
Rio Grande Valley, Western	19266	73	180	< 1	- -
Valley Wide	26392	100		5	109,759

[z] Survey conducted using color infrared aerial photography.

was determined by observing the tree shadow. On-site-inspections verified that those trees identified on the CIR photography as being infected with MLO's were either diseased or dead.

When the sample data were applied to the total area, the results were 25,072 date palms with no symptoms of LD that could be identified with CIR photography, 528 trees infected with LD, and 792 dead.

Lethal decline has been identified in date palms only in the eastern portion of the LRGV, about 54% of the total area. This area contains 7126 (27%) date palms, of which 16% were found to be diseased or dead. The western portion contains 19,266 date palms with less than 1% diseased or dead.

Washington palms were found to be four times more numerous than date palms. The photographic interpretation of the sample was 97% accurate for identifying Washington palms. Corrected photographic data indicated there were 109,759 Washington palms in the LRGV.

DISCUSSION

Color infrared aerial photography was proven to be very useful to determine the density and distribution of Washington and date palms in the LRGV and for identifying infested and dead trees. Accuracy in identifying date palm and Washington palms was 81% and 97% respectively. Most of the interpretation error of date palms was an omission error which could be attributed to three causes: 1) several palms growing together thus preventing the photo interpreter from distinguishing individual palms, 2) small palms shaded by other vegetation, and 3) small palms confused with other types of palms. These factors had little effect on photo interpretation of Washington palms. Their distinctive height and dense tuft of fan-shaped fronds made this species obvious on CIR photography.

The western portion of the LRGV contains 73% of the date palms with fewer than 1% infected or dead, while the eastern portion has only 27% of which 16% are infected or dead. The total number of Washington and date palms in the LRGV is 136,151 of which 19.4% are date palm and 80.6% are Washington palms. This survey excluded nurseries or farms where palm trees are grown commercially.

This type of aerial survey would be useful in commercial palm growing areas for determining tree density and distribution, and the physical condition of the trees.

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Relationship between Melanose Incidence and Dead Wood in Texas Grapefruit

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ABSTRACT

The relationship between melanose incidence on fruit and amount of dead wood was studied in grapefruit trees (*Citrus paradisi* Macf. cv. Ruby Red) ranging from 4 to 29 years of age. Dead wood was estimated according to the diameters and lengths of dead twigs or branches. Positive correlations were found between tree age and melanose incidence, tree age and amount of dead wood, and dead wood and melanose incidence. Trees 6 years old and younger did not have enough dead wood to justify protective fungicide applications. Dead terminal twigs were an important source of inoculum of *Diaporthe citri* (Fawc.) Wolf since they constituted a significant part of the total amount of dead wood. Large dead branches near the center of trees were not important sources of inoculum since few fruit were produced in that area. Significantly more dead wood was found in the north and west quadrants of the trees than in the south and east quadrants.

Melanose, caused by the fungus *Diaporthe citri* (Fawc.) Wolf, is a rind-blemishing disease which reduces the external quality of grapefruit. Infection occurs when spores produced on dead twigs and branches are washed onto susceptible fruit, leaves, or twigs during warm, wet weather. In young orchards melanose is seldom a serious problem since young trees contain only small amounts of dead wood. As trees age more dead wood is present and the inoculum potential in the orchard is great enough to warrant one or more applications of a fungicide. This study determines the relationships among melanose incidence, fruit distribution, and dead wood occurrence and distribution. This information should enable one to determine the tree age and condition when fungicide sprays for melanose control are justified.

MATERIALS AND METHODS

Six trees in each of eight orchards of old-line grapefruit (*Citrus paradisi* Macf. cv. Ruby Red) on sour orange rootstock (*C. aurantium* L.) at the Texas A&I University Citrus Center, Weslaco, TX, were included in the survey. Ages of trees ranged from 4 to 29 years (Table 1).

To quantify dead wood and fruit distribution, each tree was divided into north, south, east, and west quadrants; into top and bottom halves; and into three shells, inside, middle, and outside, by dividing the radius of each tree by three. Dead twigs and branches in each quadrant were categorized as follows: twigs 5 mm or less in diameter; twigs 6-10 mm in diameter; twigs 11-20 mm in diameter; and dead branches larger than 20 mm in diameter. The number and 'able 1. Characteristics of Ruby Red grapefruit trees included in the survey.

ɩge	Row orientation	Spacing[z] (meters)
4	east-west	4.6 X 8.5
6	east-west	7.6 X 9.1
7	equal	7.3 X 7.3
8	east-west	4.3 X 7.3
11	north-south	5.5 X 7.3
15	east-west	4.9 X 7.6
28	north-south	6.7 X 12.2
29	east-west	6.1 X 6.7

z Distance between trees X distance between rows.

length of dead twigs and branches in each location in each tree were recorded during the summer of 1981. The surface area of dead wood was calculated based on the number of dead twigs and branches, their length, and the assumption that the twigs and branches were cylindrical.

In October, 1981, the number of fruit in each location was recorded. Ten fruit in each location in each tree, or 240 fruit per tree (when possible), were rated for melanose damage. Melanose incidence was determined by the percentage of fruit downgraded to U.S. No. 2 or below. This grade consists of grapefruit with at least one-half of the surface affected by discoloration.

Routine cultural practices were performed throughout the year but no fungicides were applied to any of the trees used in the survey.

Linear regression was used to evaluate statistical relationships among tree age, amount of dead wood, number of dead terminal twigs, and percentage of downgraded fruit.

RESULTS

Melanose was severe in 1981 with major infection periods March 10-14, April 24-25, and May 2-4; minor infection periods occurred on May 10 and May 25. Criteria for infection was 12 hours of wet foliage with the temperature above 25°C (77°F) or 18 hours of wet foliage with temperatures 12-15°C (59-77°F) (2).

A highly significant positive correlation was found between tree age and percentage of fruit downgraded due to melanose (Fig. 1,A). Five percent or less of the sampled fruit from the 4-, 6-, or 8-year-old trees was downgraded due to melanose. A significant correlation was also found between tree age and the surface area of dead twigs and branches (Fig. 1,B). Similarly, a positive correlation was found between the surface area of dead wood and melanose incidence (Fig. 2).

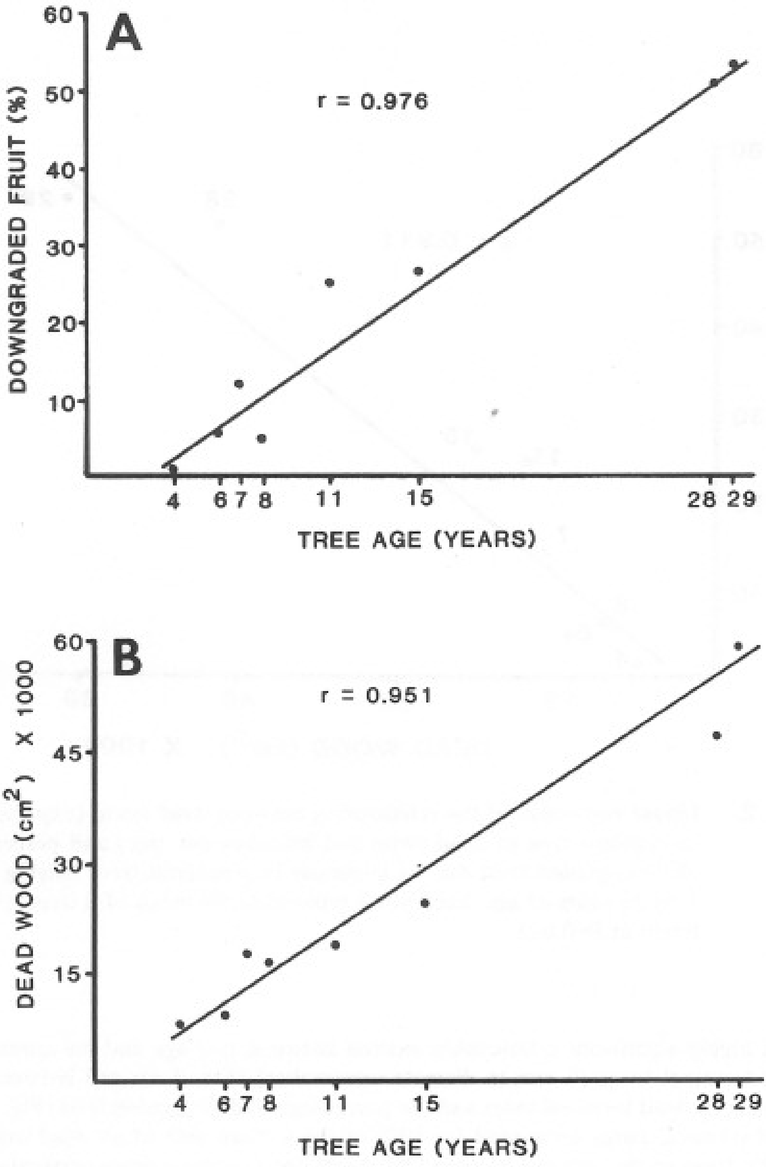

Fig. 1. A and B. Linear regression of the relationships between A) tree age and percentage of downgraded fruit due to melanose and B) tree age and dead wood (expressed as the surface area of dead twigs and branches per tree). Both are significant at P = 0.01. Each point represents the mean of 6 trees.

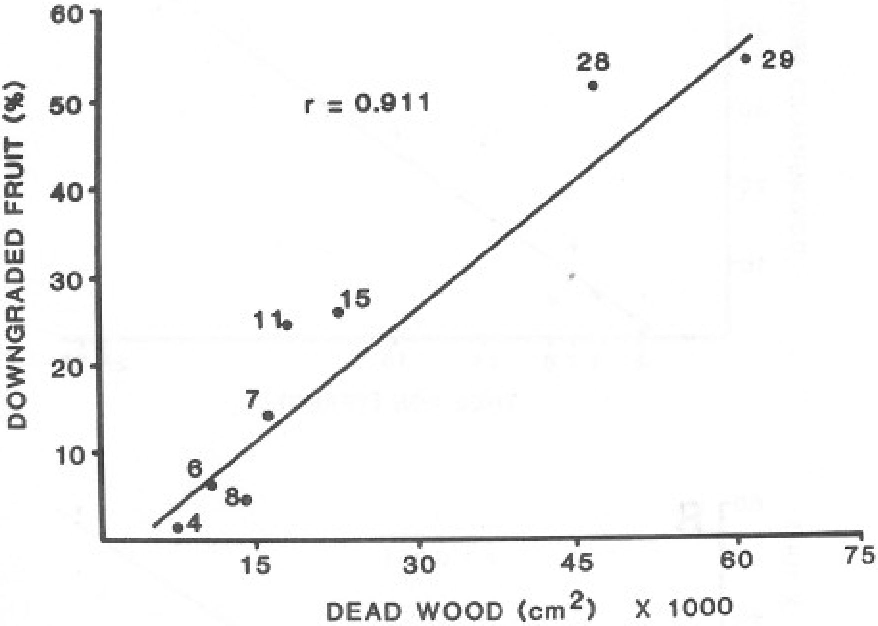

Fig. 2. Linear regression of the relationship between dead wood (expressed as the surface area of dead twigs and branches per tree) and percentage of downgraded fruit due to melanose in grapefruit trees ranging from 4 to 29 years of age. Each point represents the mean of 6 trees. (Significant at P=0.01).

A highly significant relationship existed between tree age and the number of dead terminal twigs (5 mm in diameter or smaller) (Fig. 3,A), and between the number of dead terminal twigs and the percentage of downgraded fruit (Fig. 3,B). Dead terminal twigs accounted for 51% of the surface area of all dead wood in all the trees in the survey. In many situations dead terminal twigs accounted for almost all of the total dead wood. As examples, 95% of the total dead wood in 4-year-old trees was terminal twigs; 89% of the total dead wood in 6-year-old trees was terminal twigs; and 91% of the total dead wood in the outside shells of all trees in the survey was terminal twigs.

