PROCEEDINGS

Of the Fourth Annual

RIO GRANDE VALLEY HORTICULTURAL INSTITUTE

Weslaco, Texas

January 10 - 12, 1950

PROCEEDINGS

OF

THE FOURTH ANNUAL

RIO GRANDE VALLEY HORTICULTURAL INSTITUTE

☆

Held at Texas A & I College and
Valley Experiment Station, Weslaco, Texas

January 10-12, 1950

☆

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Officials of the Horticultural Institute and members of the Rio Grande Valley Horticultural Club wish to express their sincere appreciation to every firm and individual who through their work and support have made this important project an annual contribution to the welfare of the Valley and its citizenship.

We particularly wish to express our gratitude to those listed below who assisted in the publishing of these proceedings and the securing of an outstanding group of speakers.

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18.	Eugene Goodwin	Box 85	Mission, Tex.	Goodwin Orchards
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21.	D. E. Kornegay	Box 1687	Harlingen. Tex.	Baker-Potts Nursery
22.	A. H. Law	1620 N 11th St	McAllen, Tex.	Law Nursery
23.	E. W. Linnard	Route 1	McAllen, Tex.	Nurseryman
24.	D. J. McAlexander	Box 308	Elsa, Tex.	F. H. Vahlsing Inc.
25.	Norman Maxwell	Exp. Station	Weslaco, Tex.	Exp. Station
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37.	Dr. George Wene	Exp. Station	Weslaco, Tex.	Exp. Station
38.	Leon Whitaker	% Texsun Supply	Weslaco, Tex.	Texsun Supply

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Held Under the Auspices of

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Jamie Morris
George Wene

Rio Grande Valley Horticultural Club
Monthly Programs for 1948-49

Date	Topic	Speaker
September 29, 1948	"Better Treatment of Soil and Better Use of Water"	W. T. Moon
October 27, 1948	"Landscape Notes"	Jim Walker
	"General Facts Covering Ornamental Plants for the Rio Grande Valley"	Ed Kornegay
November 24, 1948	"A Symposium on Citrus Varieties and Strains"	E. W. Linnard Norman Maxwell Dr. W. C. Cooper
January 26, 1949	"Cabbage Fertilizer and Variety Tests"	W. R. Cowley
	"Insect Control in Cabbage"	Dr. George Wene
	"Citrus Tree Pruning and Surgery"	Carl Waibel
February 23, 1949	"Report of the Horticultural Club Citrus Freeze Damage Committee"	A. L. Ryall Norman P. Maxwell Dr. P. W. Rohrbaugh
March 30, 1949	"Valley Water Problems"	A. L. Cramer
April 27, 1949	"Control of the Corn Ear Worm"	Mr. Blanchard
	"Native Trees and Shrubs"	Ray D. Goodwin
May 25, 1949	"Texas Avocado Society"	E. B. Ballard
	"Avocadoes"	Dr. R. H. Cintron
June 29, 1949	Picnic at Lake Hoblitzelle	
September 28, 1949	"Tristeza Disease of Citrus"	Dr. A. F. Camp E. P. Ducharme
October 26, 1949	"Black Fly Report"	Dr. George Wene
	"Citrus Fruit Handling"	A. L. Ryall
November 30, 1949	"California Red Scale Parasite Situation in California and Texas"	Dr. Paul DeBach

Program of the Horticultural Institute

OPENING SESSION

Tuesday Morning, January 10

William C. Cooper, Chairman

9:30 AM	General Welcome: Jack Drake, Mgr., Valley Chamber of Commerce
9:35 AM	President's Address: William C. Cooper, President, Rio Grande Valley Horticultural Club, Weslaco, Texas
9:45 AM	The National Citrus Outlook as a Result of the California and Texas Freezes: J. C. Johnston, University of California, Riverside, California
10:25 AM	Recess
10:40 AM	Outlook for Citrus in the Valley: P. W. Rohrbaugh, Director, Citrus and Vegetable Training Center, Texas A & I College, Weslaco, Texas
11:20 AM	Crops and Their Relation to Soil Productivity: R. D. Lewis, Director, Texas Agricultural Experiment Station, College Station, Texas
11:45 AM	Discussion

CITRUS SESSION

Tuesday Afternoon, January 10

Ernest Poteet, President A and I College, Chairman

2:00 PM	Findings of the Citrus Freeze Committee: P. W. Rohrbaugh, Chairman and Norman P. Maxwell, Secretary, Horticultural Club Freeze Damage Committee, Weslaco, Texas
2:20 PM	Pruning Freeze Damaged Trees: W. H. Friend, Associate County Agent for Citrus, Texas Agricultural Extension Service, Edinburg, Texas
2:50 PM	Wound Protectants in Citrus Pruning: G. H. Godfrey, Valley Experiment Station, Weslaco, Texas
3:05 PM	Recess
3:20 PM	Observations of the Freeze Damage to Some Subtropical Fruits: R. H. Cintron, Hoblitzelle Ranch, Mercedes, Texas
3:40 PM	Other Fruits Than Citrus for the Valley: J. R. Padgett, Farm Manager, Rio Farms, Inc., Edcouch, Texas
4:00 PM	Discussion
7:45 PM	Horticultural Club Banquet

Program of the Horticultural Institute

VEGETABLE SESSION

Tuesday Afternoon, January 10

W. R. Cowley, Supt., Valley Experiment Station, Chairman

2:00 PM — Cabbage Variety and Fertilizer Tests: James Morris, Valley Experiment Station, Weslaco, Texas

2:20 PM — New Developments in Vegetable Varieties: William H. Brittingham, Professor, Dept. of Horticulture, Texas A & M College, College Station, Texas

3:00 PM — Recess

3:15 PM — Tomato Variety Situation in the Lower Rio Grande Valley of Texas: Norman P. Maxwell, Valley Experiment Station, Weslaco, Texas

3:30 PM — Factors Affecting Fruit Set in Vegetables: F. W. Went, Professor of Plant Physiology, California Institute of Technology, Pasadena, California

4:00 PM — Discussion

CITRUS SESSION

Wednesday Morning, January 11

Lorne Hamme, Acting General Manager, Texsun Citrus Exchange, Chairman

9:30 AM — Fertilizer Trials with Grapefruit at Rio Farms: Cordell Edwards, Edcouch, Texas

9:45 AM — Salt and Boron Tolerance of Citrus: William C. Cooper, U.S.D.A., Weslaco and Cordell Edwards, Rio Farms, Inc., Edcouch, Texas.

10:00 AM — Progress Report for 1949 on Inspection and Registration of Psorosis Free Citrus Trees: Carl W. Waibel, Nursery Inspector, Texas Department of Agriculture, Weslaco, Texas

10:15 AM — Control of Post Harvest decay in Citrus Fruit: H. B. Johnson, U. S. Horticultural Field Laboratory, Harlingen, Texas

10:30 AM — Recess

10:45 AM — The Citrus Fulgorid: George P. Wene, Entomologist, Valley Experiment Station, Weslaco, Texas

11:00 AM — Developments in Citrus Blackfly Control: J. F. Cooper and C. C. Plummer, U. S. D. A., Bureau of Entomology and Plant Quarantine, Valles, Mexico.

11:30 AM — Round Table Discussion on the Citrus Black Fly, led by: A. C. Baker, J. F. Cooper, and C. C. Plummer

Program of the Horticultural Institute

VEGETABLE SESSION

Wednesday Morning, January 11

Walter Baxter, Walter Baxter Seed Co., Chairman.

9:30 AM — Control of Aphids on Vegetables: George P. Wene, Valley Experiment Station, Weslaco, Texas

9:50 AM — Vegetable Insect and Disease Control Recommendations for the Valley: Herman S. Mayeux, Associate County Agnt-Entomology, Texas Agricultural Extension Service, San Benito, Texas, George P. Wene and G. H. Godfrey, Valley Experiment Station, Weslaco, Texas

10:10 AM — Seed Certification: R. V. Miller, Chief, Seed Certification Division of State Dept. of Agriculture, Austin, Texas

10:40 AM — Recess

10:55 AM — Industrial Waste Disposal: C. L. Shrewsbury, Southwest Research Institute, San Antonio, Texas

11:25 AM — Progress in the Breeding of Cantaloupes for Downey Mildew Resistance: G. H. Godfrey, Valley Experiment Station, Weslaco, Texas

11:45 AM — Discussion

CITRUS SESSION

Wednesday Afternoon, January 11

J. Overby Smith, Secretary, Texas Canners Assoc., Chairman

2:00 PM — Plans for the Texas Citrus Commission: C. L. Skaggs, Chairman, Texas Citrus Commission, Weslaco, Texas

2:15 PM — Citrus Activities and Accomplishments of Research and Marketing Act of 1946: Charles A. Rogers, President, Texas Citrus and Vegetable Growers and Shippers, Alamo, Texas

2:30 PM — The Frozen Citrus Concentarte Industry in Florida and What the Industry Wants in the Way of Quality in Citrus Fruits: W. R. Roy, Chief Chemist, Minute Maid Corporation, Plymouth, Florida

3:00 PM — Recess

3:15 PM — Prospects for a Frozen Concentrate Industry in Texas: E. M. Burdick, Director of Research, Texsun Citrus Exchange, Weslaco, Texas.

Program of the Horticultural Institute

3:30 PM Distribution of Naringen in Texas Grapefruit: Robert H. Maurer, Swift & Co. Laboratory, Pharr, Texas, E. M. Burdick, Texsun Citrus Exchange, Weslaco, Texas, and Carl W. Waibel, State Dept. of Agriculture, Weslaco, Texas

3:45 PM A Brief Summary of the Current Citrus Situation Together with Excerpts from Recent Department Publications on the Dried Fruit and Deciduous Supplies for European Markets: J. Henry Burke, Marketing Specialist, International Commodities Branch, Office of Foreign Agricultural Relations, U. S. D. A., Washington, D. C.

Discussion

6:00 PM Banquet for Members of Texas Society of Food Technologists.

ORNAMENTAL HORTICULTURE

Wednesday Afternoon, January 11

A. F. DeWerth, Head, Department of Landscape Art, Texas A & M College, Chairman

2:00 PM Treatment of Rose Bushes When Harvested from Commercial Fields: E. W. Lyle, Director, Rose Research Foundation, Tyler, Texas

2:30 PM The Potential for Ornamental Horticulture in the Rio Grande Valley: A. F. DeWerth, Head, Depatrment of Landscape Art, Texas A. & M College, College Station, Texas

3:00 PM Recess

3:15 PM Oranmental Plants for the Valley: Mrs. Dale Washburn, Donna, Texas

3:35 PM Lawns: J. W. Walker, Baker-Potts Nursery, Harlingen, Texas

4:00 PM Discussion

FIELD DAY AT THE VALLEY EXPERIMENT STATION

Thursday, January 12

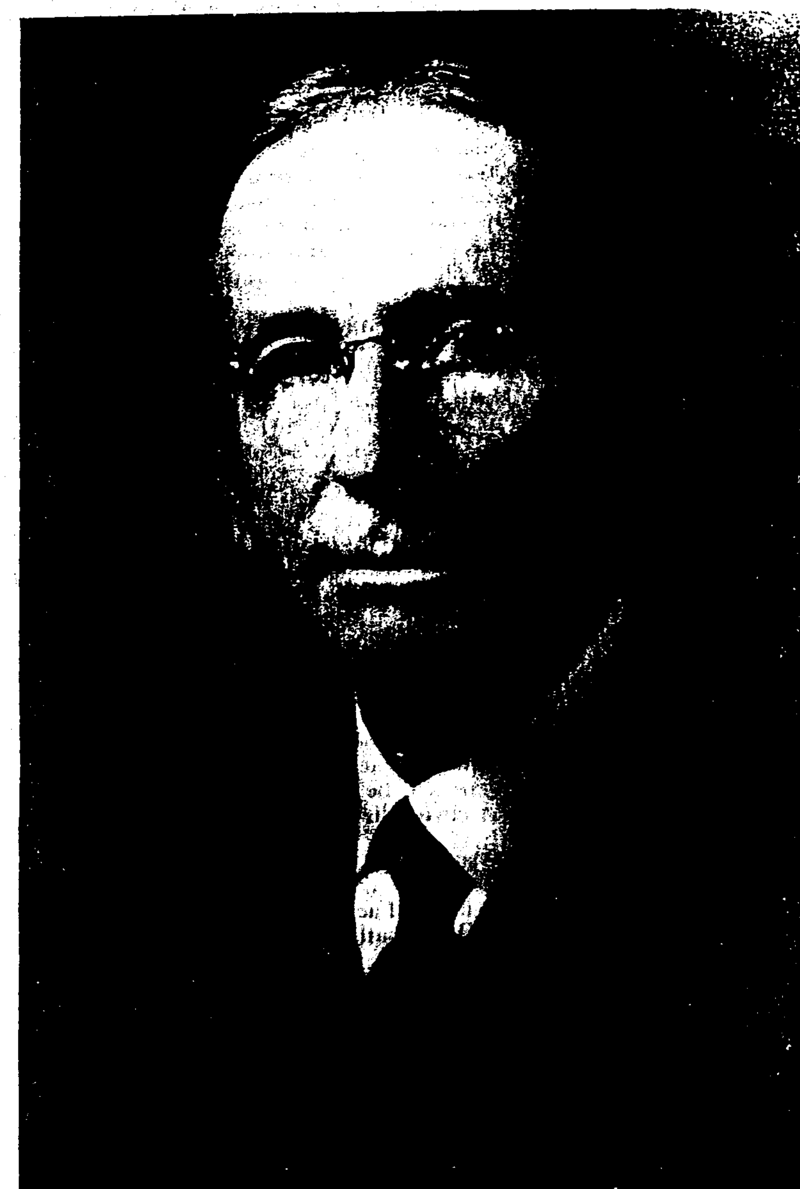
Morris Bloodworth, Valley Experiment Station, Chairman.

8:30 AM A conducted tour of Farm Equipment, Irrigation Equipment, Demonstrations, Land Leveling Equipment, Dusting and Spraying Equipment.

12:00 Noon Barbecue

1:30 PM Open House.

Dr. Howard S. Fawcett



HOWARD SAMUEL FAWCETT. 1877-1948

DR. HOWARD S. FAWCETT

Howard Samuel Fawcett, Professor Emeritus of Plant Pathology of the University of California Citrus Experiment Station, died at Riverside, California, December 12, 1948. Botanical science thus loses a world authority. Professor Fawcett was an outstanding investigator of citrus diseases, his chosen field.

In 1947, the Citrus Psorosis Committee of the Rio Grande Horticultural Club invited Dr. Howard S. Fawcett to come to the Valley to aid the Club in making a survey of psorosis and other citrus diseases. Dr. Fawcett agreed and spent the month of February, 1948 working with members of the Experiment Station and the Horticultural Club studying the psorosis status of our varieties of oranges and grapefruit.

During this period he had a profound influence both on the citrus research personnel and on the citrus men of the industry. Dr. Fawcett and his followers were in the field ten hours a day examining groves from Mission to Brownsville. Literally thousands of leaves were pulled off and examined for psorosis. Dr. Fawcett presented his findings before the Horticultural Club and published them in the July, August and September 1948 issues of Texas Farming and Citriculture.

Dr. Fawcett attended the first meeting of the Valley Nurserymen's Association and presented a plan for the registration of citrus nursery stock in the Valley. This plan has been put into effect by the combined efforts of the Nurserymen's Association and the State Department of Agriculture, and this fall, the citrus nurserymen of the Valley have state registered psorosis free nursery stock for sale.

In appreciation of his efforts in the study of citrus diseases in the Valley, and as a tribute to the world renown and outstanding talents of Dr. Fawcett, he was elected to honorary membership in the Rio Grande Horticultural Club at its regular meeting in March 1948. Our psorosis free groves in the future will be the Valley's monument to Dr. Fawcett and his great work in citrus diseases.

It is with great admiration and respect for this truly great man and scientist that we record for the people of the Rio Grande Valley some of the important facts about his life and accomplishments as published in the Journal of his field of work, Phytopathology, November, 1949.

He was born on a farm near Salem, Ohio, on April 12, 1877. His early education was at Salem where he completed the curriculum of the local high school. Then after a year's attendance at Westtown School, a Friends' preparatory school at Westtown, Pennsylvania, where he studied botany under Dr. Henry S. Conard, he was graduated in 1899. After a year (1900-1901) of teaching science in a preparatory school at Le Grande, Iowa, he went to Iowa State College where, working his way as teaching assistant to Dr. L. H. Pammel, he completed the science course in 1905, earning the B. S. degree. He filled the position of Assistant in Botany and Horticulture at the University of Florida during the year following his graduation and became Assistant Plant Pathologist

the Fifth Edition of "American Men of Science" (1933), which means his selection then as one of 250 leading American scientists and one of 25 leading botanists. In 1940 Dr. Fawcett was chosen to give the annual Faculty Research Lecture at the University of California at Los Angeles. Some of his most outstanding work is described most fascinatingly in that lecture, "Adventures in the Plant Disease World".

Dr. Fawcett's energy and enthusiasm in his research activities, his good fellowship, patience, kindness, and fairness in all relationships with his friends and fellow investigators will always be an inspiration and guide to those who have been so fortunate as to have known him and to have been associated with him.

He was a devoted, birthright member of the Society of Friends and a leading figure in the establishment and support of the Riverside Friends Meeting. He worked quietly and persistently for the advancement of peace and goodwill in all human relationships and for relief of suffering wherever it occurred. He served in the famine-stricken area of southeastern Russia in 1922-1923, during a sabbatical leave, as a member of a mission sent by the American Friends Service Committee. The constructive program of ministration to the stricken people there, and the example of the members of the mission, laid a foundation of goodwill among the Russian people of that region.

History And Objectives Of The Rio Grande Valley Horticultural Institute And The Horicultural Club

WILLIAM C. COOPER, *President*
Rio Grande Horticultural Club
Weslaco, Texas

With this our fourth Rio Grande Valley Horticultural Institute, it is fitting that we briefly review the history and aims of the Institute and of the Rio Grande Horticultural Club that is directing the Institute. The Institute is not a formal horticultural society or club. It is a three-day program of addresses and demonstrations arranged to bring to the attention of the horticultural industry of the Valley certain developments in production, marketing, and research affecting the industry. Features of this program are progress reports on local horticultural research projects, timely information on the control of diseases and insects, and discussion by prominent speakers from outside the State of subjects of special interest to the horticultural industry in southern Texas.

The first Institute held in 1946 was limited to a discussion of citrus problems. In 1947 and 1948 the scope of the Institute was enlarged to include both citrus and vegetables. This year ornamental horticulture was added to the agenda. The Rio Grande Valley has a subtropical climate which permits the growing of many exotic plants for the beautification of our homes and parks. There is a need for more information about these tropical and subtropical ornamentals.