The majority of dead terminal twigs was found in the inside shell of 4- and 6-year-old trees; in trees older than 6 years the majority of dead twigs was found in the middle and outside shells of the trees (Fig. 4,A). In general, fewer dead

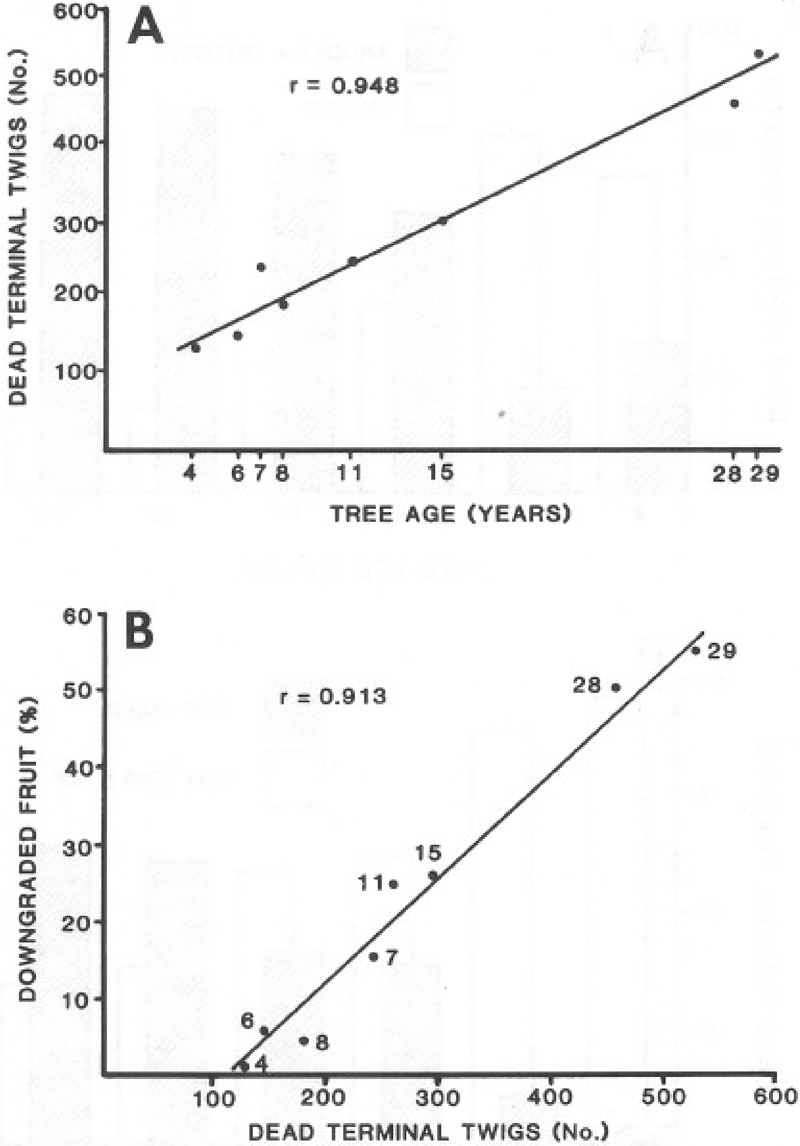

Fig. 3. A and B. Linear regression of the relationships between A) tree age and number of dead terminal twigs (based on an average length of 15 cm of twigs 5 mm or less in diameter) per tree and B) number of dead terminal twigs and percentage of downgraded fruit due to melanose in grapefruit trees ranging from 4 to 29 years of age. Both are significant at P = 0.01. Each point represents the mean of 6 trees.

Fig. 4. Relative distribution of dead terminal twigs between A) the inside shell and middle and outside shells and B) the top and bottom of Ruby Red grapefruit trees.

terminal twigs were found in the inside shells of the trees as the age of the trees increased. In the 28- and 29-year-old trees the majority of dead terminal twigs was divided between the middle and outside shells. As tree age increased, most of the dead terminal twigs were also toward the top of trees (Fig. 4,B). Large dead branches (larger than 20 mm in diameter) usually occurred in the inside shell of the trees. When the distribution of large dead branches is averaged for trees of all ages, 86% of the total amount was found in the inside shell, 13% in the middle shell, and less than 1% of all the large dead branches was found in the outside shell.

In general, a low percentage of the total amount of fruit was produced within the inner shell of the trees (Table 2). Less than 3% of the crop was produced in the inner shell in trees 15 years and older. In trees 7 years and older the distribution of fruit was rather equally divided between the middle and outside shell.

There were no significant differences in the distribution of fruit among the compass points or in the percentage of downgraded fruit among the compass points. However, significantly more dead wood was found in the north and west quadrants than in the south and east quadrants (Table 3).

Table 2. Relative in-tree distribution of fruit by percentage of total yield.

	Tree age (years)[z]							
Location	4	6	7	8	11	15	28	29
inside	21	14	4	7	7	3	2	3
middle	44	48	46	51	44	51	48	50
outside	35	38	50	42	49	46	50	47

z Six replications per age.

Table 3. Average surface area of dead wood in all trees surveyed[z].

Quadrant	Ave. dead wood (cm^2)
North	7200 a
South	5555 b
West	7230 a
East	5700 b

z Each value is the mean of 48 trees. Means separated by Duncan's Multiple Range Test, P = 0.05.

DISCUSSION

Melanose incidence was greater in older trees as a result of the progressively greater amounts of dead wood. In 4-, 6-, and 8-year-old trees little melanose occurred (5% or less) despite the lack of fungicides and several periods with favorable conditions for melanose infection. Trees 7 years old would have required application of a fungicide since an unacceptable 11% of the fruit was downgraded due to melanose. However, only 5% of the fruit from the 8-year-old trees was downgraded. This indicates that decisions for the application of fungicides should be made by individual orchard since age alone may be unreliable for determining melanose incidence. Factors such as freezes, insects, culture practices, and diseases can influence the amount of dead wood and thus influence the potential for melanose. Tree and row spacing can also influence melanose incidence since fruit distribution and amount of dead wood may be affected. However, the likelihood of melanose in trees 6 years old and younger would not warrant fungicide application, except possibly where freeze damage has occurred.

The positive correlations between dead terminal twigs and tree age and dead twigs and melanose incidence probably reflect progressively larger amounts of total dead wood in progressively older trees. However, dead terminal twigs appear to be important sources of inoculum of *D. citri* since melanose occurred in locations in trees where there were few or no other sizes of dead wood. Because almost all of the dead wood in the outside shells consisted of dead terminal twigs (91%), fruit in the outer shell downgraded with melanose were probably infected with inoculum produced on twigs in the outer shell. Rain water commonly washes spores of *D. citri* downward onto fruit below although wind-driven rain may account for some lateral movement of spores. When significant amounts of dead terminal twigs occur in the top and outside of trees, as in the 28- and 29-year-old trees in this survey, inoculum can be washed down by rain to fruit throughout the tree.

Dead wood in the inside shell of trees contributes less to melanose incidence than dead wood in the middle and outside shells since a small percentage of the total amount of fruit produced in a tree is located inside. Therefore, large dead branches in the inside of the tree where there are few fruit have less impact on melanose incidence compared to small twigs which can occur all over the tree. Moreover, fruiting bodies of *D. citri* are more common on small dead twigs than on the dead bark of large limbs (3). Spore production is also more common on tissue that has died recently than on twigs and branches that have been dead for a year or more.

Although we found no differences in fruit production or melanose incidence among compass points in trees in this study, melanose incidence has been observed to be more common on the north and west sides of trees (R. M. Davis, unpublished data). In this study greater amounts of dead wood were produced on the north and west sides, which might lead to a higher incidence of melanose. Furthermore, fruit production and vegetative growth are often greatest on the north side of trees grown in South Texas, particularly if rows are oriented east and west (1). The relationships between melanose incidence and the location of maximum fruit production and tree growth warrant more research. Since melanose incidence is directly proportional to the amount of dead wood in a tree, dead wood removal with emphasis on eliminating small dead twigs can reduce melanose incidence. The value of hedging and topping programs in this regard needs to be determined.

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Summary of Sweet Corn Performance Tests in the Rio Grande Valley, 1978 through 1981.

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ABSTRACT

Selected sweet corn varieties were tested in the Lower Rio Grande Valley of Texas in 1978, 1979, 1980 and 1981. Planting dates, agronomic practices, pesticide and fertilizer used were those common to the region. Agronomic characters and yield of the varieties tested are reported. Although not always the highest yielding varieties, Silver Queen and Golden Queen are two sweet corn varieties that yield consistently well and are well adapted to this area. Other varieties show potential for high yields but need to be subjected to testing for several more years.

In the early 1950's thousands of acres of sweet corn were successfully grown in the Lower Rio Grande Valley of Texas (LRGV) for northern markets (2). Today, limitations on insecticide use and an inability to effectively control earworms have reduced commercial sweet corn plantings in the Valley to just a few hundred.

Because of the wide interest in sweet corn in private gardens as well as some commercial acreage, the Texas Agricultural Experiment Station has continued performance testing of released varieties. Reported here is a summary of test results for 1978 through 1981.

MATERIALS AND METHODS

Sweet corn variety plots were planted March 20, March 14, March 7, and March 26 for the years 1978 through 1981, respectively. All tests were replicated four times in a randomized block design. Cultural practices followed those common to the area and irrigations were applied when plant conditions indicated a need for water. Plant populations of one plant per foot or 13,068 plants per acre were maintained. Plots consisted of two rows 30 feet long with 40 inch beds. A 1/1000 of an acre was harvested for yield.

Data recorded includes days to 50% silk or when 50% of the plants were in some stage of silk. Also recorded was ear height which is the distance from the top of the bed to the point of attachment of the ear to the stalk. Earworm damage for 1981 is also reported. A marketable ear is defined as an ear more than 6 inches long after earworm damage has been removed in keeping with previous tests at Weslaco (1). Yield was recorded in sacks of marketable ears per acre with a sack containing 72 marketable ears.

RESULTS AND DISCUSSION

Harvests began on June 1, May 26, May 20 and May 12 for 1978 through 1981, respectively, when visible examination of the silk indicated maturity.

Days to 50% silk, plant height, ear height averages as well as earworm damage for the 1981 test are shown in Table 1. Only one replication per year was recorded because of time constraints. These data are, therefore, included as an indication of plant stature and conformation but not as a selection mechanism for a variety. The selection should be based on performance of yielding ability and not the plant stature unless mechanical cultivation practices require physical characteristic limitations.

Table 1. Average days to 50% silk, average plant height, average ear height and 1981 earworm damage ratings for selected sweet corn varieties.

Variety	Color[z]	Average days to 50% silk	Average plant height (inches)	Average ear height (inches)	1981 earworm damage ratings[y]
Golden Rod	y	59.0	59.5	14.5	2.5
Main Liner	y	62.0	70.0	17.5	1.7
Kandy Korn	y	56.0	61.0	13.0	3.1
Sugar Loaf	y	59.0	59.5	14.5	2.5
Royal Gold	y	59.5	62.3	12.3	2.5
Silver Queen	w	61.5	62.5	13.7	2.0
Iobelle	y	58.4	60.0	16.0	3.1
Bonanza	y	58.3	56.0	12.3	2.6
Golden Queen	y	60.5	61.5	13.2	2.5
Style Pack	y	60.3	52.6	12.0	2.5
Sweetex	y	68.3	57.0	14.5	-
Early Sunglow	y	47.5	37.5	3.0	-
Borealis	y	46.8	37.5	4.0	-

[z] y = yellow; w = white.

[y] 1 = no earworm damage; 5 = non marketable ears due to earworm damage. Data was not available for the last three varieties listed.

Yields from the corn varieties varied greatly. The very early varieties Borealis and Early Sunglow did not perform well. March planting dates result in relatively short days during the growing season limiting exposure to light resulting in substantially reduced yields of early varieties. The required sun for photosynthesis is not available.

Sweetex did not perform well even though the days to 50% silk seems to be adequate. It can be assumed that this variety is not adapted to the Lower Rio Grande Valley of Texas.

Silver Queen, although not the highest yielding variety, has demonstrated reasonable consistency in yield. Other sources (3) suggest that white sweet corn generally has more earworm resistance than does yellow sweet corn. This consideration may outweigh yield data when insecticide avoidance is preferable.

Four varieties, Golden Rod, Main Liner, Kandy Korn, and Sugar Loaf, had high yields but the limitation of two years data does not offer an indication of yield consistency. Data from several more years are needed before these sweet corn varieties can be evaluated on their performance in the varying climatic conditions of South Texas.

Growing conditions in 1979 were not favorable to sweet corn production. Excessive drought limited production as shown in Table 2. Data from that year may be indicative of drought tolerance but should not be considered as indicative of yield potential.

Table 2. Yield of selected sweet corn varieties per year and average yield for the year tested (sacks per acre).

Variety	Year tested	Year Tested				Average
		1978	1979	1980	1981	
Golden Rod	2	-	-	187 ab	230 a	208
Main Liner	2	-	-	167 bc	214 a	190
Kandy Korn	2	-	-	151 bc	216 a	183
Sugar Loaf	2	-	-	159 bc	190 a	174
Royal Gold	3	-	126 a	143 bc	225 a	164
Silver Queen	4	234 a[z]	76 bc	115 cd	201 a	156
Iobelle	3	124 b	-	143 bc	176 a	147
Bonanza	3	-	93 ab	216 a	117 b	142
Golden Queen	4	166 a	46 c	135 bcd	210 a	139
Style Pak	3	-	38 c	155 bc	126 b	106
Suntex	2	-	63 bc	90 d f	-	77
Early Sunglow	2	-	56 bc	54 ef	-	55
Borealis	2	-	64 bc	30 f	-	47
Average		174 c.v. 14.1	70 c.v.29.9	134 c.v.20.2	190 c.v.17.6	138

[z] Mean separation in columns by Duncan's Multiple Range Test, 5% level.

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Undercut Tillage and Planting System for Double Cropping

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ABSTRACT

A combination minimum tillage-planting unit was field tested for planting fall corn following a short-season spring cotton crop. Good corn stands were achieved with the equipment. The implement permits immediate planting of a fall crop following harvest and shredding of cotton. Crop residues remain on the soil surface for conservation of soil and water resources. Short-season lint cotton yield of 699 lbs/acre was obtained from early March planting followed by a corn yield of 2490 lbs/acre planted in mid-August.

In several regions of the United States, double or multiple cropping is practiced (4, 5). The primary incentive for double cropping is the production of two or more saleable crops during the year which could increase total revenues and provide an improved cash flow. A potential growing season of 330 consecutive frost-free days is available for plant growth in the Lower Rio Grande Valley (LRGV) of South Texas (6). It has been established that several multiple crop combinations are possible in the LRGV (1). Timeliness of planting is not a critical factor with some crop combinations such as spring planted grain sorghum followed by soybeans, vegetables, or corn. However, timeliness is very critical when a second crop is to follow spring planted cotton. The mandatory cotton plow-up deadline of September 1st and the increasing rainfall frequency in August requires a quick planting technique coupled with cotton stalk destruction to enable a second crop to successfully follow spring cotton.

The development of short-season cotton cultivars (130-150 day maturity) harvested in mid-July or early August has provided the grower an increased opportunity to consider double cropping following cotton (2,3).

The objective of this work was to develop tillage-planting equipment that would achieve both rapid establishment of a second crop and destruction of cotton with minimum soil preparation and time-lapse.

MATERIALS AND METHODS

Evaluation of a mechanically drawn tool that would kill cotton stalks without ridge destruction of a ridge-furrow planting situation was initiated in 1981. Lister type implements were discarded as unsuitable because they destroyed the ridge or existing cotton bed during stalk destruction. The lister or disc method of crop removal required several tillage operations before a satisfactory planting environment could be achieved for the fall crop.

An implement (McIlroy™ root cutter) that undercuts the cotton seed bed showed considerable promise in several exploratory trials of cotton stalk destruction. It was possible with the root cutter to kill (destroy) cotton stalks and simultaneously loosen the seedbed for planting. A minimum-tillage planting system was assembled for field testing in the fall of 1981. Three standard pieces of commercially available equipment were modified into a single stalk destruction-planting unit. The implements were the McIlroy™ root cutter, Allis Chalmers™ fluted coulters, and John Deere™ flex planters (7). This equipment was used to plant corn (variety PAG 644W) in August of 1981 following a short-season cotton crop (variety GP-3774). The soil type used for the study was a Harlingen clay which is a member of the fine, montmorillonitic, hyperthermic family of Entic Chromusterts. The purpose of this study was to demonstrate the utility of this equipment for planting behind a preceding crop.

Mention of a company or trademark is included for the readers' benefit and does not constitute endorsement of a particular product listed by the U. S. Department of Agriculture over others that may be commercially available.

RESULTS AND DISCUSSION

Short-season cotton cultivar (GP-3774) shown in Fig. 1 was conventionally planted on March 2, 1981 and irrigated for seed germination. The cotton was spindle picked on August 12, 1981. The lint cotton yield was 699 lbs/ac which had been produced in 164 days. This represented approximately one-half of the available 330-day frost free growing period in the LRGV. Immediately following the cotton pickers, the cotton stalks were shredded approximately 4 inches above ground level. The shredding procedure kept pace and could be conducted simultaneously with the harvesting operation. The equipment used for undercutting the live cotton stumps for cotton destruction and planting is composed of three basic components: the undercutting knife (root cutter) (A), fluted coulter (B), and planters (C) (Fig. 2). An additional component could be a directed herbicide spray unit for weed control mounted directly behind the planter press wheel.

The corn cultivar (PAG 644 W) planted on August 13th was not immediately watered for seed germination because this would encourage regrowth of the undercut cotton plants. Other experiences with undercutting of cotton has shown that three days time elapse should occur before irrigation water is applied for corn germination. Rainfall during the period would be undesirable as it would also reset the undercut cotton plants. Fortunately, for the time period of July 15 thru August 15 (53 yr. av.), there was only a 12% chance of receiving more than .5 inch of rainfall for any three-day period. One-half (.5 inch) inch or more was considered as a sufficient amount to alter the effectiveness of the undercut tillage operation for cotton stalk destruction. Conventional cultivation in combination with a directed spray herbicide (Paraquat) was used for control of weeds and volunteer cotton that germinated following the irrigation for corn seed germination.

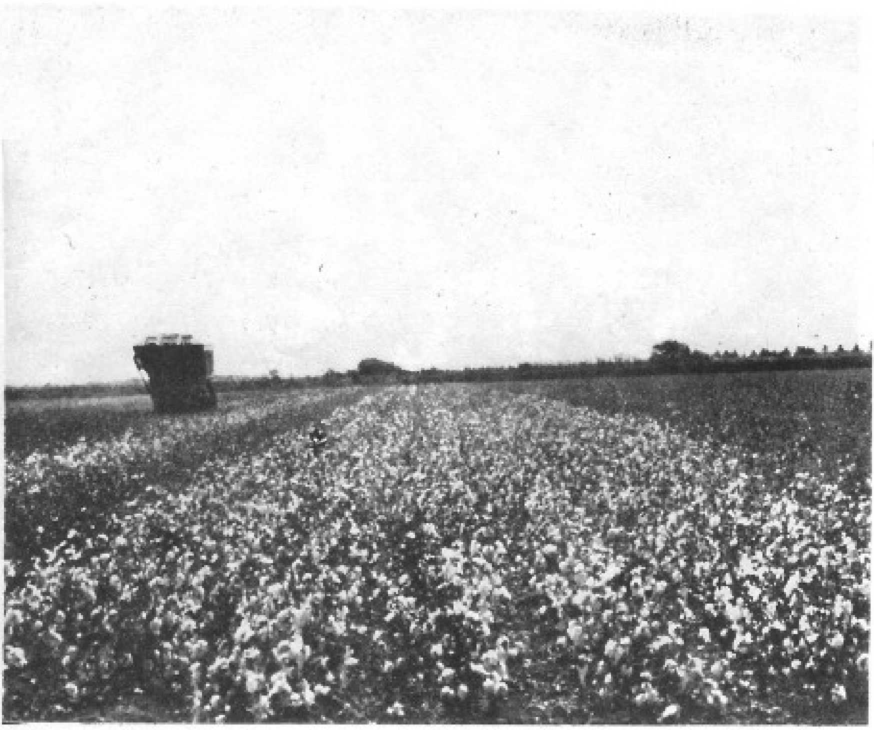

Fig. 1. Short-season cotton crop at harvest in early August. Immediately following harvest, the cotton was shredded and minimum-till planted.

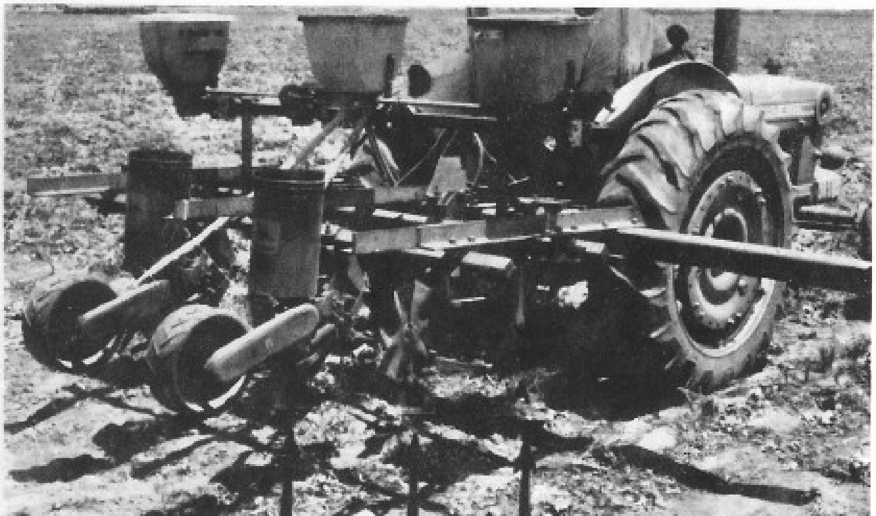

Fig. 2. Minimum-tillage planting equipment for fall corn that included a root cutter, a fluted coulter, and a flex planter mounted for fall corn planting.

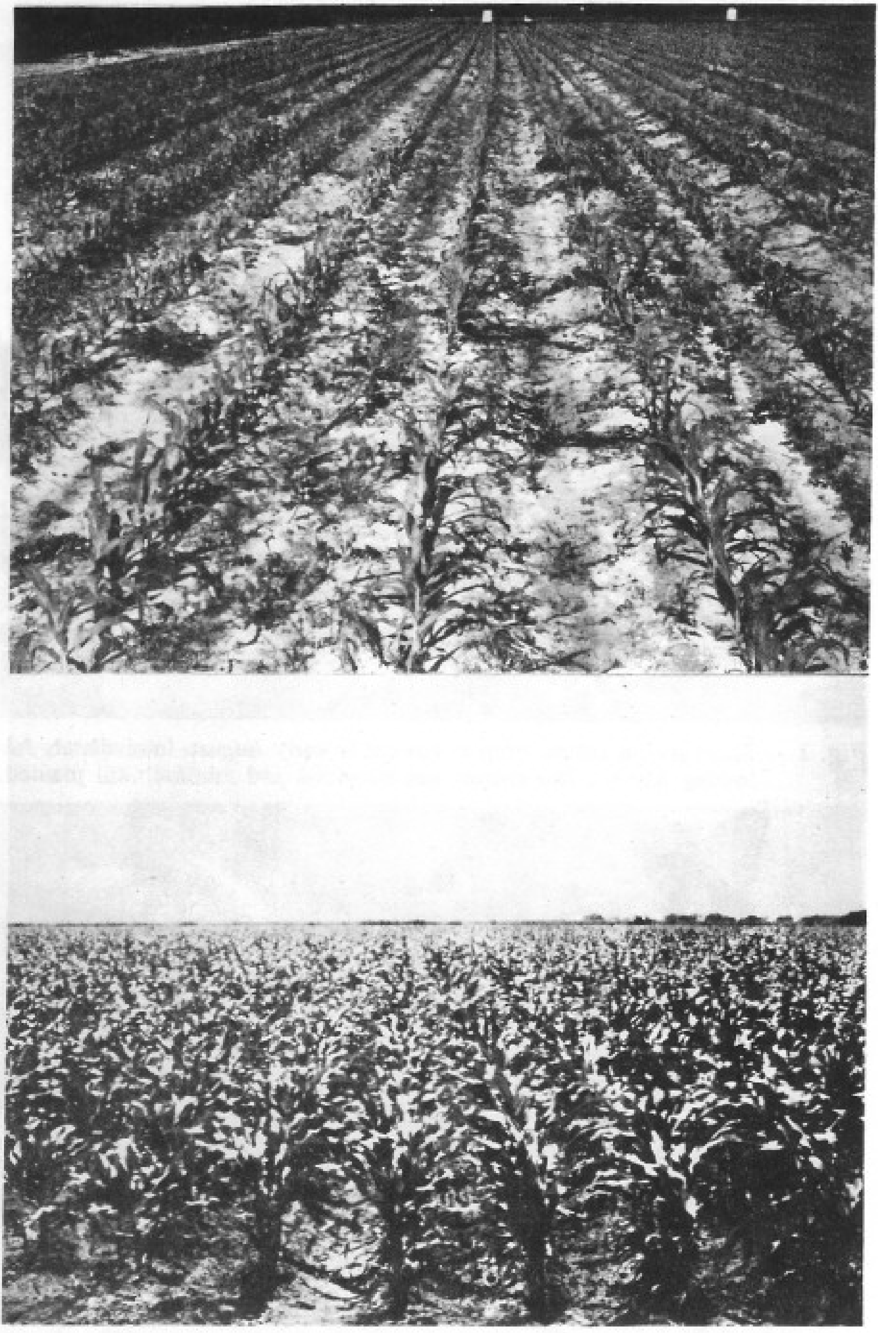

Fig. 3. Corn stand achieved with the minimum-tillage undercut and planting method shown in Fig. 2. Top, stand in early season; bottom, corn approaching the tassle growth stage.

The stand of corn is shown during early season and pretassle growth stages in Fig. 3. Corn yields following the short-season cotton crop averaged 2490 lbs/acre. Harvest date for corn was December 9. Fall corn yields on a medium-textured soil of 4700 lbs/acre have been achieved with the minimum-till planting technique. When we find the best cultivars for fall planting and cultural practices, a yield of 4800 lbs/acre is anticipated. This would be a profitable yield plus the additional conservation benefits of the crop residues and reduced tractor and tillage compaction benefits of minimum tillage.

A minimum time lapse of three days was required for the spring crop destruction before irrigation of the second crop. With conventionally used tillage and planting techniques, 7 to 10 days is required for crop destruction and seedbed preparation, assuming that rainfall does not interfere. In August, the rainfall frequencies increase, therefore it is often impossible to plant. With the minimum-tillage planting system, the second crop can be reasonably expected to be planted.

The conservation benefits of keeping plant residues on the surface and reduced compaction have not been determined. It is anticipated that overall production efficiency and natural resource conservation can be improved by the minimum tillage-planting technique.