The 1946 Institute was a joint endeavor of the Texas A. & M. College and the Rio Grande Horticultural Club. Dr. Guy Adriance, head of the College horticulture department, asked the Club to assist in conducing a short course, or institute, on citrus culture in the Valley, and the club did so. Since then the Horticultural Club has taken the lead in directing the Institute, with the College contributing agricultural workers from the staff at the Weslaco substation as well as from the main agricultural experiment station at College Station. The local staff of the Texas Agricultural and Industrial College, the staffs of several research units of the U. S. Department of Agriculture located in the Valley, and certain other workers in the industry also contribute to the program. A number of individuals and organizations in the Valley likewise contribute substantially to the Institute by underwriting the expenses of the out-of-state speakers, and of publishing the proceedings of the Institute.

The Horticultural Club, which directs the Institute, was formed in 1945. The membership is limited to forty-five persons who must be ac-

of that institution in 1907 and Plant Pathologist in 1908. In 1908 he earned his M. S. degree there. During his seven years in Florida he made important contributions on fungus diseases of citrus insects, on scaly bark and gummois diseases of citrus trees, and on stem-end rot of citrus fruits. While at the University of Florida he was associated with H. J. Webber, W. T. Swingle, and P. H. Rolfs, pioneers in citrus investigation.

In 1912 he accepted the position of Plant Pathologist with the California State Commission of Horticulture, his immediate objective being to investigate the destructive gummosis or footrot disease that was ravaging the citrus groves of that State. After a year with the Commission he joined the staff of the University of California as Associate Professor of Plant Pathology, continuing his work on gummosis. During the next three years he isolated the causal fungi, proved their relationship to the disease, and developed successful methods of treatment—results of great importance to the industry.

The years 1916 to 1918 were spent on leave at Johns Hopkins University where under Dr. Burton E. Livingston he investigated the temperature relations of certain fungi parasitic on citrus trees, and developed apparatus for temperature control which has proved very useful in botanical investigations. He received the Ph.D. degree at that institution in 1918.

As Professor of Plant Pathology in the University of California and Plant Pathologist in the Agricultural Experiment Station, Dr. Fawcett served the University and State of California from 1918 to 1947, when he became Professor Emeritus. He turned over the administrative duties of the Division of Plant Pathology in 1946 to his successor, to devote himself to research on diseases of citrus. He continued intensively active and productive until his death in December, 1948. Upwards of 300 articles were contributed in scientific and industrial journals. He introduced the scraping treatment for citrus scaly bark (psorosis) in 1922, eleven years before he demonstrated the virus nature of that malady. His discovery of the causes of gummosis and psorosis and his development of practical means for their control have been of inestimable value in the successful production of citrus in California and other areas. During the last four years he played the leading role in the investigation of the cause of quick decline of orange trees, demonstrating its virus nature. In 1940 he proposed "a simple, easily applied pro tem manner of naming viruses" in which the stem "vir" was added to the Latin genitive of the genus of the host in which the virus was first discovered and recognized, dropping the final consonants of this genitive. Quick decline and other virus and virus-like diseases of citrus, including stubborn disease of sweet orange, wood pocket of lemon, exocortis of trifoliate orange, and the various forms of psorosis were his major research interests in recent years. The great importance of his work to the citrus industry is recognized by scientists and by growers and processors of citrus fruits throughout the world.

In the first edition of the book "Citrus Diseases and Their Control", published in 1926, he collected his own contributions and the world's knowledge of citrus diseass. Dr. H. A. Lee, who was junior author of this first edition, wrote certain sections on the diseases in the Orient.

Dr. Fawcett studied citrus and date diseases in the Mediterranean countries of Europe, North Africa, and Palestine during 1929 and 1930, serving as a Collaborator of the United States Department of Agriculture. He investigated citrus troubles in Brazil and Argentina in 1936 and 1937. His findings in these travels were incorporated in technical papers and in the revision of his book, which has become the standard reference work and textbook in this field.

DR. FAWCETT AT WORK

The second edition of his book was published in 1936 and reprinted in 1946. Dr. Fawcett took up the responsibility and authorship of this edition since Dr. H. A. Lee had given up research in the field of citrus and requested that his name be omitted. In 1948, he contributed to Volume II of "The Citrus Industry" a chapter on control of citrus insects by fungi and bacteria, and, as senior author, the chapter on "Diseases and Their Control". His textbook has been translated into Hebrew and may also be printed in Spanish and Portuguests editions. With L. J. Klotz he authored in two editions, in 1941 and 1948, a "Color Handbook of Citrus Diseases" which provides citrus growers, packing house men, horticultural inspectors ,and extension workers with a ready meanes of identifying citrus diseases together with the essential information on control.

Professor Fawcett was a charter member of The American Phytopathological Society. He was vice-president of that society in 1929 and president in 1930. He was a member of Phi Beta Kappa, Sigma XI, the Botanical Society of America, the Mycological Society of America, Societa Internazionale di Microbiologia (Milano), and Fellow of the American Association for the Advancement of Science. His name was starred in

tively engaged in some branch of horticultural work and be qualified to participate in the programs and discussions arranged by the program committee. The group includes citriculturists, olericulturists, ornamental horticulturists, entomologists, plant pathologists, soil scientists, and irrigation experts; who are active in Valley horticulture. About half of the members are personnel of state and federal agricultural institutions in the Valley, while the rest are technical men in the horticultural industries. It is felt that this mixing of viewpoints of the industry and of institutional personnel would aid both groups to work more effectively for their mutual interests and the advancement of horticultural science in the Rio Grande Valley.

The Rio Grande Horticultural Club meets once a month for the discussion of two technical papers on current problems in Valley horticulture. When a problem requires further study and discussion, a committee is formed to pursue the matter further. In 1947 the Citrus psorosis problem was turned over to a committee in the club which was instrumental in bringing Dr. H. S. Fawcett, world authority on citrus diseases, to the Valley to aid the Psorosis Committee of the Club in a psorosis survey. Dr. Fawcett and the Committee recommended a State citrus budwood certification program for the ultimate solution of the problem. Since the objectives of the Club are only to study and discuss problems its responsibility in this instance ceased with this recommendation. A Valley nurserymen's association was formed as an action group to carry out the recommendation of the Psorosis Committee.

Similarly the Horticultural Club Avocado Committee studied the avocado problem during 1948 and recommended to the Club the formation of a Texas Avocado Society to cope with this problem.

The Club sponsored the Avocado Society in April 1948 and this group is now active in exploring Mexico for superior selections of avocados and in establishing four test plots in the Valley for testing the adaptability of these selections.

During the past year, following the January 31 freeze, the Club formed a special Citrus Freeze-Damage Committee which studied the effects of the freeze on citrus in the various areas of the Valley. The Committee has published reports on its findings in both the 1948 and 1949 proceedings of the Institute. These reports should be of value to growers in the event of another freeze in the future. The Committee has made frequent recommendations to growers on the pruning of freeze-damaged trees and had aided the Valley Experiment Station in setting up pruning experiments on freeze-damaged trees.

The annual Horticultural Institute is the Club's greatest endeavor. It is arranged for the discussion of the Valley's horticultural problems with the growers. We hope that these assemblies of growers and technical men will promote a mutual understanding helpful to all.

Every member of the Horticultural Club has participated in arranging for the Institute by serving as a member of one of the Institute committees. The members of these committees are listed in the proceeding of the Institute.

By requesting submittal of papers for this Institute well in advance it has been possible to publish the proceedings in time for distribution at the meeting. It is hoped that you will find the proceedings of interest and of real value to you in your horticultural enterprises. Each year more and more scientific and semi-scientific papers on local horticultural reserach projects are printed in the proceedings, thereby giving you up-to-the-minute year-by-year reports on these worthwhile projects. As years go by, these annual proceedings should constitute a compendium on horticultural research in the Valley and thus become an invaluable repository of knowledge and experience concerning Valley horticulture. It is a Valley endeavor of which we should all be proud.

The National Citrus Outlook As A Result Of The California And Texas Freezes

J. C. Johnston, *Extension Specialist in Citriculture. University of California, Riverside, California*

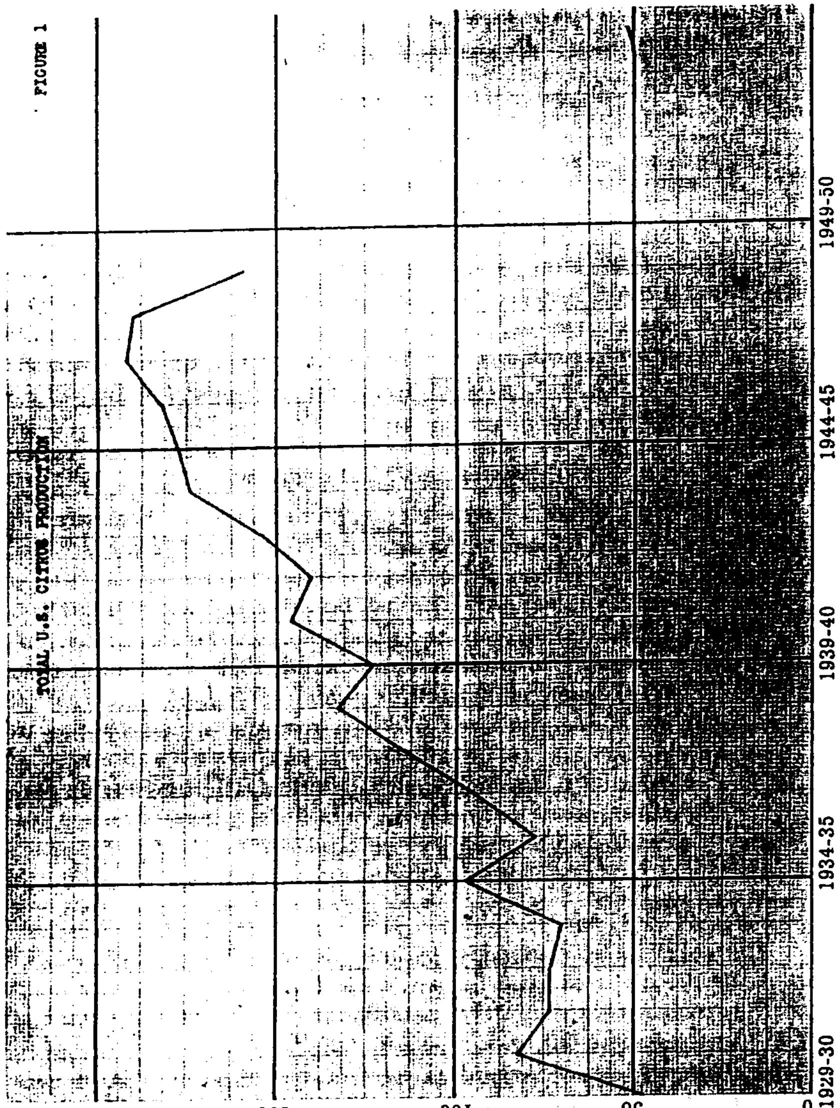
Mr. Johnston, as the Citrus Specialist with the Extension Service, is working particularly on citrus production problems.

Your Committee has asked that I discuss with you the national citrus outlook as affected by the California and Texas freezes of 1949. Since the future of the citrus industry does not appear the same to all observers, we can approach a more common viewpoint if some of the more important factors are reviewed. It will also be helpful if we examine some of the characteristics of the California industry before discussing the effects of the freeze.

The National Citrus Outlook

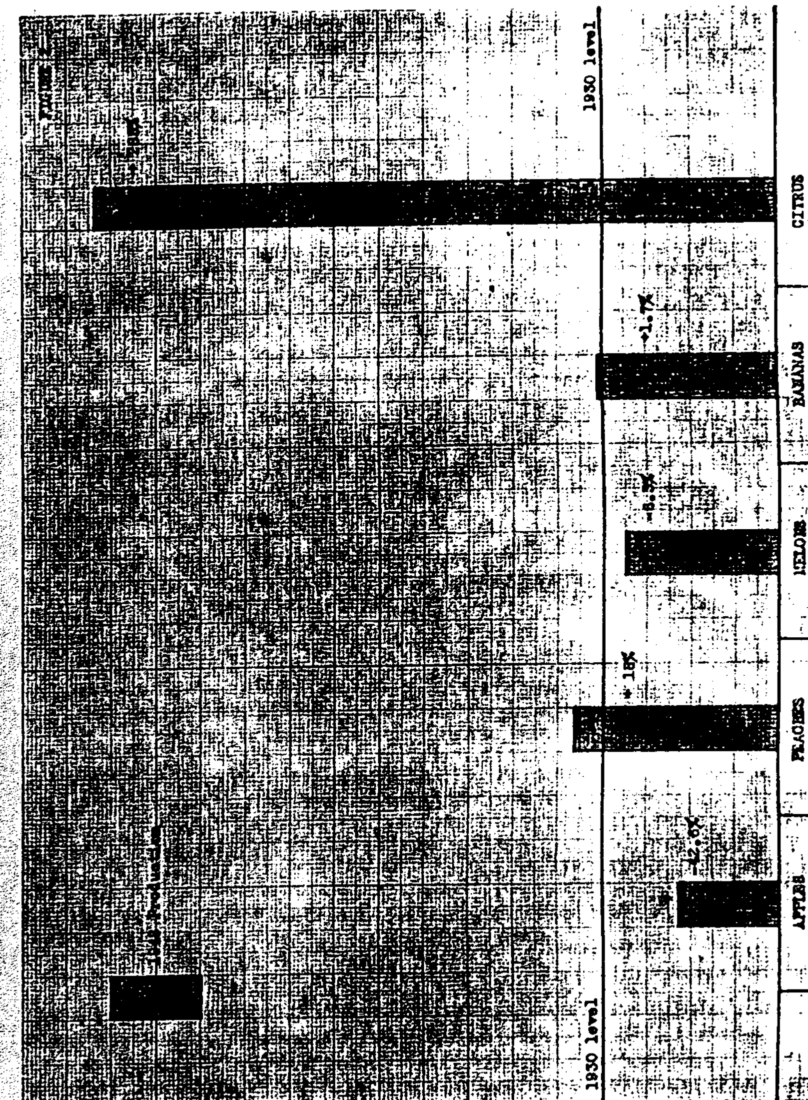
The most important single factor in the outlook for the citrus industry is the rapid increase in production. The market is not influenced so much by the volume of a product as by changes in volume. The fact that this increased volume of fruit has been marketed with some return to growers reflects great credit on the various marketing agencies. Production has increased from 50 million boxes in 1930 to 185 million boxes in 1949. This is shown graphically in figure 1. This increase has taken place largely in Texas and Florida. We have reason to expect the upward trend to continue for some time, largely as a result of the extensive nonbearing and partially bearing acreage in Florida. The nonbearing acreage in California is not sufficient to maintain the present acreage, and a gradual decline in production can be expected. The trend in Texas will be determined by the extent of new plantings that may be made in the next few years.

The volume of competing products is also an important factor in the national citrus outlook. This was well illustrated by the low return for fresh citrus fruit during the past summer. The trend in volume of a few of these products is shown in figure 2. If we use 1930 as a base, the supply of apples has decreased 42 per cent, that of peaches has increased 18 per cent, while the supplies of melons and bananas have changed little. In this same period, noncitrus fruit juice and tomato juice have increased from 1 1/3 million cases to 42 2/3 million cases. The foregoing changes are not great except in the case of fruit and tomato juices, but it is reasonable to expect increased competition from these sources. Many growers of competing products feel that citrus has taken part of their market. These interests are already planning an increased sales effort.



The great increase in production illustrated in figure 1 has not all been consumed as fresh fruit. To a very large extent it has gone into products such as canned juice, concentrate, and frozen concentrate. Only 40 per cent of the grapefruit and 63 per cent of the oranges produced in the 1947-1948 season were shipped fresh.

This outlet has relieved the industry of fruit which would have



glutted the fresh fruit markets. Unfortunately, the added production has not greatly benefited growers. Except during the war years, fruit for processing has not brought satisfactory returns. Processing places one more step between the grower and the consumer's dollar.

Currently, the spectacular development in frozen concentrate is most encouraging. The question as yet unanswered is this: At what level will the price stabilize?

The future of frozen concentrates looks bright, but it is reasonable to expect a downward trend in the price paid to growers for fruit destined for the frozen pack. Any industry which does not enjoy a natural or artificial monopoly continues to attract new producers until only the most efficient can make a profit.

Frozen concentrate differs from other products which have been marketed in that it approaches more closely the quality of fresh juice. In common with other products it has the advantage of convenience. This enables a grower in any area to compete with all other growers, regardless of season or location. In other words, the advantages of location or season of maturity will be greatly reduced. The tendency will be for the advantage to rest with the grower who can produce the most soluble solids per acre at the lowest cost per unit. The result will most likely be that buyers of fresh fruit will become more discriminating as to quality and price.

California oranges have usually enjoyed a substantial advantage in price on the fresh fruit market. For this reason, growers in that state will find it desirable to maintain a high standard of quality and to market the bulk of their fruit fresh. Florida and Texas, with a much lower cost of production, will most likely find it advantageous to market the larger part of their fruit as products.

Because of the ease with which new citrus acreage can be developed. it seems reasonable to expect production to continue its upward trend as long as returns are, or promise to be, favorable. It also appears that the volume of competing products will be maintained. The development of improved products makes it possible to market the crop over a long period of time. This brings all areas into direct competition and will tend to prevent prices from rising during periods of short supply.

On this basis, the outlook is that citrus production will continue to increase until only the more efficient growers will make a satisfactory profit. The encouraging thing is that such an outlook has been presented at frequent intervals during the past 60 years, and the industry is still solvent. I have faith in its future.

Now Let's Take a Look at California

In order to understand the effects of a freeze in that state, it is necessary to consider the conditions under which citrus is grown.

The citrus-producing areas are scattered from the Mexican border on the south to Orland in the Sacramento Valley, 600 miles to the north. In the Coachella Valley some of the plantings are 200 feet below sea level, while along the foothills they extend 2000 feet or more above sea level.

The climate varies from the cool and relatively humid coastal districts to the hot arid deserts of the interior. Some idea of the contrast can be realized from the fact that many coastal plantings require only 1 acre-foot of irrigation water per acre per year, whereas plantings in the desert valleys require as much as 6 acre-feet per acre per year. Many of the valleys are separated by ranges of hills or high mountains. As a result. the weather is never the same over the entire acreage.

In the 1949 freeze. California lost about one third of the citrus crop, but in the various districts the lost ranged from practically nothing to 100 per cent. Trees were damaged in a few places, but for the state as a whole the injury was not important.

The citrus plantings in California are far north of those in Texas and Florida: Orland is in approximately the same latitude as Kansas City and Philadelphia; and the most southern plantings are opposite Waco, in Texas, and Charleston, North Carolina. As a result, the winters are relatively cool, and the trees become almost completely dormant. Unless frost comes early in the season, the trees are very resistant to cold. This is the reason production returns to normal so quickly after a freeze. An added reason, of course, is the fact that in colder locations a large part of the acreage is protected by orchard heaters.