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The onset of rain is shown during early [illegible] growth stages in Fig. 3. [illegible] corn [illegible] 2400 [illegible] [illegible] medium-textured soil of 4500 [illegible] [illegible] [illegible] would be [illegible] yield [illegible] [illegible] [illegible].

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The [illegible] benefits of [illegible] for the surface and reduced [illegible]. It is [illegible] that overall [illegible] can be improved by the [illegible] double-cropping technique.

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Use of a Near-Infrared Video Recording System for the Detection of Freeze-Damaged Citrus Leaves

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ABSTRACT

A video recording system with a visible light blocking filter to give sensitivity in the 0.78 to 1.1 μm waveband detected freeze-damaged citrus leaves rapidly. With this technique, the time to analyze images can be decreased from about one day for conventional photography to less than one hour for video recording.

Spectrophotometric reflectance measurements detected freeze-damaged sour orange (*Citrus aurantium* L.) leaves within 5 hours after freezing temperatures; infrared and conventional color photography did not detect the damage for about 30 hours (3, 7, 8). The usefulness of reflectance for leaf freeze detection was further substantiated in studies with the cotton (*Gossypium hirsutum* L.) plant (5, 6). However, the use of narrow-band photography on citrus plants for leaf freeze detection warrants further investigation (2).

Our objective was to test a video recording system with a visible light blocking filter to give sensitivity in the 0.78 to 1.1 μm near-infrared waveband to quickly detect citrus leaf freeze damage. We wanted to decrease the time to analyze images from about one day for conventional photography to less than one hour by video recording.

MATERIALS AND METHODS

One-year-old sour orange seedlings were grown in pots in an unshaded greenhouse cooled with air circulated through moist pads. Temperatures ranged from 23.9 to 35.0 C, and humidity ranged from 70 to 95%. Ten plants were transferred to a freezing chamber (frozen), and 10 plants were left in the greenhouse (nonfrozen). The freezing chamber temperature regime was 4.4 C for 1 hour after which it was decreased at a rate of 1.1 C/hour until it reached -7.8 C, where it remained for 4 hours. The temperature was then increased to 4.4 C at a rate of 1.1 C/hour.

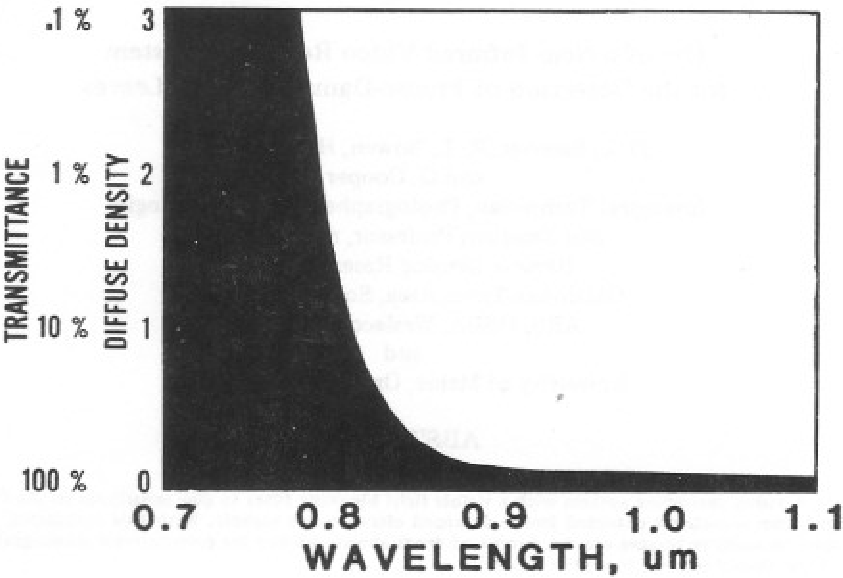

Fig. 1. The light transmittance for the Kodak Wratten Filter No. 87C.

Spectrophotometric Measurement. Reflectance measurements were made in less than 10 minutes on leaves collected from each frozen and nonfrozen plant held in the dark at 4.4 C. The leaves were taken from about 25 cm below the plants' apexes.

A Beckman Model DK-2A spectrophotometer, equipped with a reflectance attachment, was used to measure total diffuse reflectance on upper (adaxial) surfaces of single leaves over the 0.5 to 2.5 μm waveband (WB). Data were corrected for decay of the barium sulfate standard to give absolute radiometric data (1).

Leaf thickness was measured with a linear-displacement transducer and digital voltmeter (4). Water content of the leaves was determined by over-drying at 68 C for 48 hours, cooling in a desiccator, and weighing.

Twenty-four hours after completing spectral measurements, the frozen and nonfrozen plants were removed from the chamber and the greenhouse, respectively, and transferred to an automobile parking lot in juxtaposition for video recording. At that time, frozen plant leaves had no external evidence of freeze damage. The day was sunny and slightly windy with a temperature of about 25 C.

Video Recording. Nonfrozen and frozen plants were video recorded at a distance of about 6 m above their tops with a Sony Portable Video camera AVC-3450 modified with RCA Ultricon^{TM}4875/U camera tube to increase the near-infrared sensitivity from the 0.95-μm upper limit for infrared photography to 1.1 μm. A Kodak Wratten Filter No. 87C was used with the video camera to block the visible light and to allow transmittance of light from the 0.78 to 1.1 μm WB (Fig. 1).

The video camera was connected to a Betamax portable video cassette recorder, Model SLO-340. Immediately after video recording plants, the tapes were played back in a Betamax video cassette player, Model SLP-303, connected to a Panasonic Video Monitor, Model CT 1910M. The recorded imagery was analyzed visually in about 5 minutes. Video images were photographed from the video monitor with Kodak panchromatic B&W film.

RESULTS AND DISCUSSION

Spectrophotometric Measurements. Reflectances for frozen and nonfrozen citrus leaf over the 0.5 to 2.5 μm WB are shown in Fig. 2. Frozen leaf

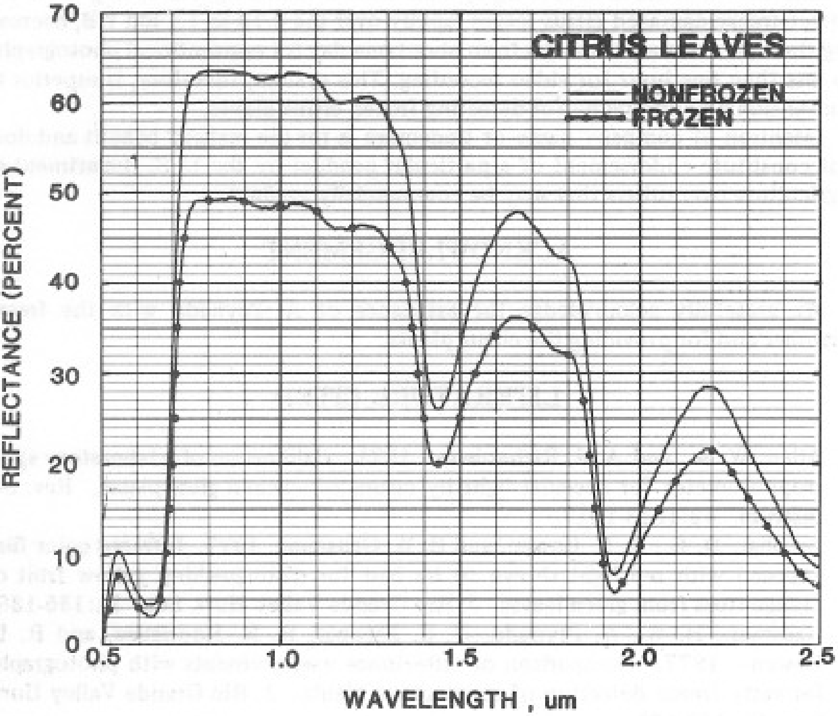

Fig. 2. Light reflectances for frozen and nonfrozen citrus leaves over the 0.5 to 2.5 μm WB.

reflectances were significantly lower (p = 0.01) than those of nonfrozen leaves over the entire WB. However, the largest difference between them occurred within the 0.75- to 1.35-μm WB.

The frozen and nonfrozen leaves that were used for the spectral measurements had similar water contents, 65.1 to 64.9%, respectively. Frozen leaves, however, were significantly (p = 0.01) thinner (0.128 mm) than nonfrozen leaves (0.156 mm). Apparently, frozen leaf cells collapsed, and leaf turgidity was decreased (3).

Video Recording. A photograph of the frozen (upper-right-hand cluster) and nonfrozen (lower-left-hand cluster) citrus plants from a video recording is shown in Fig. 3. The whitish appearance of the nonfrozen plant cluster resulted from high near-infrared light reflectance; whereas, the opaque appearance of the frozen plant cluster was caused by lower near-infrared light reflectance. Although frozen leaves had lost their water-soaked appearance at the time of video recording, the imagery still distinguished them from the nonfrozen leaves because of their low light reflectance (7). Therefore, the effectiveness of this video system with the visible light blocking filter was caused by the higher reflectance of nonfrozen leaves than that of frozen leaves over the 0.78 to 1.1 μm WB (Fig. 2).

The use of a video recording system with a visible light blocking filter can detect freeze-damaged citrus leaves rapidly over the 0.78 to 1.1 μm WB, decreasing the time to analyze images from about one day for conventional photography to less than one hour for video recording. This system, therefore, is superior to conventional photography for detecting frozen citrus plants.

(Mention of company name or trademark is for the readers' benefit and does not constitute endorsement of a particular product by the U. S. Department of Agriculture over others that may be commercially available.)

ACKNOWLEDGEMENT

We gratefully acknowledge the assistance of A. Peynado with the freeze chamber and for providing the citrus plants.

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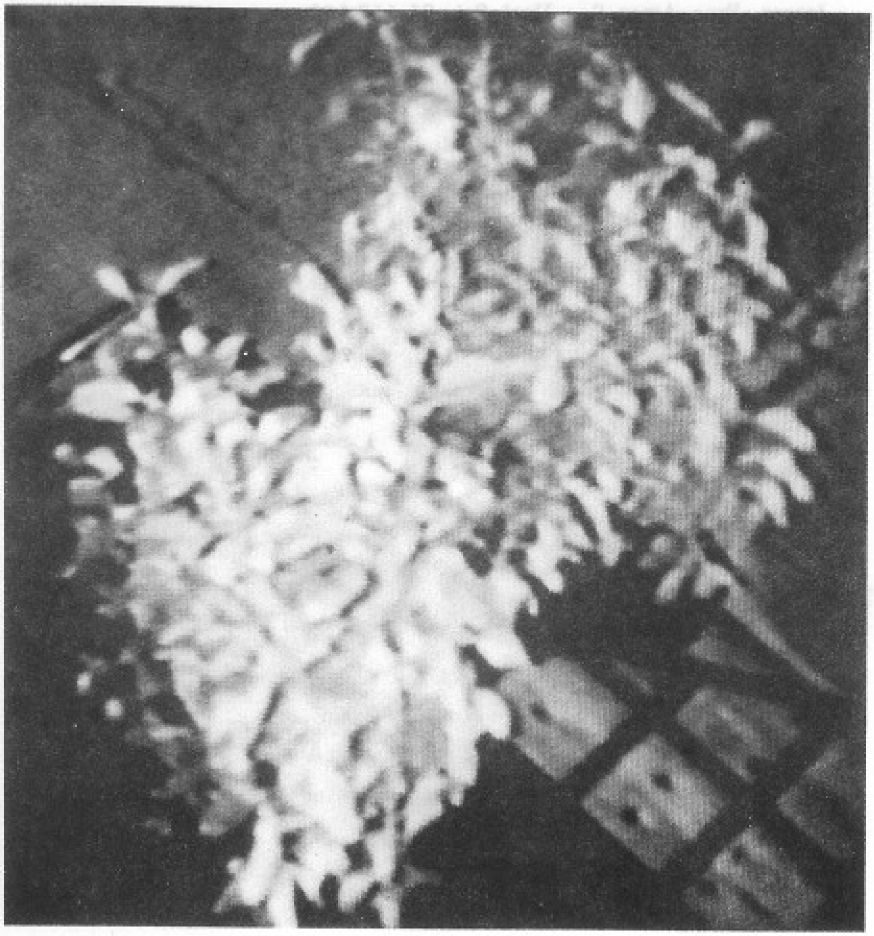

Fig. 3. A photograph of the frozen (upper-right-hand cluster) and nonfrozen (lower-left-hand cluster) citrus plants.

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Nutrition of Young 'Star Ruby' Grapefruit

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ABSTRACT

Yields of 'Star Ruby' grapefruit on sour orange rootstock growing on Hidalgo clay loam over six seasons, age five thru ten, ranged from less than 1 to more than 22 tons/acre. Variables were nitrogen and phosphorus fertilizer rates and zinc or manganese foliar sprays or both. Trees fertilized with 2 and 4 pounds of N/tree/year or those receiving manganese sprays were the most productive.

'Star Ruby' grapefruit (*Citrus paradisi* Macf.) a seedless, deep-red-fleshed cultivar derived from seedy 'Hudson' grapefruit, was released in Texas in 1970 (5). Early experience indicates the new cultivar to be more sensitive to stress or adverse conditions than the standard 'Ruby Red' grapefruit (3, 6, 10). Irregular bearing and low fruit production has been observed in some orchards. Speculation as to the cause of unfruitfulness ranges from nutritional disorders to nucellar vigor or juvenility (1, 2).