According to the record, the California orange crop following major freezes has been normal or above. The 1913 freeze was preceded by a 15 million box crop, the 1913 crop was 7 million boxes, and the 1914 crop was 20 million boxes. The 1922 freeze was preceded by a crop of 24 million boxes, the 1922 crop was 14 million boxes, and the 1923 crop was 21 million boxes. In this comparison, the 1923 crop looks small, but only two previous crops were greater, namely those of 1917 and 1921. The freeze of 1937 was preceded by 33 million box crop, the 1937 yield was 30 million boxes, and the 1938 crop was 46 million boxes.

The situation with lemons is different; it usually taks two years for the yield to return to normal. There are two reasons for this: (1) lemon trees suffer greater injury from cold than oranges, and (2) the trees bloom and set fruit almost continuously. A freeze destroys much of the immature fruit that would be harvested during the following summer. For this reason, the yield is below normal until fruit from the spring bloom can mature.

The freeze of January, 1949, was less severe than the freeze of 1937, but at this writing (October, 1949) indications are that the current citrus crop will be somewhat lower than normal. In my opinion this cannot be attributed to the freeze. There are several causes. Most important is the fact that it costs two to three times as much to produce a box of fruit in California as it does in Texas or Florida. This is causing a gradual removal of marginal acreage in California. Quick decline and other diseases have also caused the removal of a considerable acreage, and a good many very productive plantings have been subdivided for residential and industrial purposes. These tendencies have been accelerated by the freeze, but they are not a direct effect of the freeze.

Conclusion

With the foregoing considerations in mind, I see no reason to believe that the long-term outlook for the orange grower or the lemon grower will be affected by the freezes of 1949. It is true that orange production in Texas has been seriously reduced, but indications are that this will be offset by increased yield in Florida.

The situation with grapefruit is somewhat different. Production in Texas has been sharply reduced and it will take some time to restore it to normal. As a result, the market has improved generally. In California and Arizona the trend in grapefruit production has been slightly downward as orchards have been removed or topworked to oranges. This tendency will be retarded by more favorable prices. However, the volume of fruit produced in the southwest is relatively small and the general outlook will not be greatly influenced by the trend in this area.

In the country as a whole, there is more than enough grapefruit to supply the market with fresh fruit. Since the prices paid for fresh fruit are usually more attractive than for products fruit, it seems reasonable to expect all markets to have a normal supply as soon as the trade becomes adjusted to the new situation. If this takes place, fresh fruit prices can be expected to return to normal in a very short time. The reduction in supply will most likely have its greatest effect on the volume of fruit available for products. If developments follow this pattern, the most important effect of the freeze will be to strengthen the price of grapefruit destined for products. The duration of this advantage can only be a guess. I place mine at three years.

A result of the freeze which is difficult to measure is its effect on growers' decisions. For example, growers who are considering the advisability of putting their land to other uses find it easy to make up their minds after their orchards are frozen. On the other hand, growers who are favored by location may be encouraged to plant citrus. In other words, tendencies which already exist in the industry are accelerated by a freeze.

To put it briefly, this is the way it looks from here: The effects of the freeze on the orange and lemon industries are only temporary, and the long-term outlook will not be altered as a result. The national supply of grapefruit has been materially reduced by the Texas freeze. This should strengthen the price of grapefruit for some time to come. It is my belief that this improvement will be of greatest benefit to grapefruit sold for products, and that the effect will have been dissipated within three or four years. An important effect of the freeze has been to accelerate some of the changes that were already taking place in the industry.

Outlook For Citrus In The Rio Grande Valley

Dr. P. W. Rohrbaugh

Dr. Rohrbaugh's main field of interest is Citrus. He served 4 years on the staff of the Citrus Experiment Station, Riverside, California and 11 years with the California Fruit Growers Exchange in their Field and Research Departments. Dr. Rohrbaugh was on the teaching staff of the Citrus Department of California State Polytechnic College and served as head of the department until he came to Texas in 1948 as Director of the Citrus and Vegetable Training Center of Texas A & I College. Most of his research work has had to do with Physiology, Pathology and Biochemistry of fruit.

I have been asked to give an appraisal of the future of the Rio Grande Valley as a citrus growing area.

To give an appraisal of this kind, one must investigate the factors which limit the possibilities of an area. These factors may be divided into:

(A) Climatic factors, such as temperature, the variation between maximum and minimum; the humidity and its variations; the rainfall; wind; hurricane; etc.

(B) Irrigation water, where necessary; its availability; its quality as regards the salt content and kinds of salt, such as Boron; and the cost of the water.

(C) Good drainage, which is closely connected to irrigation and may be said to be an essential for growing citrus successfully.

(D) Control or elimination of serious diseases or pests.

(E) Quality of fruit, and rate of production.

(F) Markets and marketing organizations. These are very important to a citrus industry. Distances from the major markets and means of transportation to them are often major factors which limit the future of an industry. Marketing organizations, whether farm cooperatives, associations of private shippers, or organizations similar to our Citrus Commission, can be important factors in controlling the grade and quality as well as the stabilization of the rate of flow of fruit to the market.

If we are to judge the outlook, or the future of the citrus industry, of the Rio Grande Valley on the basis of these factors, and I believe there is no other logical basis for judging it, then we must see how this area compares with other areas in regard to these factors.

(A) Climate. The Rio Grande Valley has a higher average temperature than is found in California, but most citrus areas of California have a higher maximum temperature than the Valley. Valley nights are warmer and the Summers are longer, making the average temperature higher than in California. See Table 1. The average temperature in the Valley is not much different from that of Tampa, Florida.

It must be realized that Los Angeles, California is some 600 miles north of the Rio Grande Valley, and is in a latitude equal to that of 50 to 75 miles north of Dallas, Texas. Some of California citrus orchards extend nearly 500 miles north of Los Angeles, or as far north as the south Nebraska line.

The length of day is 42 minutes longer at Brownsville than at Los Angeles on Dec. 22nd., while on June 21st, the days are 38 minutes longer at Los Angeles. See Table II.

The actual number of hours of daily sunshine at Brownsville and Los Angeles is not very different. See Table III. The average number of cloudy days in the Valley is about 100, at Tampa it is about 80 and in Los Angeles it is about 60.

The average relative humidity recorded at 2 PM local time, is considerably lower at Los Angeles than in the Valley. See Table IV.

The rainfall in the Valley is roughly equal to that of California, but is much less than that of Florida.

Lowest minimum temperatures in the three areas under comparison, vary considerably. The minimum temperature is not, however, a satisfactory index of the hazards to citrus from low temperatures. During the freeze of last winter, the minimum temperature was lower in some parts of California than it was here in the Valley, yet very little damage was done to trees in California. The Laredo section of Texas also received much less tree damage than did the Lower Valley. This difference in tree injury was due not to the lowest temperatures reached, but the difference in the condition of the trees at the time of the freeze. Citrus trees in the Rio Grande Valley have a tendency to grow vigorously most of the time in the winter. The sap flows freely and they are highly susceptible to damage by cold. Low temperatures in the citrus area of California average about 10 degrees colder. This is particularly true of the night temperatures. This lower temperature leads to a certain amount of dormancy in the trees.

(B) Irrigation water. The irrigation water for citrus in the Rio Grande Valley is relatively inexpensive compared to that of California. The total cost of water in the Valley is usually from three to ten dollars per acre per year, where in California, it costs from 10 to 40 dollars per year. In Florida what irrigation is done is relatively inexpensive. The quality of most irrigation water in California and in Florda is good. Little of it contains undesirable salts in amounts detrimental to the growth of citrus.

(C) Drainage. The water of the Rio Grande has quite materially increased in salt content in recent years, due to the fact that much of the better water which came from the mountains of New Mexico and Colorado, as well as much of that from the mountains of Mexico, has been dammed up and used in those places so that it does not get into the Rio Grande in the Lower Valley to dilute the high salt concentrations of other streams, such as the Pecos River. This fact makes it more important than ever that the Valley be provided with an adequate drainage system to drain off the excess salts, including Boron, which accumulates in the water table.

TABLE I

AVERAGE MONTHLY TEMPERATURES

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Brownsville, Texas	59.4	62.9	68.3	73.7	78.6	82.4	83.8	83.9	80.5	74.6	67.5	61.5
Jacksonville, Fla.	55.8	57.6	63.2	68.6	74.8	80.0	81.9	81.6	78.4	70.8	62.5	56.4
Tampa, Florida	60.8	62.7	67.0	71.6	76.6	80.0	81.1	81.2	79.8	74.2	67.2	61.7
Redlands, California	50.9	52.7	55.8	60.1	63.6	71.4	76.8	76.6	72.2	65.4	58.2	52.2
Los Angeles, Cal.	54.5	55.5	57.3	59.7	62.1	65.2	70.2	76.1	69.4	65.1	60.9	55.3

Data from: Atlas of American Agriculture

TABLE II

LENGTH OF DAY IN HOURS AND MINUTES

	Dec. 22	June 21
Brownsville, Texas	10.36	13.46
Los Angeles, California	9.54	14.24
Tampa, Florida	10.20	13.57

Day 42 minutes longer at Brownsville than Los Angeles in winter.
Day 38 minutes longer at Los Angeles than Brownsville in summer.
Data from: Atlas of American Agriculture

In the past few years, many Valley orchards have been seriously damaged by rising water tables and high salt concentrations in the root areas. This is a hazard not prevalent in California or Florida. There are sufficient quantities of Boron in our drainage waters to cause severe damage to our trees if the drainage water is allowed to rise to the tree roots. If we use drainage water for irrigation, we will cause serious damage to our trees.

Florida has many fresh water lakes from which to obtain water when irrigation is needed. California uses water from mountain fed streams or from deep wells. California does have a few places where the water contains high Boron, but these areas are limited. California waters are generally excellent for irrigation.

(D) Diseases and insect pests. The Rio Grande Valley citrus area is very fortunate indeed from the standpoint of insect pests. There are present in the Valley at least eight potentially very destructive scale insects, all of which are controlled fairly well by parasites. There are also present in the Valley, the citrus red spider or red mite, and the rust mite as well as several other less common pests. All of these pests are quite well controlled by parasites, except the rust mite. We need a parasite to control it. The rust mite is fairly easily controlled by means of sulfur dust, but the sulfur kills many of the parasites which control the other insects. If we could eliminate the use of sulfur, the scale insects would do less damage.

California and Florida also have most of these insects. California and Florida have become dependent upon insecticides to the extent that California spends in the neighborhood of 50 dollars per year per acre for pest control. It is believed that they could and will in the next few years, find that by giving the parasites and predators a better chance, they can eliminate most of their chemical pest control. This will be a distinct advantage to the trees, as well as the purses of the growers. California will no doubt have to put in some insectaries for growing parasites and predators.

At the present time, the citrus Black Fly appears to be a serious threat to the citrus pest control problem. If the Black Fly gets into the Valley before we find a parasite which will control it, we must expect to fight it with insecticides, and then we will also have to fight all of the scale insects with insecticides.

California has the theat of the Oriental Fruit Fly which will affect not only citrus, but practically all other fruits. All citrus areas are subject to invasion by numerous other insects. Florida was, at one time, invaded by the Mediterranean Fruit Fly but they eradicated it.

California has the very serious disease called quick decline which is destroying many orchards. This disease is carried by a virus and is probably spread by insects. Florida has the slow decline which is destroying many trees. The cause of this disease is unknown.

(E) Quality of fruit and rate of production. The quality of grapefruit raised in the Valley when properly cared for is superior to that of any other area. The quality of the better types of oranges is fair. The

TABLE III

AVERAGE NUMBER OF HOURS OF ACTUAL SUNSHINE DAILY

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Brownsville, Texas	6	7	8	8	9	11	11	11	10	9	7	6
Los Angeles, Calif.	7	7	7	9	10	11	11	11	9	8	8	7
Tampa, Florida	6	7	8	9	9	9	9	9	8	8	7	6

Data from: Atlas of American Agriculture

TABLE IV

AVERAGE RELATIVE HUMIDITY: 2 PM

	Jan.	Apr.	July	Oct.
Brownsville, Texas	65	65	60	60
Los Angeles, California	55	50	40	50
Tampa, Florida	65	55	60	65

Data From: Atlas of American Agriculture quality of some of the early oranges is quite low as compared with the average fruit of other areas.

The average rate of production of citrus in the Valley is not very accurately known as few dependable data are available. It is believed, however, that the average production per acre is less than that of California and quite certainly less than that of Florida.

(F) Markets and marketing. The distance to markets is a factor which must be considered in the building of an industry. Florida probably has the best access of any citrus area to the U. S. Markets. Texas does have a considerable market area through the middle western states which is more accessible to it than to Florida. California has a definite handicap in that they have a long haul to the main markets.

California has an enormous advantage in that the growers have organized to work together in controlling their grades and the quality of the fruit, as well as the amount of fruit shipped. California has many cooperative packing associations as well as two cooperative sales organizations. On the whole, these organizations are outstanding in efficiency of operation, as well as in provision of much helpful information and guidance to the many thousands of grower members.

The growers in Florida, as well as Texas, have attempted to form similar organizations but the only effective success has been in the Indian River section of Florida.

SUMMARY

It seems, then, that we can give the following evaluation of the outlook for citrus in the Rio Grande Valley:

The citrus trees in the Valley are more subject to freeze damage than are the trees in Florida or California due to the fact that the trees are less dormant. Apparently little can be done about this and cold damage will always be a serious factor to contend with. California growers have the advantage in that they can effectively heat their orchards, while heating is futile in the Valley. Other climate factors are not serious except hurricanes and they are not frequent.

It is necessary to use irrigation water with a rather high salt content and a rather high Boron content, but the cost of irrigation water is relatively low.

The natural drainage is poor, therefore, it is necessarv to take special precautions and increase the drainage capacitv to prevent high water tables, high salt, and high Boron content in the root zone. Much work has yet to be done on the problem of drainage, but much can be done to alleviate these conditions, if and when the Valley people want to do it.

In modern agricultural industry, it is necessary that those interested work together effectively to solve their mutual problems if they are to exist for long. The Valley must have organization, including research work, which can and will develop means of keeping out, or controlling, pests and diseases, such as citrus Black Fly, the Oriental Fruit Fly, quick

decline or Tristeza, slow decline, etc. This is not an impossible task.

It appears that the outlook for grapefruit in the Valley is much brighter than that for oranges. Any commodity which has as much natural advantage in quality as that of the Texas grapefruit, requires much less selling effort than where the qualities of other products are the same. Valley oranges will sell to an advantage only as long as the market is close enough that the difference in transportation cost is significant.

The rate of production of citrus in most orchards could be increased materially with proper orchard care.

The weakest spot in the Valley citrus industry is its lack of unified grading and marketing organization or program.

It appears from this analysis, that the outlook is good for a reasonable amount of citrus and particularly grapefruit, if the people of the Valley will solve those problems of drainage, pest and disease control, and an organized marketing program.

Crops and Their Relation To Soil Productivity

R. D. Lewis, *Director*
Texas Agricultural Experiment Station
College Station, Texas

Dr. Lewis is the administrative director of the Texas Agricultural Experiment Stations. His main field of interest is in Plant Breeding and Soils and Field Crops. Dr. Lewis has held positions in Agronomic and Plant Breeding research and teaching in Extension and Administration at Pennsylvania State College, Cornell University and for a period of 16 years at Ohio State University.

An event most significant to the future agriculture of the Valley took place at the Lower Rio Grande Valley Experiment Station here at Weslaco on October 11, 1949. This was the formal initiation of a coordinated program of research and extension with grasses and legumes made possible by a grant of funds and use of lands from the Central Power and Light Company. Speakers on that occasion reminded us of the comparitive youth of the agriculture of the Valley and of the "hard life" that the soils of the Valley had already experienced; a life characterized by production of intertilled crops nearly the year round and by the lack of adequate application of "soil building" practices. It has been suggested that as we look to the future of agriculture in the Valley, it is well for us to review some of the facts and principles of interelations of crops to the productive capacities of soils.

The world over, we find that the kinds of crops grown, the systems in which they are grown, and the management practices applied in growing them are highly important determiners of the trends of productivity of most soils. A given soil under one system of cropping may decline rapidly in productivity; under another system its ability to produce crops may be raised to and sustained at higher levels.

Let us briefly review the make-up and nature of soils. Light, air, water and soil, together with the plants and animals that grow in them, are the great physical resources of the earth. Through soil, in combination with light, air and water, the lifeless mineral body of the earth is joined with the biological kingdom. Soil is much more than pulverized rocks mixed with decayed organic matter. It is a live, dynamic, changing, physical, chemical and biological complex. Without life there is no soil. In this living, dynamic soil constructive and destructive processes are constantly proceeding, side by side.

Just as in human society, each activity or process in the soil may affect other activities and the consequent end product, which with soils is primarily the production of crops. Soils have been developed by the interaction of natural factors. When man alters any natural factor in the performance of agriculture, he also changes the balance of the physical, chemical and biological factors in that soil. Thus, a cultivated soil may become quite different from its virgin state. These changes may be good or bad from the standpoint of productive capacity. Fortunately, some farming operations may actually improve the soil resource.

Every soil in its natural or pre-cultivated state is limited in its pro-

ductive capacity. Through modern science and art these limits may be expanded in terms of kinds and yields of crops. No very close relationship exists between the natural fertility of many soils and their productivity under wise use by man. Their degree of response to man's efforts is the important consideration.

By the way, do the words "fertile" and "productive" as applied to soils confuse you? They used to do so for me. Strictly, a "fertile" soil may not be necessarily be a "productive" soil. The "fertility" of a soil relates primarily to the chemical or plant nutrient levels in a soil. "Productivity" relates to the balance or combination of those physical, chemical and biological factors within the soil which together determine crop repsonse. To be highly productive, a soil must be a source of adequate air and water as well as of nutrients, and it must teem with beneficial organisms.

To understand how individual crops or successions of crops affect the productivity of a soil, we should first appreciate those processes, which singly or in combination act to lower the productive capacity. Only if these negative factors are recognized can man set up soil and crop management systems that will result in improvement and conservation of the soil resource.

Soils deteriorate in productivity because of the following processes:

1. Nutrients are removed in harvest crops;
2. Nutrients are lost in the drainage waters and by leaching;
3. Acidity of soils in humid areas tends to increase as a result of leachinging and removal of calcium in crops;
4. Salts may accumulate in irrigated and sub-humid soils;
5. Organic matter is destroyed in tillage operations;
6. Soil-air-water ratios are adversely altered by tillage, resulting in less favorable soil structure or tilth, poor drainage, etc.;
7. Lower types of life and life-processes occur;
8. Soil is removed physically by water or wind; i.e., erosion takes place.

The order of listing these negative processes has no meaning for a particular soil or field, since their relative significance varies with soil types, classes and magnagement systems. Also you will observe at once that several of these processes are interrelated and may occur together.

When one place any crop, and the cultural operations involved in growing it, next to this list of soil-deteriorating processes, it becomes evident that no harvested crop is entirely "soil-building", "soil-improving" or "soil-conserving". Next, it would appear that certain crops, especially the deep-rooted legumes or combinations of legumes and grasses effectively counteract several of the deteriorating processes; and, if properly managed, become actually "soil-building". Other crops counteract none of the negative processes and are therefore highly destructive of soil productivity. However, no one harvested crop counteracts all these negative processes.

Let's do what is suggested in the proceeding paragraph; place two crops of interest to the Valley farmers alongside the above list of soil-deteriorating processes and note whether the growing of each one tends to counteract (c) or speed up (d) the specific deteriorating process. For this illustration, let's use tomatoes and alfalfa:

PROCESS	*TOMATOES*	*ALFALFA*
1. Nutrients removed	d	d - for P, K, & Ca. c + c for nitrogen
2. Losses by leaching & drainage	d + d	c
3. Acidity increased	d	d
4. Accumulation of salts	d	?
5. Organic matter destroyed	d	c + c + c
6. Poorer soil structure	d + d	c + c + c
7. Lower types of soil organisms	d	c
8. Erosion losses	d	c

In growing a crop of tomatoes each of the deteriorating processes may take place. In the case of alfalfa, several of them are effectively counteracted. Consequently, tomatoes are labeled a "soil-depleting" or "soil-deteriorating" crop and alfalfa a "soil-building" crop.

As we developed this simple system of examining the effects of growing crops on soil productivity, you may have asked yourself, "From such an approach couldn't we develop a numerical or bookkeeping system of analyzing the effects of crops on soils and of the effects of adding fertilizers and other soil treatments?" I know of at least three states in which such a system has been developed – Ohio, Missouri, and Michigan.

For instance, as an aid to evaluating the effects of existing or contemplated cropping systems on the productivity of the soil, research and extension workers in Ohio during the period 1932-1936 developed the "soil productivity index" and "the soil productivity balance" methods of analysis.

The *soil productivity index* is the percentage changes assumed to take place in the productive capacity of a soil caused by growing a specific crop for a single year. It is the approximate measure of the balance between the favorable and unfavorable effects of that crop on soil nutrients, soil structure, organic matter and biologic activity.

The *soil productivity balance* expresses the percentage change in the productive capacity of the soil that may be expected to occurr annually under a given cropping system, with proper credits for applications of manure and fertilizers and adjustments for degree of liability to erosion.

Under this method of analysis in Ohio, corn was given an annual soil productivity index of -2.0 percent on non-erodable soil, tomatoes -2.0 percent, wheat -1.0 percent, soy beans -.5 percent, timothy +.25 percent, clover-timothy mixed +1.25 percent and alfalfa at the end of the first hay year +2.5 percent (complete details in references 1 in English and 2 in Spanish).

By using this or a similar method of analysis, the approximate trend of a cropping system, with the accompanying soil treatments and erosion

control practices, may be determined; and it will uncover the weak points in existing systems of cropping and soil management. It provides an evaluation of the probable gain or loss in soil productivity over a period of years.

There are many lessons that may be gained from such an analysis—particularly where several crops follow in succession and under varying soil conditions. Obviously, the heavier (less sandy) the soil the more important soil structure becomes as a factor in maintaining or building up productivity. There is abundant evidence of this from investigations of root growths of citrus trees here in the Valley and of trees and other horticultural and field crops at several locations in this and other states. The heavier the soil the more difficult it becomes to have and maintain a satisfactory ratio of air and water to the solid components of soils. The best method of improving soil structure yet found is by growing deep-rooted legumes such as alfalfa and sweet clovers or combinations of such legumes and grasses.

In organizing cropping systems for improved and sustained production, the evidence the world over is that legumes and grasses are the key crops. In his fine book "The Land, Now and Tomorrow", R. G. Stapledon (3) gives his point of view on the technique of more effective use of the land resource. Quoting him on legumes and grasses, "The shift in point of view has not only been in placing grass before arable in the process of land reclamation, but also in the direction of placing clover before grass . . ." ". . . the clover root that in truth deserves most of the credit". "The corner-stone in land improvement in all parts of the world is the leguminous plant". "A good sward is generally convertible into reasonably good arable." (Would that adapted leguminous plants were available for all parts of our agriculture, especially for the irrigated valleys and sub-humid range lands).

Again by referring to our list of soil deteriorating processes, we could almost write the specifications for an ideal soil improving crop:

1. It would be or contain a legume—having the power of fixing atmospheric nitrogen through the associated bacteria;
2. It would have an extensive root system, with a large portion of the total plant represented in the roots;
3. It would furnish good cover for the surface soil;
4. It would live more than one year.

Obviously, alfalfa or an alfalfa-grass combination is a near approach to this ideal of a soil-improving crop. One of the reasons for our expanded research on legumes and grasses here in the Valley is to determine more crops or combinations that may approach this ideal under these conditions.

Summary

Soil-deteriorating processes are not then contained within the soil itself; in fact, they come primarily from soil-crop interrelations. The kind of crop, its frequency, the accompanying cultural practices and soil treatments, together with special controls for the effective use of water and against losses of soil, determine whether or not the growing of that crop has a net positive effect on the productive ability of the soil. Furthermore, on cultivated land, the actual pattern of the cropping system determines whether such land is being further exploited or is being rebuilt for sustained production.

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Findings Of The Citrus Freeze Committee

Dr. P. W. Rohrbaugh, *Chairman and* Norman P. Maxwell
Horticultural Club Freeze Damage Committee

Dr. Rohrbaugh's main field of interest is Citrus. He served 4 years on the staff of the Citrus Experiment Station, Riverside, California and 11 years with the California Fruit Growers Exchange in their Field and Research Departments. Dr. Rohrbaugh was on the teaching staff of the Citrus Department of California State Polytechnic College and served as head of the department until he came to Texas in 1948 as Director of the Citrus and Vegetable Training Center of Texas A & I College. Most of his research work has had to do with Physiology, Pathology and Biochemistry of fruit.

Mr. Maxwell is working principally with citrus and vegetables at present and his main field of interest is citrus and vegetable variety and fertilization research.

The following report of the committee was prepared and released to the local press on September 27, 1949.

At the present time many of the frozen trees are showing remarkable recovery. This is particularly true of trees where good cultural and management practices have been followed. Trees which were allowed to become too dry have made little growth and new wood that has been put out has, in some cases, died back or is very weak, and little healing of the wounds has taken place.

Considerable difference in recovery in different orchards is very evident at this time. In some orchards, it appears that the wood of trunks and larger branches was damaged more severely, while in other orchards the injury was limited to bark damage. Of course where the bark is killed entirely around a branch, the whole branch has died. In some cases we find the bark is still alive but all of the wood of a limb or trunk is dead. In other cases, most of the bark is dead but the wood is largely alive.

It appears that where the wood of the trunk and larger branches was extensively damaged, the tree recovery was much slower than where just bark injury occurred and in many cases, it is still difficult to determine the future of these trees.

Some orchards which were pruned or cut back during the first month after the freeze have shown excellent recovery and growth. Other orchards which were pruned or cut back early appear to have been much retarded by this early pruning. In general, those orchards which were pruned after May first, have not been adversely affected by pruning, although when heavy pruning was done during the middle of the summer, there is evidence of considerable sunburn in some orchards.

Many trees now show there was extensive killing of the bark in the main crotch of the tree. This type of injury heals with difficulty and usually requires considerable time. Wood rotting diseases often get into these wounds before they can heal over. Yet, many of these trees with proper treatment will heal over and produce good crops for a number of years. In order to eliminate, as much as possible, wood rots and other diseases, such as Rio Grande Gummosis, trees can be cut off below the damaged crotch or other severe wounds. Nearly all of the serious bark wounds in the crotch are on trees seven years of age or younger. Such trees are usually strong and healthy and would normally be expected to heal faster than older trees. Many growers will prefer to cut their trees less severely and run more risk of losing some from diseases in hopes that most of the wounds will heal over, or that the tree will bear considerable fruit before it becomes too badly decayed. Each grower must decide for himself what the best possibilities are in his particulary orchard.

Many of the older trees had outer limbs killed to varying degrees, and they have put out new growth from the larger inside limbs. Many of the new branches grew about six to twelve inches long. These then blossomed and in many cases set considerable fruit. Much of this fruit is in clusters of from three to eight. At this time the quality of such fruit does not appear to be very good, as it has very thick rind and little juice.

In some cases, particularly in the northern and western parts of the Valley, where tree damage was much less on old trees, there are some orchards which have a fair crop of fruit. In these orchards where the trees were not entirely defoliated, the fruit appears to be almost normal in yield and quality.

Growers should remember that any heavy pruning tends to stimulate and force out new growth. Such pruning should, therefore, be done far enough in advance of cold weather that new growth which is forced out will have time to mature before a possible freeze.

In the lower part of the Valley, or anywhere that Melanose is a problem, as much dead wood as possible should be removed before the spring growth comes out. The Melanose fungus lives on dead branches and infects new shoots and fruit as they begin to develop.

The pruning wounds of many trees have been treated with pruning compounds which are not satisfactory. They have not made a permanent seal to keep the moisture and diseases out. This has not been the fault of the grower as satisfactory pruning compounds have not been readily available on the market. The Valley Experiment Station has recommended a formula for making a good pruning compound. The ingredients for making this material have not been readily available and most growers would rather buy a prepared product. Many of the pruning compounds on the market are not heavy enough to make a permanent seal over the wound cracks. A few days or weeks after application the wood of the wound cracks open, leaving an entrance for water and spores of decay oragnisms. The requirements for an ideal pruning compound are: first; it should not contain any material which will injure even the most delicate of plant tissue, such as cambium or callous tissue, second; it should contain some disinfecting substance which will kill the spores of, or prevent the growth of disease organisms, third; it should be of such a nature that it will seal the wound to prevent the entrance of moisture or disease organisms.

SUMMARY OF COMMITTEE RECOMMENDATIONS

From the observations and work done by the Committee, it is believed that the following procedure should be followed in treating citrus injured by freeze in the Rio Grande Valley.

1. No pruning or treating should be done until the trees have completed at least one cycle of growth. Then the extent of the damage can be determined and one can tell definitely what tissue is going to grow. One should be able to distinguish any dead areas of bark in the crotches or on the trunk before pruning is started.

2. The trees should be given the same normal good care after the freeze as before. The same watering and fertilizing schedules should be followed except that where the trees have been considerably reduced in size, leaf area and amount of fruit, the amount of fertilizer may be decreased.

3. When the trees are pruned, the cut should be made back to sound live wood wherever possible in order to eliminate all decay an diseases. In cases of severe bark injury in the crotch or on the trunk, a grower may wish to leave as much top as possible to produce fruit quickly even though the tree might become diseased and require removal later. He may wish to interset new trees in his orchard within a few years. Procedure in such cases must be decided by the individual grower.

4. All large pruning wounds should be treated and sealed with a good pruning compound which will prevent the entrance of moisture or disease organisms into the wound. Wounds less than 3/4 inch in diameter will usually heal over quickly and do not need special treatment.

The members of the committee are as follows:

C. W. Waibel, Nursery Inspector, State Dept. of Agriculture

Dr. W. C. Cooper, Rootstock Investigations, U. S. D. A., Weslaco

Dr. G. H. Godfrey, Plant Pathologist, Valley Experiment Station, A & M College

N. P. Maxwell, Ass't Horticulturist, Valley Experiment Station, A & M College

W. R. Cowley, Supt., Valley Experiment Station, A & M College

J. A. Oswalt, County Agent, Hidalgo County

A. L. Ryall, U. S. Horticultural Field Laboratory, Harlingen

W. C. Scott, Director, U. S. Fruit and Vegetable Products Laboratory, Weslaco

W. H. Friend, Associate County Agent-Citrus

Chairman, Dr. P. W. Rohrbaugh, Director, Citrus and Vegetable Training Center, Texas A & I College, Weslaco

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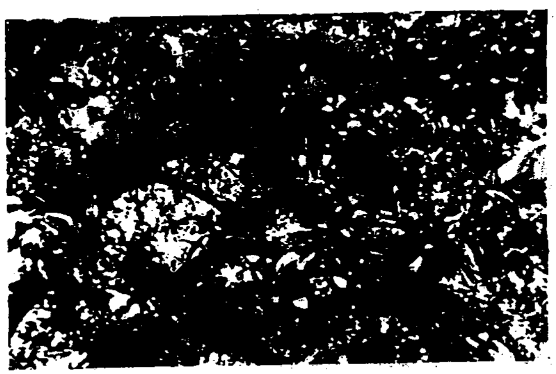
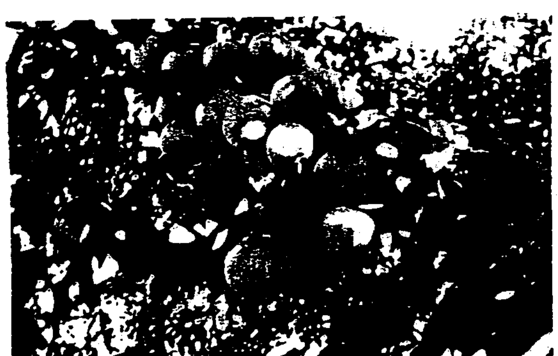
It is believed that attention should be called to two further developments which have taken place. It is stated in the report that the quality of the fruit did not appear too good at that time, but the fruit now being picked is mostly of very acceptable quality. We wish also, to call attention that in some places considerable sunburn damage has appeared. One orchard near Mission which was first pruned on March 24, 1949, and again during the period of August 29 through September 3, 1949 was sunburned very severely following the second pruning. Those trees which had no shade to protect the southwest side of the trunks had considerable areas of bark killed, and many of the trees were lost due to this burning. Dead bark did not appear except on the southwest side.



Grapefruit set following the freeze



Grapefruit set following the freeze

Young grapefruit tree 10 months after the freeze — not pruned

Young grapefruit tree 10 months after the freeze — just pruned to one trunk

Young grapefruit tree 10 months after the freeze — just pruned leaving multiple trunk

Pruning Freeze Damage Citrus Trees

W. H. Friend, *Associate County Agent — Citrus*
Lower Rio Grande Valley

Mr. Friend is interested in the field of Horticulture and his work is principally educational in the field of citrus and vegetables. He was previously Superintendent of the Valley Experiment Station, Weslaco, Texas.

Horticulturists have, for generations, been taught that one of the principal reasons for pruning fruit trees is to remove dead and diseased branches which might imperil the health of the trees. Since most citrus trees do not require pruning to regulate fruiting, the removal of dead and diseased branches is about the only legitimate excuse for pruning.

A freeze such as the Valley experienced in January 1949 caused a lot of dead wood and disease to show up in many orchards. It also created a desire on the part of the owners and caretakers to do something for their stricken trees. There was certainly an abundance of dead and diseased plant parts on most Valley trees, and it was difficult to convince the average grower that the danger of infection resulting from leaving the dead growth intact for six months or a year was less of a hazard than early pruning. Because of the psychological effect of the unsightly appearance of the trees, most growers who could hire the necessary help proceeded to prune their trees soon after the first flush of new growth appeared following the freeze. Examinations made several weeks after the freeze showed conclusively that cold injury (splitting and freezing) of the bark of trunks, crotches and arterial limbs was so extensive that the infection hazard had to be ignored, temporarily at least. Just how long this infection hazard could be safely ignored was a mooted question.

After considerable deliberation and careful evaluation of information from all sources, it seemed advisable to make one set of recommendations covering the pruning of trees in the one to five year age group, another set for those in the five to ten year age group, and still another for the older trees.

Most of the trees in the one to five year age group, and some trees in the five to ten year age group showed bark and wood damage of such proportions that a procedure involving stumping back and re-building was recommended. The time suggested for starting this work was immediately following the hardening up of the first flush of growth or just as soon as the pruner could be reasonably sure that he was removing all seriously damaged tissue in the case of unbanked trees and all damaged tissue in the case of the trees which were banked with soil at the time the freeze occurred. The pruning, in most cases, amounted to a sawing off of the trunk at an angle, and at a point just above a good sprout and below all serious bark and wood injury. In some cases, pruning was delayed too long and wood destroying fungi had invaded heart wood that was surrounded by perfectly sound sap wood and bark.

The pruning of most of the trees in the five to ten year age group and a few of the younger trees consisted of procedures varying from the removal of a few terminals under one inch in diameter to a drastic type in

which the finished "product" looked somewhat like a "hall tree" or hat rack. Orchardists were advised to start this type of pruning when the extent of the damage could be determined with a reasonable degree of accuracy. They were further advised to remove all branches showing bark and wood damage of a serious nature. Since the wood of these trees had been exposed to infection through innumerable breaks in the bark, it seemed that the danger from infection by wood destroying fungi might just as well be ignored and the job of pruning delayed until the full extent of the damage could be determined. The actual pruning operation of these trees consisted of the removal of seriously damaged branches and the thinning out or removal of unwanted watersprouts that appeared on the trunks of severely damaged trees. Growers were advised to leave all sprouts that appeared on the arterial limbs of trees that were defoliated by the freeze. These sprouts should be thinned out to about one per linear foot of limb, just prior to the spring flush of growth. In some cases it was necessary to "head back" the more vigorous, vegetative branches to make them less susceptible to breakage. This was especially true of the more severely damaged trees, which were stubbed black almost to the trunks.

Trees in which cold damage was confined to the foliage and to limbs less than one inch in diameter can be pruned according to the usual procedure recommended for normal trees. The season at which trees in this class are pruned seems to be relatively unimportant but it is logical that the job should be completed before the next crop is set.

In summarizing the pruning of cold damaged citrus trees, it might be said that we recommend the recognized procedures for a good job of pruning, with the reservation that the sections relating to the removal of all dead and diseased limbs be modified to suit the case in hand. Growers who expect to interset and eventually replace their cold damaged trees will prune less drastically than those who expect to keep their "rebuilt" trees for a relatively long period of years.

Pruning has a dwarfing effect on the trees and should be confined to the removal of parts that imperil the health and usefulness of the trees.

Observations Of The Freeze Damage To Some Sub-Tropical Fruit

RAFAEL H. CINTRON, *Hoblitzelle Ranch, Mercedes, Texas*

Dr. Cintron is continuing the research work in tropical and sub-tropical fruits which he started while teaching and doing research work at the College of Agriculture and Mechanic Arts of of Puerto Rico.

Ever since the potentialities of the Lower Rio Grande Valley area as a horticultural section were recognized, there has been an ever-increasing interest in growing sub-tropical fruits of one kind or another. The success, or perhaps the failure, with the most important of the sub-tropicals, citrus, has stimulated new interests and new efforts in other fruits hard or impossible to grow except in a few areas in the Continental United States.

Among those that have been tried with varying degrees of success or could be tried hoping for varying degrees of success, we can mention the avocado, the papaya, the mango, the white sapote (Casimiroa edulis), the wooly leaf white sapote (Casimiroa tetrameria), Ceylon gooseberry (Dovyalis hebecarpa), lychee (Litchi chinesis), Sapodilla (Archras sapota), Surinam cherry (Eugenia uniflora), jaboticaba (Myrcairia cauliflora), feijoa (Feijoa sellowiana and feijoa coolidge), common guava (Psidium guajava), Cattley guava (Psidium cattleianum) and Barbados cherry (Malpighia punicifolia). In the report of the sub-tropical fruit committee published in the first volume of the Texas Avocado Society, there is a rather complete list of other exotic fruits that could be tried, but the qualification is made that they are not cold hardy.