Leaves of 'Star Ruby' tend to be lighter green in color than those of other grapefruit varieties growing under the same conditions in Texas and often exhibit foliar symptoms suggestive of nutritional deficiencies. Nutritional studies with 'Ruby Red' grapefruit in Texas indicate a yield response to nitrogen (N) at 1 lb N/tree/year with no additional response to rates up to 4 lb N. There is no response to phosphorus (P) at rates up to 2 lb P/tree/year nor any significant N x P interaction (7, 8, 9). The work reported here was undertaken to learn something of the nutritional needs of young 'Star Ruby' trees.

MATERIALS AND METHODS

'Star Ruby' grapefruit on sour orange (*C. aurantium* L.) rootstock were planted on a 3 acre block of Hidalgo clay loam soil (Typic Calciustoll) in March 1971. Spacing was 18 x 24 (100 trees/acre). A split plot experiment was designed in three replications with N and P fertilizer rates as main plots and micronutrient sprays as sub-plots. There were two test trees in each sub-plot.

The N and P rates were established in January 1974 and applied each year in December/January. Treatments, in pounds of element/tree/year were:

N 1 lb, P zero
N 1 lb, P 0.5 lb
N 2 lb, P zero
N 2 lb, P 1 lb
N 4 lb, P 2 lb

Urea was the source of N and treble superphosphate the source of P. Foliar sprays of zinc (Zn), manganese (Mn), or both were applied in May each year 1974-78 using liquid chelate (Ciba-Geigy Corporation) at the rate of 1 qt liquid chelate in 100 gal water with 10 gals sprayed/tree which supplied 0.25 oz of metal/tree. Beginning in 1979 foliar applications were made March and July each year with sulfates of Zn and Mn at 1 lb/100 gal and 10 gals sprayed/tree which supplied annually 0.73 oz Zn and 0.79 oz Mn/tree.

Hedging of the orchard was necessary to permit passage of spray equipment in January 1978 and again in December 1980. All fruit was harvested by individual trees in December/January each season.

RESULTS

Nitrogen — Phosphorus. Highly significant differerences in yield attributable to NP rates were found in each of the 6 years of record (Table 1). In 1976 trees fertilized with N_4P_2 produced 17.8 tons/acre, about 5 tons more than the average of all other treatments. In 1977 yields from all treatments receiving at least N_2 were significantly greater than (P=.01) those receiving N_1. During 1977 the need for hedging became imperative. The trees were hedged in late January 1978 when flower bud differentiation had already taken place (4). On trees in the N_2 or N_4 treatments, which had bigger canopies, larger limbs were cut and more wood and leaves were lost than from trees in the N_1 treatment. Yields of N_2 and N_4 trees were severely reduced while yields of N_1 trees increased from the previous year.

Highest yields in all treatments were produced at 8 years of age and one season after hedging. Trees fertilized with N_2 produced significantly more (P=.01) fruit than any other treatment. All yields were depressed in 1980 but yields of trees fertilized with N_1 were significantly greater than from the other treatments. In 1980 the trees became crowded again and they were hedged immediately after harvest in mid-December in an effort to avoid the drastic effect on yield following the late hedging in 1978. The 1981 yields suggest that the early hedging did modify the yield reducing effects at the higher N rates.

Zinc — Manganese. Significant differences between micronutrient treatments occurred only in 1980, a year of low yields. There were highly significant (P=.01) differences in 6-year average yields between micronutrient treatments (Table 2). Plots receiving Mn sprays averaged 1.4 tons/acre more than those receiving no micronutrients. Differences between plots sprayed with Zn and the unsprayed controls were not significant.

The Zn content of leaves from trees receiving no Zn was consistently low or deficient. A single Zn spray/year, applied in the spring, raised the level to the optimum range for at least 6 months but permitted it to drop before spraying the following spring. When the trees were sprayed twice a year the Zn level was maintained in the optimum range thruout the year.

Without added Mn leaf tissue levels tended to be low in the spring but optimum in summer and fall. A single Mn spray in the spring kept the Mn level in the optimum range for about half the trees. As with Zn, increasing the Mn sprays to twice a year maintained the leaf tissue in the optimum range from one year to the next.

Table 1. Yield of 'Star Ruby' grapefruit in tons an acre, age 5 thru 10 years, 1976 thru 81, Weslaco, TX.

Macronutrients[z]		Micronutrient Sprays[y]				
N	P	0	Zn	Mn	Zn+Mn	Ave N,P effect
				(tons an acre)		
				1976		
1	0	9.5	8.5	11.1	16.8	11.5 B[x]
1	0.5	13.2	12.9	14.1	9.7	12.6 B
2	0	10.9	11.3	11.4	14.4	11.8 B
2	1	10.6	12.4	12.8	13.4	12.0 B
4	2	18.9	18.7	14.5	16.8	17.8 A
Ave. Micronutrient effect		12.6	12.8	12.8	14.2	NS
				1977		
1	0	3.7	2.1	0.7	12.8	4.8 B
1	0.5	0.5	1.0	9.8	0.9	3.1 B
2	0	18.2	17.2	17.7	22.8	19.0 A
2	1	18.4	16.7	17.2	22.0	18.6 A
4	2	17.5	14.0	16.2	9.8	14.4 A
Ave. Micronutrient effect		11.7	10.2	12.3	13.7	NS
				1978		
1	0	5.4	8.5	8.6	4.6	6.8 A
1	0.5	9.5	14.1	14.2	10.2	12.0 A
2	0	0.8	0.4	0.4	0.8	0.6 B
2	1	1.4	1.3	1.5	0.9	1.3 B
4	2	2.3	1.7	2.1	2.1	2.1 B
Ave. Micronutrient effect		3.9	5.2	5.4	3.7	NS
				1979		
1	0	16.8	15.2	12.2	18.6	15.7 B
1	0.5	12.3	12.6	16.3	10.4	12.9 C
2	0	16.2	20.9	18.5	24.8	20.1 A
2	1	19.8	18.5	22.8	22.2	20.8 A
4	2	18.2	17.2	20.8	15.3	17.9 B
Ave. Micronutrient effect		16.6	16.9	18.1	18.3	NS
				1980		
1	0	2.8	5.7	5.7	2.8	4.3 B
1	0.5	5.9	9.3	9.4	8.2	8.2 A
2	0	0.8	1.1	0.7	1.3	1.0 C
2	1	0.6	0.4	0.5	1.0	0.6 C
4	2	0.6	0.7	0.7	0.5	0.6 C
Ave. Micronutrient effect		2.1c	3.4a	3.4a	2.8b	
				1981		
1	0	4.6	3.2	0.2	11.5	5.1 C
1	0.5	1.9	1.3	10.4	2.1	3.9 C
2	0	11.9	13.6	14.7	14.7	13.8 A
2	1	8.0	10.6	8.2	12.6	9.8 B
4	2	12.2	13.8	12.8	13.1	13.0 A
Ave. Micronutrient effect		9.3	8.5	9.4	10.8	NS

z pounds/tree/year, soil applied December or January.
y foliar sprays applied in May, 1975 thru 1978, in March and July 1979 thru 81.
x means separated by Duncan's Multiple Range Test.

Table 2. Average annual yield of 'Star Ruby' grapefruit over 6 seasons, age 5 thru 10, as influenced by nitrogen and phosphorus rates and micronutrient sprays.

Macronutrients[z]		Micronutrient Sprays[y]				
Nitrogen	phosphorus	0	Zn	Mn	Zn+Mn	Ave N,P effect
(pounds/tree/year)		(yield, tons/acre)				
1	0	7.3 A[x]	7.2 A	6.6 A	11.1 D	8.1 A
1	0.5	6.9 A	8.5 BC	12.0 DE	7.3 A	8.7 A
2	0	9.4 C	11.2 D	11.9 D	13.1 E	11.4 B
2	1	10.2 CD	11.1 D	11.0 CD	12.0 DE	11.1 B
4	2	12.2 E	11.9 D	12.5 E	9.6 CD	11.6 B
Ave micronutrient effect		9.2 A	9.8 A	10.6 B	10.6 B	

z pounds/tree/year, applied in December or January.

y foliar sprays applied in May, 1975 thru 1978; in March and July 1979 thru 1981.

x means separated by Duncan's Multiple Range Test (P=0.01). Comparison of the interactions between N, P rates and micronutrient sprays are made within the boxed area.

DISCUSSION

Altho the experimental design does not permit separation of N and P effects on yield, the leaf analysis strongly supports N as the factor most influencing yields. The leaf level of P was in the optimum range with all treatments at all samplings. Where 2 or more pounds of N were applied leaf N was optimum (>2.2%). Where N_1 was applied leaf N was low or deficient (<2.0%) in the spring and sometimes remained low at the summer sampling.

'Star Ruby' trees not producing satisfactory yields should get nitrogen at the rate of 2 lb N/tree/year. With respect to micronutirents, the best recommendation in the light of the results reported here, is to monitor the orchard with leaf analysis between May and September. Where Mn or Zn are in the optimum range yield increases are not likely. Where these micronutrients are low or deficient an effort should be made to bring them to the optimum range with one or two foliar sprays a year.

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Germination and Growth of Seedlings From Dried Sour Orange Seeds

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ABSTRACT

Germination of sour orange (*Citrus aurantium* L.) seeds air dried for more than 1 day was delayed and germination rates were decreased. A gibberellic acid seed soak reversed the effect of drying and resulted in taller seedlings with greater stem dry weight. Stratification and a water soak did not reverse the adverse effects of air drying.

Seeds of most citrus species germinate readily when planted immediately after extraction from mature fruit (8). Dry seeds allow for easier handling, but tend to have decreased germinability. Duncan grapefruit, Pineapple sweet orange, and rough lemon seeds lose viability when stored under laboratory conditions (7). Seeds of trifoliate orange, (*Poncirus trifoliata* (L.) Raf.), a close relative of *Citrus*, are extremely sensitive to drying; thirty minutes exposure to the sun or three hours in the laboratory significantly reduces germination (9).

The effects of drying on sour orange seeds has not been studied extensively. Work by Barton (1) indicates that sour orange seeds are only slightly sensitive to drying. More recent studies on the effects of drying on rootstock seeds have not included sour orange (6, 7). The omission of sour orange in most other seed drying studies and its importance to the citrus industry in Texas prompted this investigation. The objective of this study was to further quantify the response of sour orange seeds to drying in terms of germinability and subsequent seedling growth. Attempts were also made to determine if stratification and growth regulator treatments would overcome dry storage inhibition of seed germination.

MATERIALS AND METHODS

Seeds of sour orange (*Citrus aurantium* L.) were extracted by hand from mature fruit in May, 1982. The seeds were washed in tap water and blotted dry with paper towels. Ten randomly selected seeds were weighed to determine the mean fresh seed weight. One hundred freshly harvested seeds were immediately sown in two 11 cm x 24 cm x 43 cm wood flats that were divided in half. This resulted in 4 replicates of 25 seeds each in two flats. The seeds were sown in a soilless mix containing 11 parts peat moss, 6 parts vermiculite and 3 parts sand. The flats were placed in a greenhouse at 26-35° C on a bench containing heating cables embedded in perlite. The cables were thermostatically controlled to provide 35° C bottom heat. The seeds were hand watered with tap water every 1-3 days and left on the bench under natural daylength conditions for 40 days after sowing.

The remaining seeds were spread out on aluminum foil to dry on a laboratory bench. The laboratory temperature was 25 ± 2.5° C and relative humidity ranged from 52-70%. Seeds were allowed to dry for 1, 2, 4, 8, and 14 days. After each drying period mean seed weights were determined and one hundred dried seeds were sown as above.

Some seeds dried for 14 days were treated further by stratifying for 20 days at 3-4° C or by soaking in distilled water or 1000 ppm gibberellic acid (GA_3) for 24 hours. Each treatment consisted of 100 seeds sown as above.

Forty days after each sowing the heights of the seedlings were measured *in situ*. The seedlings were then removed from the flat, washed in water, and placed in an oven at 70° C for 3-4 days to obtain dry weights of leaves, stems, and roots.

The data were analyzed using the analysis of variance and means were separated by Duncan's New Multiple Range Test or standard deviations.

RESULTS

Seeds left to dry on the laboratory bench decreased in weight during the first two days (Fig. 1). At that time the dried seeds had lost ca. 47% of their fresh weight. Additional weight loss did not occur after this period.