Most of the specimens of one or another of these fruits to be found in the Valley have been planted mostly as backyard trees and in many cases subjected to unfavorable soil environment. Their failure to make a better showing can be traced to these adverse soil conditions. But what is really going to count is their ability to stand the peculiar weather conditions during the winter months. Which of the fruits listed above will ever get out of our back-yard to go into orchard form, only time can tell. Some will remain in the care of the housewife, others even she might give up; but some can and are making a better showing than expected.

It is rather hard to change soil conditions economically and it is still much harder if not impossible to change the climate; but we can change the nature of the plant by various horticultural methods to where we can get one or more of these interesting fruits to grow in our Valley.

As pointed out earlier, it is the peculiar and unpredictable winter temperatures that limit our ability to grow some of these sub-tropical fruits. The rather sudden changes from mild, sometimes warm weather, to freezing temperatures destroys nature's way of protecting plant life against cold, which is dormancy. Most tropical and sub-tropical plants are characterized by the lack of a dormant period, but they can be induced to slow their growth, or for all practical purposes to slow it appreciably to where they can increase their dormancy and stand colder temperatures. This is possible only when steady cool temperatures pre-

ceed freezing weather, the plant will be in a state of growth making it less hardy and more vulnerable to cold. Last year's freeze was preceeded by such a period of mild temperatures, consequently bringing more damage than would have occurred otherwise. It is true that the lowest temperature recorded (20°F), was entirely too low and sudden to provide an effective measure of cold resistance in plants which were not dormant. Had the average temperature during late December and January been lower than it was, we would have had a better measure and be better able to judge varietal resistance to cold. As it was, all unprotected sub-tropicals, other than citrus, were either greatly damaged or killed.

In the avocado group, for example, the Mexican type, supposedly able to stand such low temperatures and actually proven able to have enough hardiness when growing under California conditions and subjected to lows of as much as 20°F, actually suffered extremely severe damage. In this particular case, the apparent tenderness of supposedly hardy varieties can be safely attributed to lack of dormancy at the time of the freeze. Actually, they were in full bloom at the time and had been blooming profusely for a long period before the date of the freeze. Varieties less hardy than those of the Mexican type, as Guatemalan and West Indian varieties, their hybrids and hybrids between them and the Mexican type were killed in many cases below the bud union. Again, in spite of the recognized or expected tenderness accounting for such a severe damage, there are plain indications of lack of dormancy due to growing conditions previous to February the 1st. They could have, growing conditions prevailing before the freeze being less favorable, been able to endure better than they did. In fact, some old trees of the tender West Indian type came through as well as some supposely hardier types. The factor here was a later blooming habit in the West Indian type and undoubtedly the age of the trees involved.

A series of observations made at different localities revealed that seedling avocados were less damaged than grafted trees. The writer is not at this time offering a hypothesis to explain such a reaction and wants only to record the observation.

Soon after the freeze a committee from the Texas Avocado Society made a Valley wide trip with the purpose of studying damages in avocados. At the time, all trees observed had lost foliage and damage to the wood could already be recognized. The group made many cuts into the bark so as to expose the cambium and observe damages to the bark and wood. A discoloration of the cambium layer, in many cases a general discoloration, was observed. When indications of new growth was apparent, mostly as buds sprouting from the trunk, growth always accurred above a strip or over an irregular portion of normal cambium, the portion sometimes surrounded by discolored cambium above, below and to each side. At the time, the writer thought that the discoloration was going to extend to every portion of the cambium layer, thus killing the tree. We observed later, however, an increasing ability to regenerate new cambium in such places where there was enough sound cambium to keep life long enough to permit extensive regeneration. In many cases though, death followed and such trees were forced to sucker very close to the bud union or below it.

In a letter from Dean R. W. Hodgson of the College of Agriculture of the University of California at Los Angeles, we were informed of similar cambium discoloration occurring after a severe freeze. He reports having seen such a condition in avocados and walnuts. He also observed a recovery with time. Similar cases of cambium discoloration were noticed by the writer in guavas, Cattley guavas, white sapote and Ceylon gooseberry. The guavas had been banked rather high saving a good portion of the trunk and all have made wonderful recovery since the freeze. The Cattley guava showed very plain cambium discoloration, clear down to the trunk. In spite of this, they are showing recovery. The white sapote have made some recovery although slow. Neither of these two plants were banked since being seven or eight years old they were thought safe. The Ceylon gooseberry has recovered also very well.

We regret that the mangos available for observation were too young at the time and did not offer good opportunities to measure their resistance to cold and their ability to recover. This is a plant which will see trials in larger scales.

The papaya is another of the sub-tropical fruits that have caught the eye of some Valley growers. They are easy to grow and the question has arisen as to the possibilities of commercial production of this fruit. It must be said that this is perhaps the most tropical of the fruits listed above and that no hardy varieties have been found in nature or produced by hybridization. It is so tender that even a light frost will cause damage and temperatures of 32° or below will kill the tops and cause a loss of the crop for that year. The trunk, however, will resist temperature below freezing and be capable of suckering again specially if banked high. Temperatures of 30° or below will damage the trunk, the severeness of the damage depending on how low the temperature gets. As expected, the February 1st. freeze killed all papayas as far down as the bank or outright if this was not provided.

The writer wants to point here to the advisability of protecting the trunk against possible freeze damage. It has been observed time and again that dirt banking is very effective in accomplishing such results. It has saved almost all of the banked portion of the trunks of all sub-tropicals observed. Other methods of protection could be worked out where a bigger portion of the trunk could be saved, thus enabling the grower to reshape his trees better and faster.

Other Fruits Than Citrus For The Valley

J. R. Padgett, *Manager*
Demonstration Farm, Rio Farms, Inc.

That day when Valley residents home grown fruit diet is restricted to Citrus fruit is over. For this we can be grateful for several factors—among them, the easing of Federal restrictions, research in the field of horticulture and an awakened public interest in other fruit crops than citrus.

In the new group that are known to be available are certain of the decidious fruits of the temperate zone and several sub-tropicals of considerable promise.

Already proven in the Valley are several of the honey type peaches, viz: Luttischau, Jewel and Walden—all of these are excellent varieties for home planting only. They produce enormous crops of small peaches with a high sugar content, but they are very thin skinned and tender and will not ship in good condition. There is a new honey peach known as the Melba that is now available. It originated as a sport on a Pallas peach tree growing at Dilley. This Melba is considerably larger than any of the other honey types. It has a beautiful red color and a skin so tough that it will ship in good condition.

This peach is owned exclusively by the Wolfe Nurseries at Stephenville, Texas, who secured control of the sport buds on the tree at Dilley. The fact that this Melba peach originated further South than any other known variety makes it probable that it will require a shorter period of dormancy than other varieties available, thus removing one of the principal hazards to successful peach growing in the Valley.

Several Texas nurseries are now able to furnish both peaches and plums on rootstock resistant to root knot nematode which removes another major hazard to growing these fruits in the Valley.

The Bruce plum has demonstrated its adaptability to Valley conditions and belongs in every home planting. It is a large red plum with yellow flesh and is a prolific bearer. It can be obtained on Marianna rootstock which is nematode resistant and will add years to the life of the tree. This plum probably has some commercial possibilities in the upper part of the Valley.

Another supposedly difficult fruit to grow in the Valley is not difficult at all, if proper care is given to the selection of adapted varieties. Here again the nematode and a short period of dormancy are discouraging factors, but can be overcome and every Valley family can have a plentiful supply of grapes, if they make the proper effort.

The Black Spanish grape is now growing in many parts of the Valley. There are plantings more than 40 years old still thrifty and bearing heavy crops of fruit each year. I know of several Sultanas that have borne in the Valley for ten years or more—all of them on their own roots. I know of several other vines, some of them bearing an excellent white grape and others a purple grape similar to the Carmen. The origin of these grape vines and their variety is unknown, because their present owners have no knowledge of their history. All of this goes to prove that grapes can, with proper selection, become a common fruit in all the backyards of the Valley. California nurseries are now offering all their varieties on nematode resistant rootstock which affords the Valley horticulturists, whether professional or amateur, an opportunity to do some research in the growing of grapes with more chance of success than ever before.

The Demonstration Farm at Rio Farms has accumulated a variety of resistant grape rootstocks and will gladly share it with anyone interested in the propagation of grapes in the Valley.

A new comer in the berry family—the Nessberry—has broken the Valley's resistance to the introduction of berries that will grow and prosper. Years of effort with black berries, dewberries, boysenberries and all of the excellent hybrids have failed to produce a berry that would live and fruit consistently in the Valley. The Ness was bred at A & M Experiment Station. It is a Rasberry-Dewberry cross, a prolific bearer of delicious fruit that resembles a large dewberry. It should be in every backyard planting.

An introduction from the highland of Northern China—the JuJube—will contribute to the pleasure of growing a variety of fruits in the home garden. It is a hardy, rugged tree with a beautiful glossy foliage. Incidentally, it is the only fruit in the world that grows suspended from the leaf of the parent tree. I have seen the fruit pickled in its green stage and make a very satisfactory substitute for green olives. Many people enjoy it as a fresh fruit when it ripens. The flesh has the consistency of an apple and a taste all its own. Preserved, the ripe fruits are very similar to dates. It should be in every home planting, especially where there are children.

No home should be without its strawberry bed. A small planting of 200 plants well cared for will provide a small family with all the fruit they can use. They should be planted in October if one desires a maximum bearing season. With fertilization, ample water and an adequate mulch they will bear for four or five months and afford an unbelievable amount of fruit for such a small plot.

A new fruit—the Avocado—or possibly I should say an old timer in the Valley, is coming out of retirement and claiming prominence among the Valley's fruits. From Brownsville to Mission in many backyards of the older settled homes there are one or more beautiful avocado trees, some of them 20 or 25 years old. For years their owners have enjoyed their delicious fruit. The most of them are seedlings and there is no uniformity of type. Some of them are of Mexican origin, some of them West Indian or Guatamalan or some hybrid mixture of the three.

When citrus in the Valley had passed its peak, the avocado came out of its retirement and now bids for a place of prominence in the economic picture in the Valley. Due to the efforts of a few enthusiasts who place great faith in the future of this crop, it is fast coming into prominence.

It is the opinion of Valley horticulturists who know their avocados that the ideal avocado for the Valley will come—not from California or from Florida, but from a Mexican-West Indian hybrid originating somewhere in the Victoria-El Mante region of Mexico. For that reason this area is being constantly scouted by the Valley's specialists in sub-tropical fruits. From all promising varieties found, budwood is brought back to the Valley and propagated on seedlings—mostly West Indian grown here for that purpose. Hundreds of these top Mexican varieties are now growing in the Valley and somewhere among them is probably one that will do for the avocado industry in Texas what the Fuerte, also a Mexican introduction, has done in California. Every Valley home should have its avocados chosen to fruit from early June through to March or April. Your nurseryman can provide you with such a selection of varieties.

Only Florida and the Valley can grow the papaya and even those two areas have their difficulties, but the rapidity of its growth and the short time needed to produce its fruit from the seedling plant are encouraging factors. In the Valley are centered the choice papayas from tropical areas all over the world. We have long had the Solo from Hawaii, the Betty from Florida and the Red Rock whose origin is obscure. All of these are choice varieties. At the close of the late war our Valley soldiers returned from all the islands of the South Seas with seed of all the choice papayas of those islands in their pockets. Today we probably have a greater variety of choice papayas in the Valley than any other area in the world.

Several Valley homes are today blessed with a source of delicious mangos right in their backyard. Years ago somone had the foresight and the courage to attempt a thing thought at that time to be impossible. The locations in which these trees grow are no different than your yard or mine. From this it should be evident that we can all have mangos if we will only give them intelligent care for a few years.

In another yard with which I am acquainted there has grown, for years, a beautiful Guava tree. This tree has supplied the family and the neighbors with an abundance of fruit. It is of the yellow Mexican type. There are many varieties of Guavas. Among them is the strawberry, a small tree that begins to bear when only knee high. Another excellent fruit is the pineapple guava or fejoa. These and many more are available from California nurseries at moderate cost. They should be included in all Valley fruit plantings.

From Florida comes a fruit known as the Surinam or Japanese cherry. It is perfectly happy in the Valley and bears heavy crops of fruit. I know of only two families in the Valley who are enjoying this excellent fruit. It is available to all of us from Florida nurseries. The fruit is about the size of the small red Early Richmond cherry and is black in color when ripe. Every Valley family can have an abundance of this fruit if they desire it.

Some few families are now enjoying the delicious fruit of the loquat. It seems to thrive on all of our soil types. It bears consistently and ripens its fruit over a long period of time. The tree is beautiful as an ornamental and can be used effectively in landscape plantings.

There is a long list of sub-tropicals that could be added to this list and that will some day be grown generally in the Valley, but I have endeavored to mention only those of which I have personal knowledge. The introduction of these new varieties can provide a vast source of interest for the home owner who likes to surround himself with the good things of life and has the courage to pioneer in plant production. Fortunately, there are some very progressive nurserymen in the Valley who have made these fruits easily available to those who desire them.

Cabbage Variety And Fertility Tests In The Lower Rio Grande Valley

J. S. Morris, *Assistant Agronomist, Texas Agricultural Experiment Station, Substation 15, Weslaco, Texas*

Mr. Morris is interested in Fertilizers and has previously served as Research Assistant at Texas College of A & M at College Station, Texas.

The production of cabbage in the Lower Rio Grande Valley first assumed commercial importance in 1909-1910. Today cabbage is the major crop of the winter vegetable industry in this area.

Varieties such as Glory of Enkhuizen and Copenhagen Market are the predominate types planted. Both varieties produce prominent, large, round heads weighing 3 to 6 pounds. Although these varieties are standard for this area, they rarely ever produce more than 15 tons per acre of which not more than 55 percent is marketable.

Data from fertility experiments conducted with cabbage during the 1947-48 season revealed that further research was needed to improve crop quality. Low yields of quality grades and the high percentage of culls produced under optimum fertility conditions indicated the need for research to find a variety which would produce higher yields of quality cabbage and thus utilize more efficiently applications of commercial fertilizers.

A program to test cabbage varieties under conditions of a high density stand and a high fertility level was initiated during the 1948-49 season. Trials with the varieties, Glory of Enkhuizen, Early Round Dutch, Marion Market and Green Acre were conducted at four locations on three planting dates. The plants were grown in seedbeds and transplanted into 8 row plots which were 30 feet long. Two rows were transplanted on each bed row at a spacing of 8 inches within and between rows. The plants were alternately set to result in a spacing of three single plants per linear foot of bed row. The spacing between bed rows at the outfield locations was determined by the practice of the cooperators; the spacing at Hobiltzelle Ranch on Harlingen clay was 40 inches; at Rio Farms on Brennan fine sandy loam and at the Station on Willacy loam the spacing between bed rows was 36 inches. A mixed fertilizer containing 120 pounds of nitrogen, 40 pounds of phosphoric acid and 80 pounds of potassium oxide from 32 percent ammonium nitrate, 20 percent superphosphate and 60 percent muriate of potash, respectively, was applied in the bed row prior to the transplanting operation. An application of 80 pounds of nitrogen from the same source was made as a side dressing at the time of initial head formation. The test design was a Latin square. All plants which produced a head, regardless of its grade or size, were harvested. All heads were individually weighed and graded in the field.

Results

Yields of the different varieties at the three locations by market grades in tons per acre are shown in Table 1. The different times of planting are indicated by the dates of transplanting and last harvest respectively at each location.

Table 1 Yield of cabbage varieties by market grades in tons per acre

Location	Growth Period	Variety	Yields in tons per acre: Grade 1	Grade 2	Market-able	Grade 3	Total
Rio Farms, Inc. (Experiment No. 1)	9-48 2-49	Early Round Dutch	8.9	7.1	16.0	1.5	17.5
		Glory of Enkhuizen	1.7	6.4	8.1	7.6	15.7
		Marion Market	2.5	7.5	10.0	7.7	17.7
		Green Acre	1.8	8.0	9.8	9.9	19.7
Rio Farms, Inc. (Experiment No. 2)	10-48 2-49	Early Round Dutch	8.9	4.1	13.0	1.3	14.7
		Glory of Enkhuizen	1.3	3.1	4.5	7.7	12.1
		Marion Market	2.1	4.3	6.4	5.4	11.8
		Green Acre	2.9		8.4	10.5	18.9
Experiment Station	11-48 2-49	Early Round Dutch	12.4	4.1	17.5	1.1	18.6
		Glory of Enkhuizen	.7	5.0	8.4	6.5	12.2
		Marion Market	1.6	6.8	10.0	4.3	12.7
		Green Acre	1.4	8.6		9.9	19.9
Hoblitzelle Ranch	9-48 2-49	Early Round Dutch	9.1	7.1	16.2	1.6	17.7
		Glory of Enkhuizen	1.8	6.5	8.3	7.8	16.1
		Marion Market		7.2	9.7	7.3	16.9
		Green Acre		8.1	9.8	11.3	21.2

Table 2 Percentage of total yields of Cabbage varieties in three market grades

Location	Growth Period	Variety	Percentage of total yield in: Grade 1	Grade 2	Market-able	Grade 3
Rio Farms, Inc.	9-48 2-49	Early Round Dutch	50.5	40.2	90.7	9.3
		Glory of Enkhuizen	10.6	40.8	51.4	48.6
		Marion Market	14.5	42.9	57.4	42.6
		Green Acre	9.2	40.6	49.9	50.2
Rio Farms, Inc.	10-48 2-49	Early Round Dutch	62.3	28.9	91.3	8.8
		Glory of Enkhuizen	11.1	25.5	36.7	63.3
		Marion Market	18.0	36.6	54.5	45.6
		Green Acre	11.0	23.7	44.6	55.4
Experiment Station	11-48 2-49	Early Round Dutch	71.9	22.9	94.0	6.0
		Glory of Enkhuizen	5.7	41.0	46.7	53.3
		Marion Market	12.6	53.6	66.2	33.8
		Green Acre	7.1	43.3	50.4	49.6
Hoblitzelle Ranch	9-48 2-49	Early Round Dutch	51.1	40.9	91.1	8.8
		Glory of Enkhuizen	11.3	40.4	51.7	48.3
		Marion Market	14.8	42.1	56.7	43.2
		Green Acre	8.4	38.1	46.5	53.5

The percentage of the total yields of varieties falling into the different grade classes is shown in Table 2.

The distribution of harvested heads into weight classes by grades and varieties from the test conducted on the statio nis shown in Table 3.