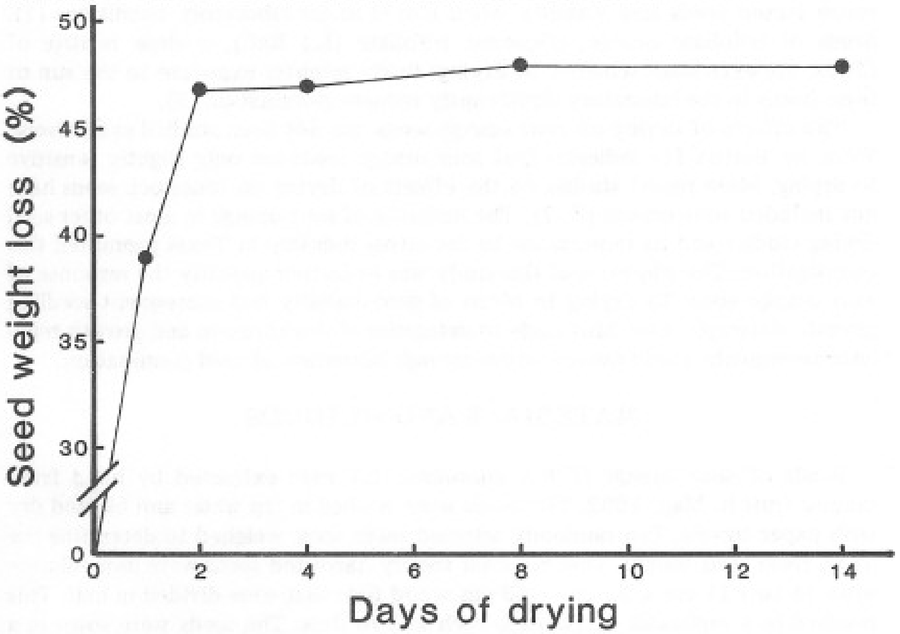

Fig. 1. Loss of fresh weight of sour orange seeds with time of air drying in the laboratory.

Drying the seeds for more than 1 day significantly inhibited germination (Fig. 2). The main effects of drying were to delay germination and to decrease the rate of germination. Fourteen days after sowing, undried seeds and those seeds dried for 1 day exhibited 10-17% germination, whereas seeds dried for more than 1 day had germination percentages less than 4%. From 14 to 30 days after sowing, undried seeds and those seeds air dried for one day exhibited higher germination percentages than those seeds dried for more than 1 day. By the 40th day after sowing, however, there were no significant differences in germination percentage between the seeds dried for 2-14 days and undried seeds.

The inhibition of germination by drying was overome with 1000 ppm GA_3 (Fig. 3). Seeds dried for 14 days and treated with GA_3 germinated as well as undried seeds, while seeds dried for 14 days and untreated, soaked in water or cold-treated for 20 days germinated slower than undried seeds. After 35 days, seeds dried for 14 days and treated with GA_3 reached the germination percentage of undried seeds.

Seedling height was increased by ca. 50% only when the seeds were treated with 1000 ppm GA_3 (Table 1).

Dry weight of leaves and roots was unaffected by any of the seed treatments (Table 1). However, stem dry weight of seedlings from seeds treated with GA_3 was significantly increased.

DISCUSSION

Drying of sour orange seeds for 2 days or more at room temperature inhibited germination. Coincident with this inhibition was the lack of additional water loss after 2 days. This suggests that sour orange seeds have a threshold water content, below which germination is inhibited. The results from seeds dried for 14 days and then soaked in water for 24 hours indicated that the loss of water was not the only controlling factor in germinability. Based on other studies (4, 6), a 24-hour soak should be enough time for the dried seeds to imbibe the water that was lost during drying, yet those seeds dried 14 days and then soaked in water for 24 hours did not germinate as well as undried seeds.

Germination inhibitors might accumulate or concentrate as the seeds dry and thus explain the decreased germination rates of dried seeds. There is evidence that such inhibitors exist in the seed coats of undried citrus seeds (4). The inhibition of germination by the seed coat has been overcome by removal or by water soaks (3, 4). As has been mentioned, a 24-hour water soak after drying for 14 days was not beneficial in the present study.

Gibberellic acid was able to reverse the effect of drying on sour orange seed germination. Seeds dried for 14 days and then soaked in 1000 ppm GA_3 germinated as well as undried seeds. This suggests that germination inhibition after drying might be due in part to lower gibberellin levels in the seed (6).

Gibberellin and cold treatments have been shown to benefit citrus seed germination (2, 3, 5). In this study, germination was not enhanced when seeds dried for 14 days were held at 3-4° C for 20 days.

Gibberellic acid treatment increased the height of the seedlings and dry weight of stems without sacrificing leaf or root dry weight. The increase of seedling height and stem dry weight supports the fact that gibberellins increase cell division in the sub-apical meristem and do cause elongated internodes in

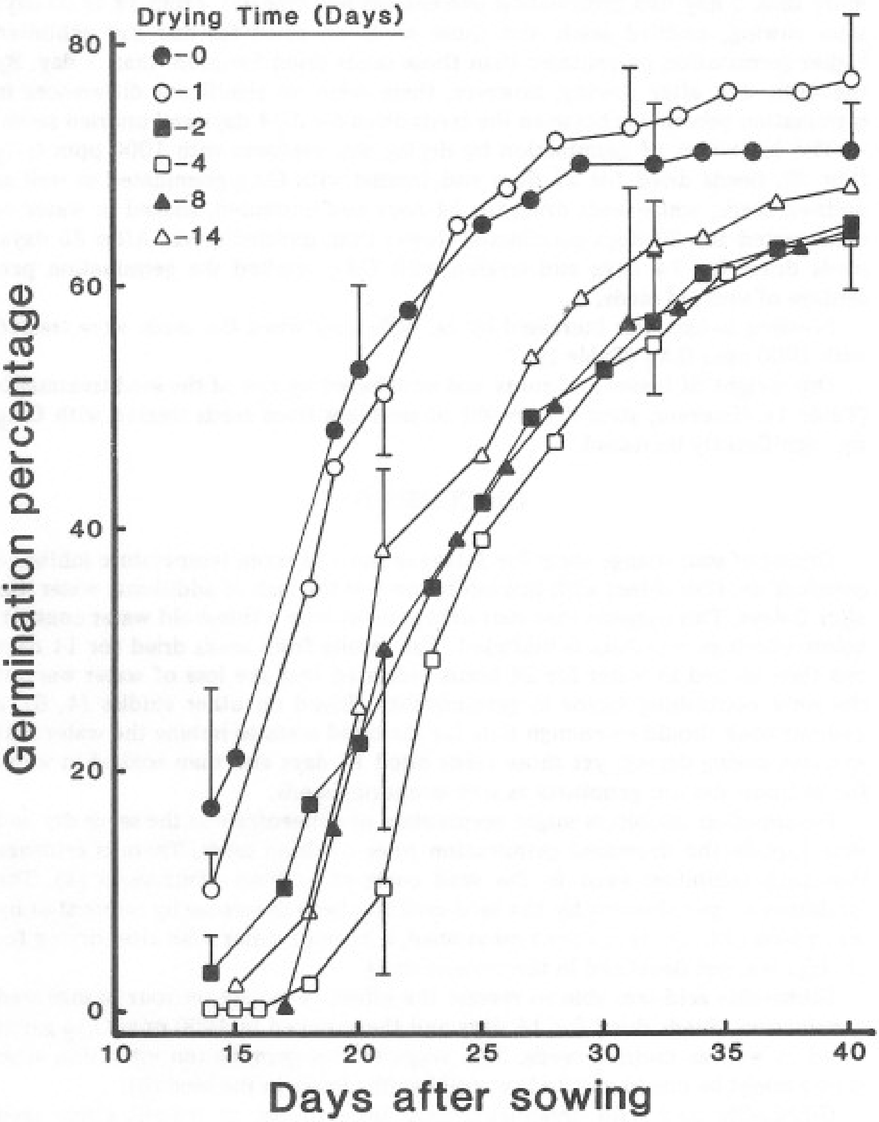

Fig. 2. Time course of sour orange seed germination. Seeds dried from 0-14 days before sowing. Bars represent ± SD of the mean of 4 replicates consisting of 25 seeds each.

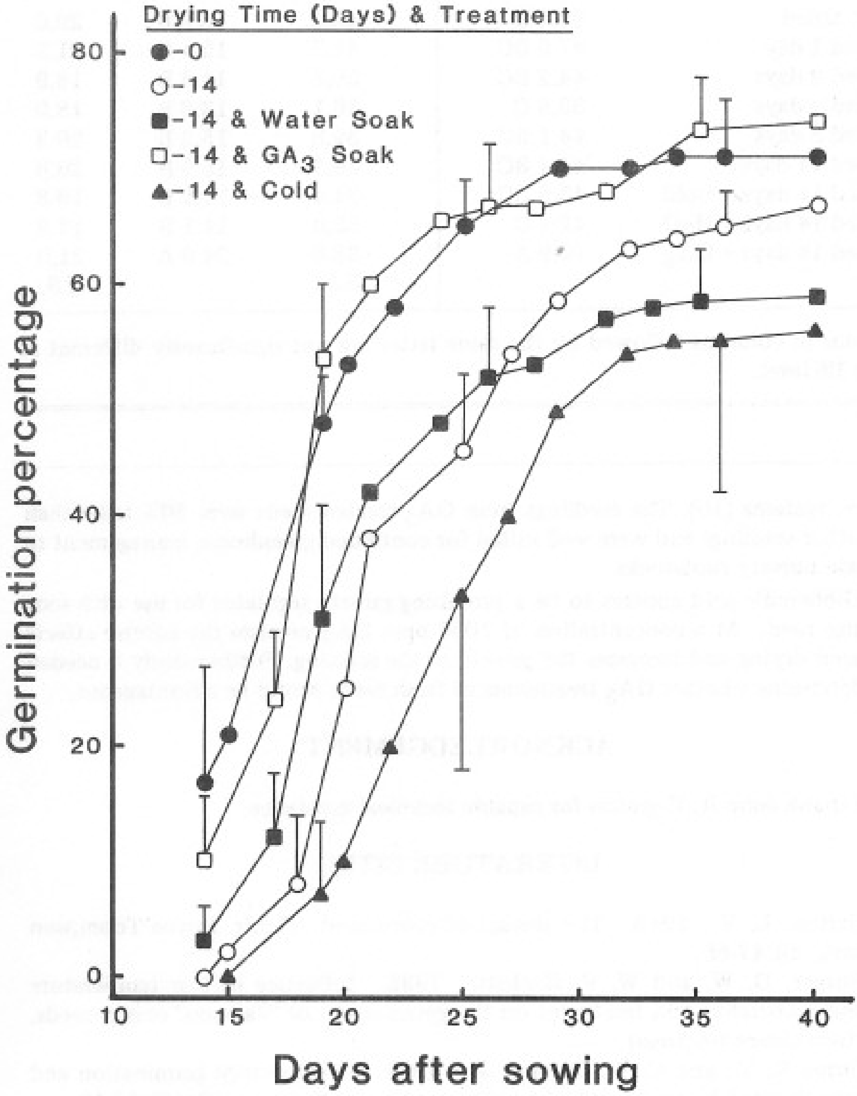

Fig. 3. Time course of sour orange seed germination. Bars represent ± SD of the mean of 4 replicates consisting of 25 seeds each.

Table 1. Height and dry weight of sour orange seedlings 40 days after sowing the seed.

Seed Treatment	Seedling Height (mm)	Dry weight (mg) Leaves	Stems	Roots
Not Dried	50.4 B	43.0	16.8 B	20.0
Dried 1 day	47.0 BC	41.7	15.4 B	21.7
Dried 2 days	44.2 BC	39.4	14.3 B	18.9
Dried 4 days	39.8 C	36.1	13.8 B	18.0
Dried 8 days	44.1 BC	39.8	15.2 B	20.3
Dried 14 days	44.4 BC	44.1	16.5 B	20.8
Dried 14 days + Cold	43.2 BC	34.4	14.5 B	18.8
Dried 14 days + H_2O	42.7 C	33.0	14.1 B	17.3
Dried 14 days + GA_3	70.9 A	38.8	24.0 A	21.0
		N.S.		N.S.

Means in columns followed by the same letter are not significantly different at the 1% level.

other systems (10). The seedlings from GA_3-treated seeds were 50% taller than all other seedlings and were well suited for continued greenhouse management to obtain nursery rootstocks.

Gibberellic acid appears to be a promising growth regulator for use with sour orange seeds. At a concentration of 1000 ppm GA_3 reverses the adverse effects of seed drying and increases the growth of the seedling. Further study is needed to determine whether GA_3 treatments of fresh seeds would be advantageous.

ACKNOWLEDGEMENT

I thank John R. Wiginton for capable technical assistance.

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Evaluation of Carbosulfan for Rust Mite Suppression on Texas Citrus

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ABSTRACT

Carbosulfan at rates as low as 1 oz ai/100 gal, demonstrated efficacy against citrus rust mite, *Phyllocoptruta oleivora* (Ashmead) on Texas citrus. In 1979, a program of 3-4 oz carbosulfan ai/100 gal applied by handgun (1000 gal/acre) at post bloom, summer and fall provided full season rust mite suppression. In 1980, 10 and 15 oz carbosulfan ai/acre applied by commercial air blast sprayer at 250 gal/acre to mature grapefruit trees gave mite suppression equal or superior to that by chlorobenzilate (32 oz ai/acre) or Ethion (64 oz ai/acre). Mite suppression with the carbosulfan high rate exceeded 12 weeks postspray.

Carbosulfan (Advantage[R]), a new insecticide-acaricide product of FMC Corporation, was recently granted an experimental use permit for Texas citrus by the Environmental Protection Agency. Tested as experimental FMC 35001, carbosulfan has demonstrated efficacy against the citrus rust mite, *Phyllocoptruta oleivora* (Ashmead), in acaricide screening trials at the Texas A&I University Citrus Center. Results of carbosulfan trials conducted during the 1979 and 1980 seasons are reported here.

METHODS AND MATERIALS

Carbosulfan Formulation and Spray Application. Carbosulfan, 2,3-dihydro-2, 2-dimethyl-7-benzofuranyl [(dibutylamino) thio] methylcarbamate, formulated as a 2.5 lb ai/gal emulsifiable concentrate, was tested both as a high volume dilute spray (ca. 1000 gal/acre) and as a semi-dilute spray (250 gal/acre). High volume sprays were applied with a John Bean Model 1010-MTBT Sprayer[R] handgun at 225 psi, ca. 10-12 gal/tree. Semi-dilute sprays were applied with either a commercial John Bean F-357 CP Speed Sprayer[R] or a Lockwood Hardie Super 40 Sprayer[R]. Sprayer speed during application was 1 mph with pressure adjusted to 130 psi.

Citrus Rust Mite (CRM) Counts and Fruit Damage Evaluations. Efficacy of carbosulfan was determined by pre- and post-treatment mite counts made at 2-3 week intervals. In early season prior to fruit development CRM were counted on leaves; thereafter, CRM were counted on fruit after it attained $\geq$ 3.0 cm in diameter. A 10X handlens with a 1 cm^2 grid was used to count all life stages of CRM in 3 lens fields on the underside of each leaf and 1 lens field on the top, median and bottom of each fruit. One hundred leaves and/or fruit were selected at random and examined per treatment replicate, CRM counts were subjected to analysis of variance and separated by Duncan's multiple range test.

In full season efficacy trials mite feeding damage (russeting) was assessed on harvested fruit in November or December. One hundred fruit randomly selected from each treatment replicate were rated for damage severity. Fruit was downgraded if one half or more of the surface area was damaged. Damaged fruit in each treatment was expressed as 'Percent Russet.'

1979 Carbosulfan High Volume Spray Trial. Carbosulfan was compared to a standard acaricide (Ethion 4E) in a full season high volume spray trial on both 'Marrs' orange and 'Ruby Red' grapefruit. The test block of oranges contained 16-yr-old trees spaced 15ft x 20ft and the grapefruit test block had 6-yr-old trees spaced 24ft x 24ft. The following spray programs were compared in each block: Treatment 1 - carbosulfan at 1 oz ai/100 gal water applied at postbloom (PB)-May 14 with summer, (S)-July 12, and fall (F)-October 12, reapplications; Treatment 2 - carbosulfan at 3.2, 4 and 4 oz ai/100 gal, applied at PB, S, and F, respectively; and Treatment 3 - Ethion 4E at 8 oz ai/100 gal applied PB, S, and F. All treatments were replicated 4 times on single-tree plots in a completely randomized design. No adjuvants or sticking agents were used in any treatment. Mite counts were not continued after the fall spray; this application was made to prevent late season rust mite damage to fruit prior to harvest evaluations.

1980 Carbosulfan Semi-Dilute Trial Applied by Commercial Sprayer. Carbosulfan at 10 oz and 15 oz ai/acre was compared to the standard acaricides, chlorobenzilate (32 oz ai/acre) and Ethion (64 oz ai/acre), for efficacy against rust mite. Tests were conducted on 20-yr-old 'Ruby Red' grapefruit trees (16ft x 22ft spacing). Treatments were arranged in a randomized block design with 3 replicates; each replicate consisted of 2 rows of 6 trees, i.e. 36 trees/treatment. Treatments were applied April 22 (PB) July 17 (S) and October 8 (F). Treatments contained no additives.

RESULTS

1979 High Volume Dilute Trial. Carbosulfan demonstrated efficacy against citrus rust mite in tests on both grapefruit and oranges (Table 1 and 2). Season-long rust mite suppression was obtained with a carbosulfan spray program of 3-4 oz ai/100 gal applied at PB, S, and F. A program of 1 oz ai/100 gal carbosulfan applied in each of 3 sprays (PB, S, F) gave shorter residual with mite populations on grapefruit increasing significantly between the 3rd and 8th week following the July 12 application. During this same period the CRM populations declined in the untreated controls due to the already severe mite damage on the fruit. Percentage of russeted fruit at harvest was significantly lower ($P=0.05$) in all carbosulfan and Ethion treatments than in the untreated controls (Table 2). No phytotoxicity was observed following any treatments.

1980 Commercial Sprayer Trial. Citrus rust mite populations in test trees were insufficient for early season efficacy evaluations due to hot and dry weather, with less than 2 inches of precipitation during the period of April 1 - July 1, 1980. Rust mite numbers increased after hurricane Allen on August 9, 1980. Carbosulfan at 10 and 15 oz ai/acre applied by commercial air blast sprayer provided rust mite suppression equal to, or greater than, that by chlorobenzilate or Ethion (Table 3). Following the summer application all treatments,

Table 1. Counts of citrus rust mite on mature 'Marrs' orange trees receiving carbosulfan or Ethion treatments applied in dilute high volume spray by handgun, 1979.

		No. of Rust Mite/cm^2							
			1st Spray May 14			2nd Spray Jul 12		3rd Spray Oct 12	
Treatment	Rate oz ai/ 100 gal	Pre^z Spray	(+2)^y	(+4)	(+7)	(+3)	(+8)		Percent^x Russet
Carbosulfan	1.0^w	0.1	0.0	0.1_b^v	0.2_b	0.9_b	0.1_b		14_b
Carbosulfan	3.2,4.0^w & 4.0	0.1	0.0	0.0_b	0.1_b	0.0_b	0.1_b		2_c
Ethion	8.0^w	0.0	0.0	0.1_b	0.4_b	0.0_b	0.5_b		5_c
Control	-----	0.4	0.4	2.1_a	8.4_a	19.3_a	23.6_a		28_a

z Mite count on leaves

y Weeks post-spray, mite counts on fruit

x Percentage of fruit at harvest downgraded due to rust mite damage

w Rate used for postbloom, summer and fall sprays

v Treatment means per column separated by Duncan's multiple range test at P=0.05

Table 2. Counts of citrus rust mite on mature 'Ruby Red' grapefruit trees receiving carbosulfan or Ethion treatments applied in dilute high volume spray by sprayer handgun, 1979.

		No. of Rust Mite/cm^2							
			1st Spray May 14			2nd Spray Jul 12		3rd Spray Oct 12	
Treatment	Rate oz ai/ 100 gal	Pre^z Spray	(+2)^y	(+4)	(+7)	(+3)	(+8)		Percent^x Russet
Carbosulfan	1.0^w	0.0	0.0	0.1	1.1_b^v	2.1_b	53.1_a		16_b
Carbosulfan	3.2,4.0^w & 4.0	0.0	0.0	0.0	0.2_b	0.3_b	6.4_c		5_c
Ethion	8.0^w	0.0	0.0	0.1	2.8_b	3.0_b	7.7_c		7_c
Control	-----	0.0	0.0	0.1	10.7_a	61.6_a	19.5_b		54_a

z Mite count on leaves

y Weeks post-spray, mite counts on fruit

x Percentage of fruit at harvest downgraded due to rust mite damage

w Rate used for postbloom, summer and fall sprays

v Treatment means per column separated by Duncan's multiple range test at P=0.05

Table 3. Counts of citrus rust mite on mature 'Ruby Red' grapefruit trees receiving different acaricide treatments applied in semi-dilute sprays by Commercial sprayer, 1980.

		No. of Rust Mite/cm^2								
			1st Spray Apr 22			2nd Spray Jul 17			3rd Spray Oct 8	
Treatment	Rate oz ai/ Acre	Pre Spray[z]	(+2)[y]	(+5)	(+10)	(+3)	(+7)	(+12)	(+4)	Percent Russet[x]
Carbosulfan	10	0.1	0.0	0.1	0.2_{c}[w]	0.0_{b}	0.1_{b}	10.2_{b}	0.0_{b}	7_{b}
Carbosulfan	15	0.2	0.0	0.0	0.4_{c}	0.0_{b}	0.0_{b}	0.1_{c}	0.0_{b}	0_{b}
Ethion	64	0.1	0.0	0.1	2.9_{b}	0.0_{b}	0.0_{b}	3.2_{c}	0.0_{b}	3_{b}
Chlorobenzilate	32	0.1	0.0	0.1	0.5_{c}	0.0_{b}	0.1_{b}	4.4_{bc}	0.1_{b}	5_{b}
Control	----	0.2	0.2	0.4	8.9_{a}	1.4_{a}	3.8_{a}	19.4_{a}	2.3_{a}	20_{a}

[z] Mite count on leaves
[y] Weeks post-spray, mite counts on fruit
[x] Percent of fruit at harvest downgraded due to rust mite damage
[w] Treatment means per column separated by Duncan's multiple range test at P=0.05

except the high rate of carbosulfan, lost residual mite control by 12 weeks post spray. A significantly lower percentage of russeted fruit was harvested from all acaricide treatments (Table 3). No phytotoxicity was observed.

SUMMARY AND DISCUSSION

Results of these trials demonstrated the efficacy of carbosulfan against citrus rust mite. If labelled, carbosulfan would provide Texas citrus growers an added alternative acaricide for rust mite control. Tests are underway to determine carbosulfan's efficacy against 2 other important mites - Texas citrus mite, *Eutetranychus banksi* (McG), and citrus red mite, *Panonychus citri* (McG); however, preliminary data (author's unpublished) indicates that it is not effectively controlling these species.

Carbosulfan is hydrolyzed in aqueous solutions with the rate dependent on pH. Carbosulfan becomes progressively less stable at lower pH, e.g. it has a half-life of 22 hrs at pH 6 and only 1 hr at pH 4 (Advantage^R Technical Information, FMC Corp). Due to the Valley's alkaline water (pH 7.5 - 8.0) it has become increasingly common to add buffering agents to pesticide tank mixes. Since some of these agents at recommended rates can reduce tank mixes even below pH 5, precautions will have to be taken by growers when formulating mixes containing carbosulfan.

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Further Observations on Pecan Cultivar Adaptation in the Lower Rio Grande Valley

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ABSTRACT

Tree growth and nut yields are reported for 44 pecan, *Carya illinoensis* (Wang.), cultivars and USDA selections, grown in the subtropical Lower Rio Grande Valley of Texas. Trees were planted in 1974 either as nursery-budded or as seedlings that were later grafted in the field. 'GraBohls' and 'Chickasaw' were the most precocious with consistently highest yields of the nursery-budded trees. USDA selection 55-17-3 had the highest yields of the field-grafted trees and in 1982 outyielded all cultivars and selections.

A report by Madden and Hensz (1) in 1978 described the establishment of a pecan, *Carya illinoensis* (Wang.), cultivar adaptation test at the Texas A&I University Citrus Center in the Lower Rio Grande Valley. The response of certain cultivars and some selections from the USDA pecan breeding program to the subtropical, minimal-chilling growing conditions of the Valley is of primary interest in this planting. This report describes the progress of 21 cultivars and 23 numbered selections from planting in February 1974 through harvest in 1982. The study is a cooperative effort between the USDA-ARS and Texas A&I University.

'Riverside' seedlings and nursery-budded pecan trees from the USDA, W. R. Poage Pecan Field Station at Brownwood, Texas, were planted at the Texas A&I University Citrus Center in February 1974. The 44 varieties and selections, with only two or three trees each, were randomly arranged in the planting disregarding location of protogenous (late pollen) and protandrous (early pollen) types.

Two or three trees of each of the following were planted as nursery-budded trees with one-year-old budded tops on three-year-old 'Riverside' rootstocks:

Chickasaw	Gratex	GraBohls
Caddo	Wichita	Cheyenne
Cherokee	Choctaw	56-10-6
Desirable	Mohawk	

The 'Riverside' seedlings, three years old when planted, were inlay bark-grafted in April, 1977, three years after planting, with two each of the following cultivars and numbered selections:

Graking	52-1-9	48-15-3
Cape Fear	53-9-1	45-10-38
Shoshoni	56-6-148	55-11-11
Kiowa	48-3-33	48-13-311

Kernoodle	53-9-340	53-9-203
Tejas	55-17-3	64-11-17
Apache	49-20-112	53-11-139
Sioux	41-19-20	61-6-67
Gra-Cross	49-23-16	56-15-11
Shawnee	47-4-10	56-15-13
Forkert	N-2-43	62-11-26

Some of the seedlings required regrafting in 1978 and 1979 and some grafts were extensively damaged in 1980 by hurricane Allen.

The trees were planted 30 ft X 30 ft (48 trees/acre) on Hidalgo clay loam soil. A close-cut grass cover was maintained in the orchard and supplemental water was provided by flood irrigation. The irrigation schedule was the same as for nearby, full-grown citrus trees, five irrigations per year with approximately 6 inches of water per irrigation.

The orchard was fertilized in early winter with approximately 150 lbs of nitrogen per acre, either as urea or ammonium nitrate. Zinc sulfate was applied 2-3 times a year in conjunction with pesticide sprays.