As shown in Table 1, the market superiority of Early Round Dutch was outstanding in all experiments at the three locations. The yield of grade 1 cabbage was more than 3 times that of the next highest yielding variety; in the test on the Station the yield of this select grade of Early Round Dutch was more than 20 times that of Glory of Enkhuizen. The low yields of grade 1 cabbage produced by Glory of Enkhuizen, Marion Market and Green Acre indicate that the quality of these varieties may have been adversely affected by the conditions of the high density stands under which they were grown. Green Acers produced the highest yields

Table 3

Distribution of heads into weight classes by grades and varieties

Variety	Number of heads in weight classes (lbs.-oz.) 0-1.0	1-1 2-0	2-1 3-0	3-11 4-0	Plants harvested Total No.	Plants harvested Percent	Percentage of plants producing heads
Early Round Dutch							80.1
Grade 1	172	180	17		369	63.7	
Grade 2	102	45	2		149	25.7	
Grade 3	56	5	—		61	10.5	
Total	330	230	19		579		
Percent	57.0	39.7	3.3				
Glory of Enkhuizen							53.7
Grade 1	7	2	6		15	3.9	
Grade 2	67	61	8		135	35.1	
Grade 3	174	55	5	2	236	61.0	
Total	248	118	19	2	387		
Percent	64.1	30.5	4.9	0.5			
Marion Market							65.7
Grade 1	16	25	1		42	9.0	
Grade 2	132	71	5		208	44.4	
Grade 3	192	25	1		218	46.6	
Total	340	121	7	468			
Percent	72.6	25.8	1.5				
Green Acre							62.5
Grade 1	2	18	5	1	26	4.7	
Grade 2	56	105	26	4	191	34.7	
Grade 3	216	108	9	1	334	60.6	
Total	274	231	7.3	6	551		
Percent	49.7	41.9	7.3	1.09			
Grand Total	1192	700	85	8	1985		
Percent	60.0	35.3	4.3	.4			

of grade 2 cabbage in all of the tests; however, these yields do not reflect the wide differences of grade 1 cabbage produced by the different varieties. The yield of marketable cabbage (grade 1 plus grade 2) produced from Early Round Dutch was almost double that of the next highest yielding variety in all trials.

In Experiment No. 2 at Rio Farms and in the trial at the Station, the marketable yield of Early Round Dutch was 3 times that of Glory of Enkhuizen. The small percentage of Early Round Dutch falling into grade 3, the cull grade, further confirms the market superiority of this variety under the management practices of the trials. Green Acre produced the highest total yields in all of the tests but the marketable yield was greatly below that of Early Round Dutch because of the large proportion of cull cabbage produced. These observations are further indicated in Table 2 where the percentages of total yields by grade classes is shown. It is significant that the marketable cabbage produced by Early Round Dutch was above 90 percent in all trials.

The distribution of heads into weight classes by grades together with the percentage of plants producing heads from the trials conducted on the Station is shown in Table 3. It is significant that under the conditions of the high density plantings, the head weights of all the varieties were greatly reduced; slightly more than 60 percent of all the heads harvested weighed less than 1 pound each while the production of heads weighing from 3 to 4 pounds was negligible. Although overcrowding of the plants reduced the average size below that favored by the markets, it is significant that the detrimental effects of the high density stand were less pronounced in the Early Round Dutch Variety.

Based on the preliminary results of the variety tests, a fertilizer experiment with the Early Round Dutch was conducted during 1948-49 on Willacy fine sandy loam at this Station. The experimental design was a complete factorial in randomized blocks with four replications. The fertilizer treatment included 4 rates of nitrogen from 32 percent am-

Table 4

Effect of different rates of nitrogen, phosphoric acid and potash on yields of ccabbage by grades and tons per acre

Total nutrient in fertilizer, pounds per acre	Grade 1	Grade 2	Total Marketable	Grade 3	Total
		Nitrogen			
0	1.6	1.3	2.8	0.7	3.5
40	4.6	2.6	7.1	1.2	8.4
80	6.2	3.1	9.3	1.1	10.4
160	8.7	4.3	13.0	1.3	14.3
		Phosphoric acid			
0	4.4	2.8	7.2	1.1	9.3
80	6.1	2.8	8.9	1.0	10.0
		Potash			
0	4.8	2.7	7.6	1.0	8.6
80	5.7	2.9	8.5	1.2	9.7

m nium nitrate, 0, 40, and 80 and 160 pounds per acre; 2 rates of phosphoric acid from 20 percent superphosphate, 0 and 80 pounds per acre; and 2 rates of potash from ~~0 percent muriate of potash, 0 and 80 pounds per acre.

These treatments were used singly and in all combination. They were applied in the bed prior to seeding the Early Round Dutch variety directly into the field. Two rows were planted in 36-inch beds with 12-inch spacing in the row and 8 inches between the rows on the bed. A high density stand was used because of the smaller head size. All plants which produced a head were harvested regardless of its grade or size. All heads were individually weighed and graded in the field on two harvest dates, April and May 6.

Discussion

As indicated in Table 4, both total and marketable yields were significantly increased by applications of nitrogen. As compared with plots receiving no nitrogen fertilizer, the tonnage of marketable cabbage was greatly increased with each added increment of nitrogen. Total yields were also incrased several time. There was only a slight increase of cull cabbage. Phosphoric acid and potash accounted for a small increase in both total and marketabl cabbage.

Table 5 shows a direct relationship between the number of plants forming heads and the increased nitrogen increments. As the nitrogen increments increased, the percentage of marketable cabbage increased and the percentage of cull cabbage decreased.

The effect of nitrogen on head size is shown in Table 6. Added nitrogen increments materially reduced the percentage of heads falling

Table 5

Effect of nitrogen on the percentage of plants producing heads of different grades

Total nitrogen in fertilizer, pounds per acre	Percent heads produced	Percent grade 1	Percent grade 2	Percent market-able	Percent grade 3
0	22.6	29.5	35.8	65.4	34.6
40	43.9	44.0	36.4	80.4	19.6
80	55.5	46.1	33.6	79.7	20.3
160	75.2	49.1	34.5	83.5	16.5

Table 6

Effect of nitrogen on head size

Total nitrogen in fertilizer, pounds per acre	Percent heads between 2 and 4 lbs.	Percent heads 1 to 2 lbs. inclusive	Percent heads under 1 lb.
0	2.5	49.1	48.3
40	4.1	63.8	32.1
80	4.4	66.3	29.3
160	8.2	70.7	21.1

under 1 pound. In plots receiving no nitrogen, 48.3 percent of the heads weighed less than 1 pound. For plots receiving nitrogen (40, 80 and 160 pounds per acre) 67.9 to 78.9 percent of the heads weighed 1 pound or more, but not more than 4 pounds.

Summary and Conclusions

The results of this exploratory experiment to screen standard cabbage varieties at a high fertility level and at a high density stand indicate that:

The conditions resulting from the high plant densities adversely affected the head size of all the varieties despite the high fertility level that was provided.

Under the cultural conditions exercised in the trials, Early Round Dutch showed outstanding superiority in both yield and quality, indicating that this variety merits further investigation under different cultual practices.

The results from this fertility experiment indicate that:

Early Dound Dutch cabbage grown under irrigation on Willacy fine sandy loam responds primarily to applications of nitrogen.

The head size is materially increased by nitrogen. There were no heads harvested from the experiment that were not acceptable to the market because of excessive size. A good percentage of heads were too small for the market.

The marketable quality of the cabbage produced under the conditions of the experiment was very good.

The response to nitrogen was similar to the results found in tests with Glory of Enkhuizen on Brennan fine sandy loam; however, on Willacy fine sandy loam in addition to the nitrogen there appears to be an increase due to phosphorus and potash.

These results indicate that further research with this variety is desirable.

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New Developments in Vegetable Varities

WM. H. BRITTINGHAM, *Department of Horticulture, Texas Agricultural Experiment Station*

Dr. Brittingham is principally engaged in the field of plant breeding and is interested in the particular field of varietal improvement in vegetables.

It is always interesting, and sometimes profitable, to examine the new introductions among vegetable varieties. Most of the time, as many of us know, we find that the new varieties do not measure up to the old varieties when subjected to a critical comparison in our part of the country. This failure to perform well may be due to one or more of the following reasons: (1) poor general adaptability, (2) low yields, (3) lack of resistance to diseases of the area, (4) poor buyer acceptance, (5) poor shipping qualities, and (6) poor consumer acceptance. The opposite of the six above statements may, in fact, be taken as criteria of a good commercial variety. It is an exceptional variety among the new introductions that can succeed in a commercial area today if it lacks any one of the above requirements.

The South has a great practical interest in vegetable breeding and in the introduction of new varieties. This is for two reasons. The first is that 14 Southern states (Md., Va., Ky., Tenn., N. C., S. C., Ga., Fla., Ala., Miss., Ark., La., Okla., and Texas) grew in the 10 year period from 1935-1945, 48% of the truck crops acreage for fresh market in the United States and 20% of the acreage grown for processing. Of these acreages, Texas grew about 40% of the Southern plantings and about 18% of the national plantings.

The second reason why the South and particularly Texas has a large stake in vegetable breeding is that, with very few exceptions, the best available varieties have not been developed in the southern area of this country. In fact, some varieties have not even been developed in the United States. Such varieties owe their existence in commercial areas usually to certain qualities that determine yield, market acceptance, or disease resistance, but usually not a combination of all these.

It is generally considered that the most realistic approach to the problem of vegetable breeding is to develop the new types in the area in which they are to be used. When this is done, and when the new strains developed are adequately tested for horticultural qualities, shipping qualities, and disease resistance, new vegetable industries may arise or old ones rejuvenated.

In the discussion which follows, reference will be made only to new vegetable varieties that have appeared within recent years. It should be emphasized that their mention does not imply a recommendation for this area. Many of them are undergoing tests throughout the state; some we may question as being worthwhile; a few *may* have value.

Bean, lima — Fordhook 242, Peerless

Bean, snap, bush — Topcrop, Rival, Ranger Tenderlong, Logan Cherokee Wax; — *pole* — Alabama No. 1, Potomac, Stringless Blue Lake, Stringless Blue Lake No. B-5

Cantaloupe — Texas Resistant No. 1

Corn, sweet — Huron, Gulfport, Golden Hybrid, No. 1734, Hybrid No. 48947, Oto, Golden Sweet, Calumet, and Golden Hybrid No. 2439.

Cucumber, slicing — Palmette; *pickling*, Magnolia.

Lettuce — Great Lakes, Premier Great Lakes, Pennlake.

Onion — Texas Grano, Excel (Bermuda 986)

English Pea — Wando

Irish Potato — Sebago, Pontiac

Tomato — Summer Prolific, Southland, Lakeland, Wisconsin 55.

Sweet Potato — Murff bush Porto Rico.

Watermelon — Congo (46-40), Ironsides.

Before closing this discussion of the new vegetable varieties, mention may be made of three developments in the breeding program at College Station. These are receiving state wide tests and may be released soon.

Texas 107 Broccoli traces to a single plant selection of green Sprouting Broccoli made in 1938. This plant was selfed and careful selections have been made in its progeny to produce a well adapted productive variety of early uniform maturity with small budded, non-leafy heads and shoots. Texas 107 was originally selcted as a market type and has been maintained as such. Attention has been given, however, to good side shoot productions.

Purple Hull Pea No. 49 is a selection from the cross between Extra Early Blackeye and a rather late high yielding commercial Purple Hull strain. The objective has been to develop an early, productive Purple Hull of a compact bunch type of growth with the pods borne on long peduncles above the foliage. This new variety, in addition, has buff-eye seed which results in a better color in the processed product than does its nearst competitor in season and yield, Jackson (or Bunch) Purple Hull, having maroon-eye seed. In state wide tests during 1949 Purple Hull No. 49 was as early as the Extra Early Blackeye parent and either exceeded or equalled it in yield. From its Blackeye parent it has inherited a pod type which shells easily and results in a higher shellout than can be obtained from other Purple hull varieties.

From a cross between Extra Early Blackeye and mid-season Long Pod Cream, four Cream Pea selections have been obtained and are being tested to determine the one best suitd for relase. All of these are as early as the Blackeye parent and as productive. Plant size is small, with an extreme compact bunch type of growth. The pods are borne high on erect peduncles, usually well above the foliage. Attention has been given to the selection of long podded types since shelling tests have shown conclusively that these types have a greater machine shellout percentage than the crowder strains. An early, productive, long podded bunch type cream pea variety is expected to fill an important need. For the first time, Cream Peas can compete in season and yield with the Blackeyes. The increased yields and lower costs of production expected from the new Cream Pea varieties could mean an expansion of the canning and freezing of this type.

The vegetable plant breeder has served, and will continue to serve, the horticulture of the South. It is recognized that the final solution to many problems regarding adaptability, yield, disease and insect resistance, and quality, will be solved largely through the efforts of the plant breeder.

It happens, however, that sometimes the nature of the plant material imposes limitations on the plant breeder. Three of these may be mentioned:

1. No closely related source for the character desired may be known. If there is no known source for variation the plant breeder is dependent solely on mutation. An example of this is mildew on English peas. There is no known source of resistance in commercial varieties or in colsely related forms.

2. Certain combinations of characters expected to be incorporated in new varieties may be incompatible. As a general statement, earliness and plant size and often yield are impossible combinations. A good example is offered in tomatoes. An ideal tomato variety for this area would combine earliness and a large plant with abundant foliage to protect the fruit against sunscald: It is doubtful if this ideal will ever be fully obtained. Also, as the size of the tomato fruit is increased it becomes more subject to cracks, puffing, and the other defects which lower grade.

3. There may be antagonistic linkages between characters that we wish to combine in one variety. It may happen that high yields of marketable size and quality are not associated with adaptability to the growing conditions often found in the Southwest.

The plant breeding activity in the South at the present time is at an all-time high. The U. S. Vegetable Breeding Laboratory at Charleston, S. C. and the 13 Southern states affiliated with it are engaged in varietal improvement programs involving 28 vegetable crops. These breeding programs vary from one participating experiment station, in cases of highly specialized crops, such as the celery breeding at the Florida station, to the 23 participating locations in the case of the highly important and generally grown crop of tomatoes. The Texas station has, at present, vegetable breeding programs involving lima beans, broccoli, cabbage, cucumber, muskmelon, onion, southern pea, spinach, tomato, and watermelon. Some of these could well be expanded and others added to serve better the vegetable industry of Texas.

The Tomato Variety Situation In The Lower Rio Grande Valley of Texas

Norman P. Maxwell

Mr. Maxwell is working principally with citrus and vegetables at present and his main field of interest is citrus and vegetable variety and fertilization research.

The "greenwrap" tomato industry consisting of two crops a year (one in spring and one in fall) is a major horticulture enterprise in the Rio Grande Valley. It has become apparent over a period of time that the early fruit of each crop demands the highest price. Accordingly, the ideal variety is one possessing high quality, good yields and maturing early in the season.

This fact is recognized by the Texas Agricultural Experiment Station at Weslaco, and a project has been initiated to test under a high fertility level a large number of commercial tomato varieties for earliness of ripening, quality and yield. This test is being conducted on both greenwrap tomato varieties and canning tomato varieties because, in the past, the canning industry has had to take what was left from greenwrap tomato fields after the shipping season was finished. Naturally, this has resulted in a low grade canning product. It is the object of this project to find varieties satisfactory for both the greenwrap and canning tomato industries in the spring and in the fall.

The results obtained in a greenwrap test conducted in the spring of 1949 are presented in this paper. The data of the test merely represents one season's results under the conditions of the spring of 1949. Conclusions on this problem await further trials.

The following tomato varieties comprise the greenwrap variety test:

Bonny Best	Valiant	Gulf State Market
Cardinal	Grothen's Blobe	Earliana
Pritchard	Stokesdale	Lakeland
Improved Pearson	Break O'Day	John Baer
Early Rutgers	Marglobe	Southland

The fertilizer applied to the plots was 80 pounds of nitrogen, 80 pounds of available phosphoric acid and 40 pounds of potash per acre. All of the phosphorus and potash and half of the nitrogen were applied at planting time. The other 40 pounds of nitrogen were sidedressed when the majority of the plants set their first fruit cluster. The source of nutrients was 32 percent ammonium nitrate, 20 percent super-phosphote and 50 percent muriate of potash.

Each plot consisted of two 30-foot rows that were planted 36 inches apart and included an area of .00435 of an acre. Two buffer rows 36 inches apart separated the plots. The plants were spaced about 20 inches apart in the rows. The tomatoes were seeded in the field on February 22, and the test design was a randomized block with four replications.

Table 1 shows that Bonny Best, Cardinal, Valiant, Earliana, Lakeland and John Baer flowered from 3 to 5 days earlier than the other varieties. All of these early flowering varieties, except the Cardinal, produced more early fruit than the other varieties. Whether this fact is significant or not will require further tests.

Table 2 gives data on the quality, size, grade, total yield and percentage of marketable tomatoes. From a quality standpoint, the varieties showing the most promise for the Valley under the conditions of this test were Early Rutgers, Valiant, Stokesdale, Marglobe and Lakeland. The varieties having over 7 tons of marketable tomatoes to the acre were Bonny Best, Early Rutgers, Valiant, Stokesdale, Break O'Day, Lakeland and John Baer. The data also show that Bonny Best, Early Rutgers, Valiant and John Baer have a greater percentage of marketable tonage in sizes 6x7 and 6x6 than do Stokesdale, Break O'Day and Lakeland.

The results of the tomato experiment indicate that under the growing conditions of the spring of 1949, the Valiant variety was one of the earliest and gave the highest yield of marketable tomatoes of the 15 varieties being tested. One disadvantage, however, of the valiant was its tendency to produce open vines which allowed the fruit to sunburn.

Early Rutgers presented the highest quality from the standpoint of a greenwrap tomato desired by most shippers, but it did not have the factor for early maturity which is important for a greenwrap tomato variety in this area.

Table 1

Flowering and harvest dates of tomato varieties

Variety	Ave. No. of plants per rep.	Date when 25% or more of plants were in blossom: 4-13	4-15	4-18	Average tons per acre of marketable tomatoes by harvest dates: 5-24	5-31	6-14	Total
Bonny Best	37	•			1.77	3.53	2.57	7.87
Cardinal	37		•		.24	2.79	3.37	6.40
Improved Pearson	38			•	.09	1.03	3.60	4.72
Pritchard	35			•	.42	1.13	4.48	6.08
Early Rutgers	38			•	.27	2.08	4.90	7.25
Valiant	39	•			2.30	2.99	4.55	9.84
Grothen's Globe	35			•	.12	1.33	4.26	5.71
Stokesdale	38			•	.69	3.02	4.70	8.41
Break O'Day	38			•	1.14	1.81	5.29	8.24
Marglobe	37			•	.13	1.38	4.17	5.68
Gulf State Market	37			•	.04	.79	3.41	4.24
Earliana	38	•			1.10	2.49	1.35	4.94
Lakeland	40		•		1.50	2.78	4.55	8.83
John Baer	38		•		1.85	2.73	3.47	8.05
Southland	39			•	.02	1.95	4.85	6.82

Table 2. Fruit notes and yield of tomatoes by grades

Variety	Fruit notes on greenwrap tomatoes*	Average yields of tomatoes in tons per acre**: 7x7	6x7	6x6	5x6	Total mkt.	Total Yield	Percent mkt.
Bonney Best	Fair shape (depth fair) fair color	4.03	3.43	.46	.01	7.83	12.18	64.28
Cardinal	Flat, misshaped, light color	2.29	2.12	.59	.08	6.39	10.18	62.77
Improved Pearson	Off-shape (oblong puffy) poor color	2.58	1.88	.03	-.	4.73	7.48	63.23
Pritchard	Poor shape, (lopsided, ribbed) good color	4.04	3.37	.05	-	5.97	9.39	63.57
Early Rutgers	Good shape, good color	3.25	4.39	.61	.01	7.24	10.17	71.19
Valiant	Good shape, good color	4.76	2.64	.68	.06	9.89	14.23	69.26
Grothen's Globe	Slightly flat, misshaped, light color	2.97	2.82	.13	-	5.74	8.29	69.24
Stockesdale	Good shape, good color	5.34	2.88	.26	-	8.42	12.15	69.30
Break O'Day	Fair shape, slightly puffy, fair color	4.98	2.13	.42	-	8.28	12.99	63.74
Marglobe	Good shape, good color	3.42	2.12	.08	.01	5.64	9.49	59.43
Gulf State Market	Puffy, fair shape, fair color	1.85	2.16	.13	-	4.10	7.65	53.59
Earliana	Very flat and misshaped	2.13		.66	-	4.95	10.18	48.62
Lakeland	Good shape, good color inclined to be slightly on the small side	5.94	2.77	.23	-	8.94	12.92	69.19
John Baer	Fair shape, good color	2.73	4.14	1.33	-	8.20	11.86	69.14
Southland	Good shape, fair color	4.10	2.65	.11	.04	6.90	10.27	67.18

*Brief fruit notes were taken based on the type green-wrap tomatoes preferred by most shippers, which is one having a medium to deep green color, especially around the stem end, and a shape which has enough depth that the fruit appears to be globe shaped.

**The fruit was sized by hand and graded according to U. S. Standards for fresh tomatoes.

Another tomato variety which showed promise of being adaptable to this area was the Lakeland. Its main disadvantage was a tendency to produce small fruit.

It is clear from the results obtained in this test that further research is needed on tomato varieties for the Lower Rio Grande Valley of Texas.

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Factors Affecting Fruit Set in Vegetables

F. W. Went

Dr. Went's main interest is Botany and Horticulture. He has done outstanding work in the field of plant hormones at the University of Utrecht, Buitenzorg Gardens, and the California Institute of Technology. He is currently engaged in research on effects of climate on plants.

There are fashions in research, as in anything else. Sometimes they take on the proportions of fads. Research on flowering of plants has gone through several periods in which one or another concept dominated.

The earliest—not very successful—stage was when Sachs suggested the existence of special flower forming substance. It became then almost a fashion to disprove Sachs' contention. This gradually, especcially through the work of Klebs, changed into an investigation of the effect of nutrition on flowering. Thus the main emphasis was shifted from the control of flowering by internal factors to an external control, through carbohydrate or nitrogen levels inside the plant. Klebs had had good success in the control of sexual reproduction of algae and fungi, which we now believe must have been fortuitous, because he partially used heterothalic organisms.

In America these viewpoints were introduced by Kraus and Kraybill (6), who published experiments in which they controlled flowering and fruiting in tomato plants by different levels of nitrogen nutrition and variations in shading. They interpreted their results as an expression of the carbon-nitrogen ratio inside the plant. We would perhaps now interpret their results somewhat differently, for it is too simple to assume that shading has only an effect on carbohydrate content of the plant. Yet it was their work, and that of Garner and Allard (3), which strongly stimulated all experimental work on flowering and fruiting in the last 30 years here in America. Garner and Allard had found, that the seasonal flowering of so many plants was predominantly caused by differences in day length from season to season. This amazing discovery enabled investigators to change plants from vegetative to flowering at will. The success of this work, and even more the ease and simplicity with which plants could thus be flowered made photoperiodism a pet subject of investigations in botanical, agricultural and horticultural institutions.

This has led to a possible over-emphasis on the importance of photoperiodism in the life of plants in general, at least as far as flowering and fruiting is concerned.

Let me first give some examples from work published years ago, about the effect of other factors, mainly temperature, on flowering and fruiting. Two hundred years ago Adanson pointed out that the time of leafing out and flowering of fruit trees in spring is connected with the temperature. One hundred years ago Boussingault in France showed that the ripening of wheat and other field crops depended on the amount of heat it had received during its life. When for each wheat growing area the mean temperatures during the life cycle of wheat were added for each day, so-called heat sums were obtained, which were about the same for all regions. This meant that in a warmer climate wheat needed fewer days to ripen than in a cooler region. In a variation, introduced in 1855 by Alphonse DeCandolle (1), the heat sum is still in use to make predictions as to ripening date of peas or grapes. The improvement was not to use the freezing point as the base for the heat sums, but to use a higher temperature, for instance 40°F. on the assumption that practically no physiological processes occur below this critical base temperature. Recently Nuttonson (9) had suggested a further modification of the heat-sum method, by introducing the photoperiod into it. This gives a great improvement in the calculations for those plants which are photoperiodically sensitive.

All this work on heat sums assumes that there is an arithmetical relationship between temperature and plant response. Since the days of Sachs, Van't Hoff, Blackman and so many others we know that this is not so. Above a certain critical temperature (the optimum) the temperature effect becomes negative. Therefore not only the lower temperatures, but also the higher ones should be subtracted. This, however, is not the only difficulty. There are two others, equally serious in impairing the theoretical significance of the heat sum as controlling plant development. One of these objections is that often the relationship between temperature eand development is not arithmetical, but exponential. Another objection is that usually each development stage of a plant has a different temperature response and optimum temperature. This was first argued by Sachs, but excellent experimental evidence was produced by Blaauw and collaborators (4,7) in a series of very important papers, starting about 1920. Blaauw worked especially with flowering bulbs, such as tulip, hyacinth and daffodil. He found that e.g. in the hyacinth the optimum temperature for initiation of leaves is 34°C, for actual elongation about 20°C and for root formation and root growth 27°C. Whereas for each process a heat-sum might be calculated, for the plant as a whole this has no meaning. There is no one temperature, in which the hyacinth will grow and flower, if kept constant throughout the year. Therefore hyacinths and tulips only grow in temperate climates with the proper temperature fluctuation from season to season.

It is a sad commentary on the so-called impartiality of scientists, that very few plant scientists know of the work of Blaauw, but every one can tell you about Lysenko and his discovery of the effects of temperature treatment of seeds on shortening or lengthing of the growing period of some crop plants. Blaauw's work is much more comprehensive, worked out in much greater detail, and proceeds that of Lysenko by many years.

Recently more information about flowering and fruiting of plants has come from experiments in air conditioned greenhouses (2, 10, 11, 12) in which temperature, humidity and other atmospheric factors can be controlled and kept constant over any desired length of time. This has led to a better appreciation of the effects of climate in general on plants. Let me first describe the Earhart Plant Research Laboratory (13) in which this work is now being carried out at the California Institute of Technology.

This building contains 6 separate greenhouses, each of which can be kept at a different temperature. The controls are such that the temperature anywhere inside the greenhouse does not differ more than 1 degree from what the thermostat has been set for. In addition there are 9 rooms, kept at temperatures ranging from 36° to 86° F. Here the plants are subject to artificial light to darkness. Because the plants are grown on wheeled tables, they can easily be moved from one condition to another, and thus a very large number of combinations of temperature and light treatments are possible. Not only temperature, humidity and light can be controlled, but also wind, rain, fog, gasses and nutrition. Therefore we can expect in the future the solution of a number of problems connected with the response of plants to climate.

As an example of what can be accomplished in these greenhouses, I want to describe an experiment with tomatoes, just completed. Plants were grown in 2-gallon crocks, and as soon as they were well established they were placed in the different experimental conditions. Partly the greenhouses were used for natural daylight, and partly the artificial light rooms. It turned out, that at light intensities of about 1000 f.c. fairly normal growth occurred, but most flower stands aborted until the light intensity was increased to btween 1500 and 2000 f.c. Then normal flowers developed, and fruits started to grow, provided the light from fluorescent tubes was augmented with incandescent light. As the photographs show, magnificent tomato plants could be grown in this artificial light. But when the temperature was kept at 50°F, practically no growth occurred, and when the plants were kept at still lower temperatures they soon died. At 86°F. constantly they also looked rather sickly, with drying of the leaf margins.

Fruit set was strongly affected by night temperature. At two different day temperatures of 70° and 80° there was very little difference in response to night temperature, in general the plants under the warmer day conditions produced ripe fruit a week earlier, but did not produce more fruit. The best fruit set and fruit ripening occurred in these Essex Wonder tomatoes at about 70°F. As the curves show, a few degrees lower or higher temperature decreases fruit setting and ripening so much, that commercial production is impossible. Most interesting is the gradual shift in optimal conditions for fruit set. Where most fruits start to set at about 70-75°F, a month later the plants kept at 60-65° set more fruits, and for ripening of the fruit the same holds. Therefore a tomato plant requires fairly high night temperatures to start setting fruit, but once it has started, it gradually adapts itself to lower night temperatures. This is not due to just a slower rate of development at the lower night temperatures, for the plants gradually start to grow faster and faster at lower night temperatures, whereas they continue to grow at the same rate at the higher night temperatures. The tomato is not an exceptional plant either, for we found the same temperature adaption in chili pepper plants, in which it is more extreme. Therefore we have a very nice parallelism between the usual climatic changes and optimal fruit setting conditions for tomatoes and peppers. When these plants are set out in the field, usually in late spring or early summer, the night temperatures are too low to allow fruit set. Around the first of July the nights get warm enough and the first fruit set. As the season progresses, and the nights get cooler again, tomato and pepper plants continue to set fruit. This is particularly pronounced in peppers, which are being harvested in California until the first killing frost.

Not only fruit set and ripening, but also fruit size is strongly affected by temperature. The higher the temperature, the smaller tomato fruits are. In this respect day and night temperatures both are effective.

We now come to the problem why we get such enormous differences in production. Let us first look at the vegetative development. Although there are big differences at the lowest temperature (below 40° F night temperature), between 43 and 86° night temperature, vegetative development is not very different, at least not sufficiently so, to explain the differences in fruit set. We see however a very significant trend; root weight decreases steadily as the night temperature increases. This shows that, since growth of isolated roots is greater at higher temperatures than at lower, the higher night (and day) temperatures have an indirect inhibitory effect on root growth. This same effect we see, less pronounced, for the weight of fruits developing on the plant after the initial advantage of the plants kept in higher temperatures has worn off. Finally we see another clear-cut temperature effect: the higher the night temperature, the greater the number of flowers and flowerbuds which abscise, and thus never develop into fruit. When this is viewed from the standpoint of basic physiological processes, as influenced by temperature, we can draw the following conclusions.

1. Sugar transport can explain most of the previously mentioned phenomena, because in the tomato it decreases as the temperature rises. That decreases the sugar supply towards the roots, and the sugar transport becomes an increasingly critical process as the plant grows. This sugar transport is less important for leaf development. Therefore we see that those parts of the plant which are farthest removed from the leaves, are most reduced in development by high night temperatures: fruits and roots. In addition there is the effect of temperature on respiration, which will tend to accentuate the relative sugar lack in roots, fruits and growing tips of the plants grown at high night tempratures.

2. Most of the growth of a tomato plant occurs during night. Therefore the night temperature is so important in its development. In judging the suitability of a particular climate for tomato growth it is essential to know the night temperature. As a simple rule one can arrive at this by adding ¼ of the difference between maximum and minimum temperatures to the minimum temperature. This rule holds for individual days and for monthly averages. Also as a general rule it can be said, that when the night temperature is suitable for tomato growth and fruit set, the day temperatures (which should be higher than the night temperature) are probably within the proper range, although the tomato plant does better when the days are relatively cool.

3. A number of details about the response of tomatoes to climate have yet to be worked out. What would happen, for instance, when plants were subjected during the first half of the night to a high temperature, which would increase sugar transport. It is conceivable that this would speed up overall development of the plant. Or it is possible to

apply sugar to plants grown at high temperatures, making translocation of sugar not critical any more.

4. There are considerable differences in response to climate between tomato varieties. Some have a very narrow range of night temperatures within which they can set fruit (like the Santa Clara Canner and other varieties grown in Central California). Others do well over a fairly wide range of night temperatures (such as the Earliana, Essex Wonder or greenhouse varieties), and the majority of varieties range between these two types of response. This means not only that different tomato varieties have to be grown in different climates, but also that differences in production from year to year in the same location may be largely due to slight differences in climate from year to year. When in a certain year the average night temperature is only 2°F. lower in the critical range, this may result in only half the tonnage per acre.

5. Such knowledge of climatic responses of plants will become particularly important when long-range weather forecasting is developed more extensively. Then the proper tomato variety can be planted for the type of weather to be expected. This should be entirely practical if e.g. the July night temperatures can be predicted in early May. But even now canneries can predict almost a month in advance when heavy fruit production can be expected. This always occurs a month after a series of about 5 nights during which the temperature has not dropped below 60°F. (or higher or lower, depending on the variety).

6. I will not dwell on the importance this knowledge has on the selection of varieties, because in a warm year warm weather varieties will be selctede, whereas in a cool year the opposite happens. But I want to point out, that once we can express the climatic response of a plant in the form of a mathematical formula (of which the heat unit is an over-simplified example), it will become possible to determine the hereditary behavior of this response, which almost certainly will be complex, and thus we may be able to produce more easily just the type of variety we want, by combining the proper group of genes.

There is another approach to the problem of fruit growth now being followed at the California Institute of Technology. Two students, Nitsch (8) and Jansen (5), have succeeded in cultivating tomato fruits detached from the plant. They took tomato flowers, which were externally sterilized to kill all adhering bacteria and fungi, and they placed them on a medium containing salts, sugar and other substances. If the latter were properly chosen, the ovaries in the flowers started to enlarge and grow into normal although small fruits, which ripend in the same time as the fruits developing while attached to the plant. After about 6 weeks these test tube tomatoes turned red, and tasted like normal tomatoes. Although it is unlikely that such test tube fruits will ever replace plant-grown fruits on the market, these studies are important because they tell us what the exact food requirements are for the growing fruit, and we may improve fruit set and growth on the plant.

I think that the work in the field of Plant Physiology carried out in the last 2 decennia has sufficiently proven that we cannot discover new facts about the basic principles of growth, be it of stems, roots, leaves, flowers or fruits, which will not, within shorter or longer time, become valuable for the practical grower. After all our whole existence on the earth is dependent upon plant growth, directly or indirectly, and anything we find out about it, no matter how apparently trivial, may mean thousands or millions of dollars when applied to agriculture or horticulture. But the important thing is, that we must have *something to apply*, some basic piece of knowledge. We must realize, that the very intensive search for improvements in practical plant growing by applying existing knowledge must ultimately lead to diminishing returns, unless new knowledge becomes available. It is my firm conviction, that proportionately not enough energy and money is spent on the investigation of basic problems, and that, even in the near future, funds invested in basic research on plant growth will yield disproportionately large returns. I believe that we are on the verge of very great advances in agriculture, and that future historians will speak of the next few decennia as the "agricultural revolution", like we now speak of "the industrial revolution" during the last century, when controlled technological development replaced the rule of thumb in manufacturing and the chemical industry. We will achieve this by much better knowledge of the plant and soil, and by weather control. Among the latter irrigation and greenhouse culture are well-developed, but we will see many other climatic factors controlled, such as wind, night temperature, photo-period, and even rain. This will become particularly important in regions like the Rio Grande Valley, where winter does not mean cessation of all growth and horticulture.

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Fertilizer Trials with Grapefruit at Rio Farms, Inc.

CORDELL EDWARDS[1], *Horticulturist,*
Rio Farms, Inc., Edcouch, Texas

Mr. Edwards has been horticulturist and soil scientist at Rio Farms since 1945. His main fields of interest are; citrus nursery practice, irrigation, drainage, and fertilizers.

The only published report on the effect of fertilization on citrus production in the Rio Grande Valley is by Friend, who presented it before this Institute in 1947. He reported that a sleet storm, red scale epidemic, flood, hurricane, and freeze greatly interfered with the early fertilizer trials initiated on Marsh Grapefruit at the Valley Experiment Station in 1924. The various fertilizer treatments used were not described but, according to Friend, "we arrived at the conclusion that nitrogen is the element of primary importance in the nutrition of Valley citrus trees". In another test started in 1933 on eight year old Marsh Grapefruit he compared the effect of a complete fertilizer (10-30-10) with 10-30-0 and 10-0-0 formulas. He used ten pounds per tree per year of each fertilizer mixture. From this test Friend reported "potassium had no effect on increasing yields over nitrogen alone or nitrogen plus phosphorous."

In a third test, lasting eight years, Friend compared the effect of a complete fertilizer (10-30-10) with that of a 16-20-0 and of sulfate of ammonia. The quantity of fertilizer used per treatment was based on "comparable money values". Since the money value of the different fertilizer formulas varied from year to year and no data is given as to the exact amounts used, it is difficult to arrive at any conclusions from his report on the efficacy of the treatments.

The purpose of this paper is to present the results of a fertilizer tests conducted by Rio Farms, Inc., on Marsh Grapefruit from 1945 to 1948. Two levels of nitrogen fertilization, low nitrogen plus low phosphate and low nitrogen plus high phosphate, are compared with a complete (low nitrogen plus low phosphate plus potash) fertilizer control. The tests were conducted on Brennan fine sandy loam, the predominant soil type of the Rio Farms area. This report is concerned with yield data only.

Experimental Methods

A system of six plots was established in each of three blocks. Block I was located on Rio Farms block 52 lot 5, Block II on Rio Farms block 52 lot 12, and Block III on Rio Farms block 59 lot 7. Blocks I and II were adjacent while block III was located one mile distant from I and II. Each plot consisted of sixteen trees in a square four trees wide by four trees long and is completely surrounded by buffer rows. The planting distance is 25 x 25 feet. Six fertilizer treatments, arranged in random fashion, were established in each of the tree blocks.

[1]The writer wishes to express appreciation to Dr. Bars Pickett, formerly Valley Experiment Station and now of Univ. of Ga. for helpful guidance arranging the experiments.

The trees were fourteen years old at the beginning of the test. They had not been fertilized during the five year period prior to the treatments. The differential fertilizer mixtures were applied during the tree crop years 1946-47 through 1948-49. The total poundage was applied in one application per year in January. It was distributed by hand under the trees and outside the skirts of the trees to cover the entire root zone of the tree. A light discing and irrigation following the fertilizer application to mix the fertilizer into the soil.

The six fertilizer treatments were as follows:

Treatment	Fertilizer materials, pounds per tree
A	No fertilizer
B-Low N	5 lbs. ammonium nitrate
C-High N	7.73 lbs. ammonium nitrate
D-Low N + Low P2O5	5 lbs. ammonium nitrate + 8.125 lbs. superphosphate
E-Low N + High P2O5	5lbs. ammonium nitrate + 16.25 lbs. superphosphate
F-Low N + low P2O5 + low K2O5	lbs. ammonium nitrate + 8.125 lbs. superphosphate + 1.693 lbs. muriate of potash.