The pest control program was limited to three sprays a year: the first application at full leaf, the second in early summer and the third during mid- to late summer. These sprays included Zolone or Cygon and Benlate or Du-Ter. Occasionally, an additional spray of Sevin or Thuricide was applied to control web worms.

OBSERVATIONS

Nursery-Budded Trees. Yields for these trees for 1978 through 1982 are shown in Table 1. The first nuts were produced in 1977, three years after planting. While most trees produced just a few scattered nuts, one 'GraBohls' tree produced over 200 nuts. 'Chickasaw' and 'GraBohls' consistently had the highest yields and are the most precocious in this group. 'Wichita', 'Mohawk' and 'Desirable', cultivars popular in the commercial pecan areas, are not as yet producing well here. Yields of some of the cultivars slightly dropped or gained little in 1982 when compared to the 1981 season.

'Chickasaw', a late pollen type, grew to 32 feet in height in 8-1/2 years. These fast growing trees would be ideal in a yard where there is plenty of room and a large tree is desired. Nut size is not large, numbering 55-65 to the pound. The trees of this cultivar averaged 34 lbs/tree in 1981, which, at a spacing of 48 trees/acre, would have produced over 1600 lbs of nuts/acre. Average yield dropped to 30 lbs/tree in 1982.

'GraBohls', a late pollen type, would have to be a favorite candidate for planting in the Rio Grande Valley. This cultivar produced nearly as many nuts as 'Chickasaw'; one tree yielded 43 lbs in 1981, 7-1/2 years from planting. The average of the three trees in 1981 and again in 1982 was 33 lbs, which, at their spacing, would have been nearly 1600 lbs/acre at 7-1/2 and 8-1/2 years. Nut size of 'GraBohls' is large, numbering 45-50 to the pound. 'GraBohls', a small tree, would be suited for high density planting in commercial orchards.

'Cheyenne', an early pollen type, is of interest in that it is precocious and is frequently used in other areas as a pollinizer for late pollen types. Yields, while not as high as for 'GraBohls' and 'Chickasaw', are comparable to the best of the

Table 1. Performance of pecan trees at Weslaco, Texas. Nursery budded trees with one-year-old scion on three-year-old 'Riverside' rootstock, planted February 1974.

		Yield lbs/tree[z]					Nuts/lb	Date 70% harvested			Tree size width/ht
Variety	Tree	1978	1979	1980	1981	1982		1980	1981	1982	9/1/82
Chickasaw	A	5	15	14	44	40	55-65	10/10	9/8	10/12	24'/32'
	B	11	13	20	24	20					32'/32'
Caddo	A	0	0	1	8	7	60-65	10/10	9/21	10/12	25'/40'
	B	0	1	2	12	13					24'/25'
	C	0	1	1	10	9					22'/26'
Cherokee	A	1	4	14	17	14	55-60	10/10	9/21	10/12	28'/24'
	B	2	2	8	19	7					22'/24'
	C	1	4	12	24	8					28'/24'
Desirable	A	0	1	1	5	10	40-50	10/27	10/8	10/12	22'/20'
	B	0	1	*	9	18					26'/22'
Gratex	A	0	1	2	5	18	40-45	10/10	9/28	10/12	28'/25'
	B	1	1	1	6	17					24'/22'
	C	0	0	1	6	12					24'/20'
Wichita	A	0	1	6	4	9	35-45	10/10	9/21	10/12	22'/30'
	B	0	0	4	7	5					24'/30'
	C	0	0	5	8	4					22'/30'
Choctaw	A	1	1	8	7	15	40-50	10/10	9/28	10/12	26'/30'
	B	1	1	7	11	25					32'/30'
	C	1	2	12	6	17					28'/24'
Mohawk	A	0	0	6	10	12	35-40	10/10	9/15	10/12	28'/30'
	B	0	1	8	10	17					28'/26'
Gra-Bohls	A	4	12	13	31	29	45-50	10/10	9/28	10/12	26'/22'
	B	3	13	16	27	32					24'/25'
	C	10	7	12	43	38					28'/22'
Cheyenne	A	1	1	4	8	15	55-60	10/10	9/28	10/12	24'/22'
	B	1	1	6	15	13					24'/22'
	C	2	1	5	16	14					24'/20'
56-10-6	A	0	0	2	16	16	60-65	10/10	9/14	10/12	40'/27'
	B	0	0	3	11	3					22'/25'
	C	0	0	*	4	1					25'/40'

[z] Weight rounded to nearest lb, (* denotes less than one lb).

remaining cultivars in this group. 'Cheyenne' produces medium size nuts that have excellent flavor.

'Choctaw', 'Gratex', and 'Mohawk', all late pollen types, had improved yields in 1982. All three cultivars have large nut size and, although not as precocious as 'GraBohls' and 'Chickasaw', may be of interest for commercial plantings if yields continue to increase.

Grafted Seedlings. These trees were allowed to grow in the field for three years before grafting with a named cultivar or USDA selection. Not all grafts were successful and some required regrafting in 1978 and again in 1979. Although it may be too early to make valid comparisons within this group or with the cultivars in the nursery-budded group, some useful observations can be made. The performance to date of the trees in this group are shown in Table 2.

Twelve of the numbered USDA selections have been omitted from Table 2 because they either have produced little or no crops or the size of the nuts were so small as to make their value doubtful.

Of the named cultivars, 'Shoshoni', a late pollen type, stands above the rest in size of the trees, nut size and yield. The two trees were 38 feet tall 5-1/2 years after grafting. Continued growth in tree size and increasing yield make this cultivar look promising. It had a problem with pre-harvest nut sprouting, 25%, in 1981. 'Sioux' had good crops in 1981 and 1982 but the nut size is medium to small, numbering 65-70 to the pound.

Several USDA numbered selections have produced good to excellent crops. An early pollen type, 55-17-3, outyielded all cultivars and selections in both groups in 1981 except 'Chickasaw' and 'GraBohls'. It had the highest yield of all cultivars and selections in 1982. Nut size is medium, numbering 60-65 nuts/lb. Other numbered selections that have yielded well are 48-3-33, 53-9-340, 49-20-112, 41-19-20 and 56-15-13. These all have good nut size, particularly 41-19-20 and 53-9-340.

Tables 1 and 2 show the approximate date when 70% of the nuts were harvested in 1980, 1981 and 1982. Of interest is the 2-3 week later harvest in 1980 and 1982 compared to 1981 and also the difference between cultivars and selections the same year. Inferior nuts begin to show up towards the end of the harvest.

Tables 1 and 2 also show, for each cultivar and USDA selection, the number of nuts/lb and the tree size 8-1/2 years after planting. The number of nuts/lb is a useful measure of the size of the nuts, the fewer nuts/lb the larger the nuts. Tree size is a measure of the early vigor of the planting and provides a comparison of the relative growth of the different cultivars and USDA selections.

DISCUSSION

Pecan trees live for many years and grow very large. Some cultivars may take longer to reach their full bearing potential than others that are more precocious. Yields presented here show only the progress these trees have made through their first 8-1/2 years from planting and may not be an indication of highest yielding cultivars when the planting is 15 to 20 years old.

Insect pests have not been controlled well with three sprays a year. Major pests have been aphids, stinkbugs, shuck worms and web worms. Aphids have been the

Table 2. Performance of pecan trees at Weslaco, Texas. Scions grafted in April 1977 on 'Riverside' rootstocks that were three years old when planted February 1974.

		Yield lbs/tree[y]			Nuts/lb	Date 70% harvested			Tree size width/ht
Variety	Tree[z]	1980	1981	1982		1980	1981	1982	9/1/82
Graking	A	2	1	3	35-40	10/10	10/8	10/21	12'/22'
	B(78)	0	0	0					10'/20'
Cape Fear	A	*	1	1	50-55	10/16	10/8	10/21	22'/30'
	B(78)	*	0	0					18'/35'
Shoshoni	A	3	10	14	40-45	10/27	9/29	10/21	22'/38'
	B	1	7	17					22'/38'
Kiowa	A(78)	*	2	4	40-45	10/16	10/8	10/13	16'/21'
	B	1	1	1					10'/15'
Kernoodle	A	*	*	1	50-55	10/27	10/15	10/21	18'/28'
	B	*	0	*					18'/28'
Tejas	A(78)	1	3	8	50-55	10/14	9/30	10/11	16'/25'
Apache	A	2	6	3	45-50	10/14	9/30	10/29	30'/26'
	B	1	7	3					32'/28'
Sioux	A	*	4	7	65-70	10/14	9/30	10/12	24'/28'
	B	1	10	19					30'/35'
Gra-Cross	A	*	7	4	40-45	10/14	9/30	10/20	22'/22'
	B	*	5	6					22'/24'
Shawnee	A	1	11	4	45-50	10/14	9/22	10/20	20'/28'
Forkert	A	1	4	10	40-45	10/14	9/30	10/21	26'/28'
	B	*	3	7					26'/26'
52-1-9	A	1	13	17	50-55	10/14	9/30	10/20	24'/30'
	B	1	6	7					22'/32'
56-6-148	A	1	3	9	45-50	10/16	9/29	10/21	18'/30'
	B	1	6	9					20'/30'
56-15-11	A	*	1	4	50-55	10/16	10/8	10/21	16'/24'
	B	1	3	8					16'/24'
48-3-33	A	*	11	17	50-55	10/14	9/23	10/11	24'/24'
	B	*	3	16					22'/24'
53-9-340	A	*	7	21	40-45	10/14	9/30	10/20	22'/26'
55-17-3	A	7	24	39	60-65	10/14	9/22	10/12	24'/22'
	B	6	25	37					22'/26'
49-20-112	A	*	13	13	55-60	10/14	10/9	10/20	22'/28'
	B	*	11	9					24'/24'
41-19-20	A	1	14	19	45-55	10/14	9/10	10/21	20'/22'
45-10-38	A	*	1	9	50-60	10/27	10/15	10/13	18'/22'
	B	*	1	12					20'/20'
56-15-13	A	*	1	13	45-50	10/14	10/9	10/20	20'/26'
	B	0	1	16					22'/28'

[y] Weight rounded to nearest lb, (* denotes less than one lb).

[z] ( ) Indicates year re-grafted.

greatest problem and appear more attracted to some cultivars and selections than others.

Diseases have not been a major problem. There has been less pecan scab than was anticipated when the planting was established, although there is considerable varietal difference. A fungicide was applied in each spray application.

Embryo-rot was observed on many nuts in 1981. This was likely due to the wet weather just before and during harvest. Pre-harvest nut sprouting may be a problem with some varieties. 'Shoshoni' and 'Kiowa' had 25% and 38% nut sprouting in 1981.

Bud break usually takes place the later part of March. There is a difference between the various cultivars and selections as to when this occurs but the range is not great. There is also a difference in time of leaf drop in the fall.

Hurricane Allen in August 1980 showed the susceptibility of pecan trees to wind damage. Although a great number of limbs were broken, some affecting the major structure of the tree, regrowth was rapid. Where limbs remained attached, though broken, nuts remained to harvest 6-8 weeks later.

Based on these early observations of precocity and yields, 'Chickasaw', 'Gra-Bohls', 'Mohawk', 'Shoshoni', 'Cheyenne', 'Shawnee', 55-17-3, 41-19-20 and 49-20-112 have been placed in an expanded planting for further study. Others that had good yields in 1982 and should also be considered for further study are 'Choctaw', 'Gratex', 48-3-33 and 53-9-340.

CONCLUSIONS

It is still too early to draw conclusions as to the most suited pecan cultivars for the Valley. Those that start bearing heavy crops at an early age would be initially the most desirable. We have already seen that cultivars popular in other parts of the state, where there is a difference in winter chilling and soil types, have not been the quickest to bear and have not had the highest yields in this test planting. Given more time the less precocious cultivars may become the highest yielders. A pecan orchard is a long term investment, therefore, careful study must go into choice of cultivar. Furthermore, some of the USDA numbered selections look quite promising for the Valley and it is possible that in time some will be named and released.

It is difficult to resist comparing the prospects for commercial pecan production in the Valley with the production of citrus. Caring for the pecan orchard is not a great deal different than for citrus. In general, the same equipment can be used. The pest control materials are different and more caution must accompany the use of herbicides. While harvesting has been mechanized for large pecan orchards, owners of small orchards in the Valley could resort to hand collecting if custom harvesting isn't available.

LITERATURE CITED

1. Madden, George D. and Richard A. Hensz. 1978. Five years observations on pecan variety adaptation to the Lower Rio Grande Valley. J. Rio Grande Valley Hort. Soc. 32:101-104.

ON THE COVER

ABOVE: Pecans (actual size) grown at the Texas A&I University Citrus Center, Weslaco. The varieties are: 1) GraBohls 2) Cheyenne 3) Chickasaw 4) Mohawk 5) Shoshoni 6) Shawnee 7) Gratex 8) Choctaw 9) 41-19-20 10) 48-3-33 11) 49-20-112 12) 53-9-340 13) 55-17-3.

FRONT: Pecan variety orchard at the Citrus Center. See page 87.