The amonium nitrate contained 32% N, the superphosphate 20% P2O5, and the muriate of potash 5% of K2O.

Weeds in the grove were kept under control by the use of a stalk cutter and a light dicing. Sprinkler irrigation was employed throughout the entire three years experiment.

Yield records were obtained on each individual test tree during the year (1945-46 season) previous to the application of the fertilizers and during a two year period of the fertilizer trials. The freeze of January 30, 1949 caused so much damage to the trees that the fertilizer test was discontinued at this time. No measurements were made on growth of the trees but occasional inspections were made of color of foliage and amount of new growth.

Experimental Results

During the first year of the experiment very little difference appeared in color of the foliage and growth of the trees within the plots. However, during the second and third year, outstanding difference occurred. The foliage of the trees in the no fertilizer plot was a very dull greenish yellow color and the trees showed very little new growth the second and third year. The trees in the other treatments showed much new growth and the foliage was a very dark green. The highest nitrogen treatment induced more new growth and a darker green color than the other fertilizer treatments. The other four treated plots showed about the same amount of growth, and there seemed to be no difference in the color of foliage among the plots.

The yield data by plots for the tree blocks for three crops of fruit is presented in table I. The figures are average yield in pounds per tree for the sixteen trees in each plot.

The record for the 1945-46 crops represents the yield before differential treatments began. It is seen that the trees in block II had the most uniform yields at the onset of the fertilizer treatments. The yields in block I were high for treatment B and low for C and E. In block III the yields showed extreme variation, being low for A, B and C and high

TABLE I

The Effect of Fertilizer Treatment on Yield of Marsh Grapefruit for Three Locations

Treatment	Average Yield in pounds per tree by crop year		
	*1945-46	1946-47	1947-48
Block I			
A-No fertilizer	269	619	397
B-Low N	481	695	777
C-High N	316	615	700
D-Low N + low P2O5	378	599	619
E-Low N + high P2O5	307	629	643
F-Low N + low P2O5 + low K2O	394	524	526
Block II			
A-No fertilizer	494	394	563
B-Low N	521	465	569
C-High N	481	488	723
D-Low N + low P2O5	493	479	613
E-Low N + high P2O5	561	556	642
F-Low N + low P2O5 + low K2O	533	611	667
Block III			
A-No fertilizer	227	1042	800
B-Low N	195	928	660
C-High N	215	645	475
D-Low N + low P2O5	662	577	390
E-Low N + high P2O5	366	546	287
F-Low N + low P2O5 + low K2O	468	602	466

* Average for sixteen trees in each plot

for D. The trees in block III were of irregular size and had not been irrigated adequately the year prior to the fertilizer test and these factors probably account for some of these variations in the yields.

Because of these differences in yields in the plots of the various blocks at the onset of the treatments it appeared desirable to examine the data for each block separately for trends on the effect of fertilizer treatments on yield.

In block I for the 1946-47 crop there was no trend in yields in favor of any treatment. The low N treatment (B) was high but the difference in yield was no greater than was observed between plots at the onset of the test. During the second crop year (1947-48) all fertilizer treatments showed a large increase in yield over the no fertilizer control. Of the five fertilizer treatments, B gave the highest yield and F the lowest.

An inspection of the yield records for block II shows a large increase in yield for all fertilizer treatments over the control (A) during the first crop year of differential treatments and for all except low N (B) during the second crop year. The highest yield durifg the first crop year was obtained on the complete fertilizer (F) treatment while in the second year the highest yield was obtained on the high N treatment (C).

The record for block III shows the highest yield for the no-fertilizer treatment (A) for both crop years for differential treatment. The extreme nonuniformity of yield and the neglected condition of the trees of the plots of this block at the onset of the test may account for the erratic yields obtained under differential treatments.

Discussion

The data for blocks I and II which had fairly uniform yields at the beginning of the experiment show an outstanding increase in yield of fruit for treatments B to F as compared to the no-fertilizer treatment A. In block I this increase in yield was not apparent until the second year of differential treatments while in block II the increase occurred during both years.

While the trees in all fertilizer treatments (B to F) in blocks I and II showed increases in yields over no fertilizer, there were no consistent differences from year to year and plot to plot in yields observed among the various treatments. The only fertilizer constitutent which occurred in all of these treatments was nitrogen and in all probability this was the effective constituent of all treatments. The additions of P2O5 and K2O probably did not increase the effectiveness of the nitrogen component.

The results obtained in block III differ radically from those of block I and II. The non-uniformity of the trees of block III at the onset of the test indicated that factors other than fertilizer were affecting yields more than the fertilizer treatment and little knowledge can be gained on the effect of fertilization on such plots. These results suggest that in establishing fertilizer plots more care should be given to obtaining uniform trees. The trees should be given uniform cultural treatment for several years prior to the test as well as during the test to eliminate as much as possible factors other than the fertilizer treatments.

Salt and Boron Tolerance of Shary Red Grapefruit and Valencia Orange on Sour Orange and Cleopatra Mandarin Rootstocks[1]

William C. Cooper[2], *U. S. Department of Agriculture, Weslaco, Texas and* Cordell Edwards, *Rio Farms, Inc., Edcouch, Texas*

Dr. Cooper is interested in plant hormones, in citrus and other sub-tropical fruits. He has been associated with the U.S.D.A. as Plant Physiologist for 20 years and has done work in this field in California, Florida, Texas, Puterto Rico and Peru.

Mr. Edwards has been horticulturist and soil scientist at Rio Farms since 1945. His main fields in interest are citrus nursery practice, irrigation, drainage, and fertilizers.

INTRODUCTION

Underlying water tables in many of the citrus orchards usually contain harmful quantities of soluble salts and boron (Maierhofer, 1947, Bloodworth, 1948, and Wilcox, 1948). The amounts of salt and of boron in such ground water have been generally observed to be several times as much as in irrigation water used on these lands. It is known from the work of Kelly and Thomas (1920), Haas (1932), and Chapman and Kelley (1943) that oranges and grapefruit are extremely sensitive to soluble salts in the soil. Likewise the work of Kelley and Brown (1928), Haas (1929), Scofield and Wilcox (1931), and Eaton (1935) show that soluble boron in concentrations as low as one part per million in the irrigation water is extremely toxic to citrus.

Eaton and Blair (1935) have shown that boron concentrations accumulating in the leaves of Eureka lemon and *Severinia buxifolia* were directly influenced by the rootstocks upon which the species were grown. Plants of lemon on *Severinia buxifolia* roots had only one-third as much boron in their leaves as those of lemon plants grown on their own roots; likewise, the boron cencentration in leaves of *Severinia* was increased threefold in the plants grown on lemon roots. Also it was reported by Roy (1943) in Florida that leaves of grapefruit on sour orange root contained considerably less boron than leaves of grapefruit on rough lemon or Cleopatra mandarin. Later Haas (19) found that sour orange rootstocks cause the least accumulation of boron in Valencia orange leaves; the sweet orange and Cleopatra mandarin rootstocks somewhat more; and the trifoliate orange the highest accumulation.

In regard to the influence of rootstock on salt injury to the scion variety of citrus, very little has been reported. Swingle (1943) has directed attention to the fact that shaddocks and several citrus relatives, including *Merope angulata, Severinia buxifolia, Eremocitrus glauca,* and the eremolemon, are very resistant to salt injury and seem worthy of trial as rootstocks for citrus. Webber (1948) states that in salty areas of California the sour orange root is more susceptible to salt injury than the sweet orange root. He attributes this salt tolerance of sweet orange to its shallow root system which takes in less water by subirrigation from a salty water table than the deep-rooted sour orange.

Because of these reports indicating an influence of rootstock on salt injury of the scion and on the accumulation of boron in the leaves of the scion, it has seemed desireable to consider salt and boron tolerance of rootstocks in the search for an adaptable rootstock to replace the Tristeza-susceptible sour orange stock.

The investigations on salt tolerance of the sour orange rootstock (the stock used exclusively in the Valley previous to recognition of its association with Tristeza in South America) and the Cleopatra mandarin (a Tristeza-resistant stock now being used extensively by the Valley nurserymen) was started in 1947 in three plots at the Valley Experiment Station. In these plots Cleopatra mandarin seedlings, sour orange seedlings, Red Blush grapefruit on sour orange and Cleopatra mandarin, and Valencia orange on Cleopatra mandarin were irrigated with canal water, and with canal water to which salts were added to raise the salt content to 2500 ppm and 5000 ppm. These tests indicated that grapefruit on Cleopatra mandarin stock is slower in developing leaf symptoms of salt excess at the high salt treatment than is grapefruit on sour orange. The low salt (2500 ppm) treatment caused no leaf symptoms of salt excess on grapefruit grown on either rootstock. Also it was shown that Valencia orange on Cleopatra root developed fewer leaf symptoms of salt excess with the high salt treatment than did Red Blush grapefruit on the same root.

A boron impurity in the salt solutions used in the early part of these tests complicated the interpretation of the data. In order to clarify the questions raised by the 1947-48 tests, a new series of plots involving red grapefruit and Valencia orange on Cleopatra mandarin and sour orange rootstock were treated with canal water, canal water plus salt (calcium chloride and sodium chloride) relatively free of boron, canal water plus boron, and canal water plus boron-salt mixture. The present paper reports progress made during 1949 in these tests. The tests are by no means completed as treatments have not continued long enough for full effects of treatment on growth. Also chemical analysis of leaves for sodium, chlorides, and boron have not been completed. This report deals mainly with leaf symptoms developed.

1 These investigations are a part of the cooperative citrus rootstock project conducted by the Texas Agricultural Experiment Station and the U.S. Department of Agriculture The work was supported in part by a grant to the Texas Agricultural Experiment Station by Rio Farms, Inc., Edcouch, Texas.

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2 Physiologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture, Weslaco, Texas.

3 Horticulturist, Rio Farms, Inc., Edcouch, Texas.

EXPERIMENTAL PROCEDURES

Plant Materials

Tests were made with the following plant materials:

Valencia orange on sour orange
Valencia orange on Cleopatra mandarin
Shary red grapefruit on sour orange
Shary red grapefruit on Cleopatra mandarin
Cleopatra mandarin seedling.

The plant materials were donated to the project by Mr. A. H. Law of McAllen. The Cleopatra and sour orange rootstocks were started from seed planted in the spring of 1947. The seedlings were lined out in the nursery in September 1947 and were budded in the spring of 1948. The Shary red grapefruit were taken from a thirteen-year-old progeny orchard of Shary red trees said to have come directly from buds on the original sport limb of this red grapefruit strain.

The plant material was dug from the Law nursery, balled, and transplanted to sixteen test plots at Rio Farms, Inc., Monte Alto, on Dcember 1, 1948. The fifteen-foot-square plots were of the same design as those used in the previous tests (Cooper 1948). The trees in each plot were planted in a Latin square design of five rows, three feet apart with one tree of each of the five test combinations in each row.

The soil of the test plot area is classed as a Brennan fine sandy loam. The surface two feet of soil is of grayish brown color, fine granular, friable, and non-calcareous, with a saturation percentage of 34. It is well drained, with no sign of a water table in a 14-foot deep test hole.

The plants of all plots were irrigated with canal water until May 1949. Most of the plants were dormant at the time of the January 31, 1949 freeze and only a few were injured. The plants grew luxuriantly through March and April and had developed a fair sized top by May.

Salt and Boron Treatments

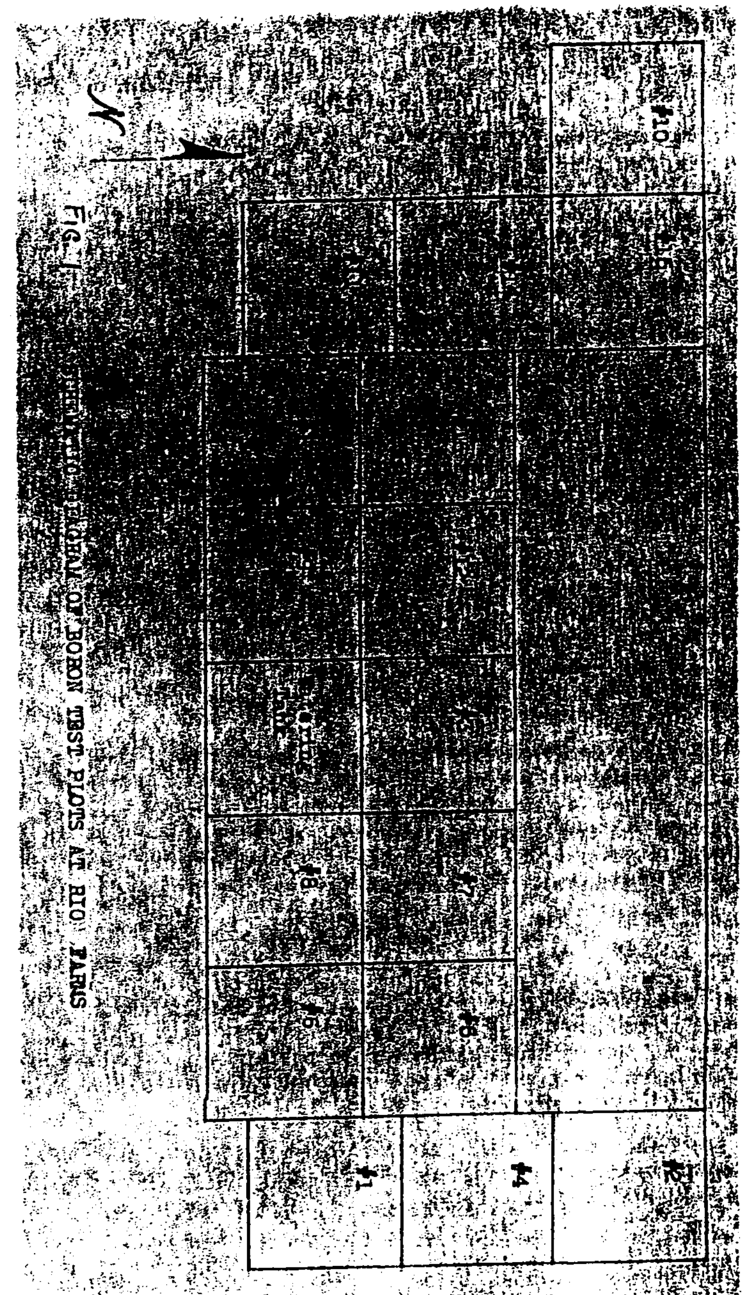
Beginning May 9 duplicate plots were irrigated with eight treatment solutions, as follows:

Treatment No.	Plot No.	Boron added, p.p.m.[4]	Salt added, p.p.m.
1	1 and 9	0	0
2	2 and 10	1	0
3	3 and 11	3	0
4	4 and 12	6	0
5	5 and 13	0	5000
6	6 and 14	1	5000
7	7 and 15	3	5000
8	8 and 16	6	5000

Each of treatments 1 to 8 was assigned by chance to one of the eight plots on the east side of the planting area and one of the eight plots on the west of the planting area, as shown in figure 1.

The added salt in each instance was one-half calcium chloride ($CaCl_2$)[5] and one-half sodium chloride ($NaCl$)[5]. It was applied in the

4 Parts per million
5 Hereafter refered to by these symbols.



sam manner as described for th 1948 series (Cooper, 1948). Analysis of the NaCl showed only a trace of boron, and the CaCl2 (sample of salt from bulk purchase) showed only 24 ppm. The added boron was supplied in the form of Boric Acid Crystals, USP grade.

Calculated amounts of NaCl, CaCl2, and boric acid were added to canal water in preparing the treatment solutions. After the salts were dissolved in the tank of water the solution was mixed thoroughly by pumping the solution from the bottom of the tank back into the top for fifteen minutes. The solution was then pumped from irrigation tank to the plots. A sample of the solution was taken from the irrigating hose when half of the water had been pumped from the mixing tank.

A salt and boron analysis of these samples of eight irrigation solutions for the various irrigation dates is given in table 1. There was no significant difference in the salinity of irrigation treatments No. 1 to No. 4. The salinity for the four irrigation solutions at all dates averaged 1.24 mllimhos per cm., or approximately 744 p.p.m.

The salt analysis of irrigation solutions 5 to 8 inclusive, averaged 9.14 millimhos per cm, or 5484 p.p.m. There was no apparent difference in the salt concentrations of the solutions.

The boron analysis shows values near the desired levels with a few exceptions. The concentration of boron in canal water (treatment No. 1) was approximately 0.25 ppm and that in canal water plus salt (treatment No. 5) was approximately 0.4 p.p.m. The 3.50 figure for treatment No. 2 on 6-15-49 and the 25.69 figure for treatment No. 3 on 6-16-49 were out of line and unaccountable, and they are not associated with any unusual leaf symptoms for these plots.

The boron determinations were made in the Citrus Rootstock Laboratory at Weslaco by a modification[6] of the Hatcher and Wilcox (1949) Carmine methòd. A few determinations shown in table 1 were made by Hatcher by the electrometric titration method.. These values (5.92 for treatment No. 4 and 6.04 for treatment No. 8) are similar to the desired value of 6.00 p.p.m. for these plots.

Irrigation Schedule

The plots were irrigated with the test and boron solutions approximately every fifteen days from May 9 until September 8. Two and three-quarters inches of solution were applied to each plot at each irrigation. No rain occurred at the test location during the above period; but rain beginning on September 9 interrupted the fifteen-day irrigation schedule following this date.

The temperatures were unusually high during the greater part of the test period and were in the neighborhood of 100°F. many days during June, July, and August.

6 The analyses were made by George Ulvild who found that the blank solution used in the original method could not be brought on the scale of the Klett-Summerson instrument by use of the coarse and fine adjustment knob. By using 20 ml. of conc. H2SO4 and 5 ml. of the carmine solution, he could zero the instrument and improve the sensitivity of the galvanometer.

TABLE I

ANALYSIS OF IRRIGATION WATER FOR CONCENTRATION OF SALTS AND BORON

Date Applied	Irrigation Treatment 1	2	3	4	5	6	7	8
	Concentration of salts — E.C., millmhos per cm.							
5-14-49	1.4	2.0	—	—	—	—	—	
6- 1-49	1.4	1.3	1.4	1.4	8.0	9.0	11.0	10.5
6-16-49	1.4	1.4	1.4	1.4	10.0	10.0	10.0	9.5
6-30-49	0.9	0.9	0.9	0.9	7.2	8.2	8.9	9.0
7-15-49	1.0	1.0	0.9	1.0	8.5	8.9	9.0	8.7
7-30-49	—	—	1.1	—	8.1	9.5	8.6	—
8-16-49	1.3	1.3	1.2	1.2	9.0	9.5	9.8	9.5
9- 2-49	1.6	1.4	1.5	1.0	9.0	8.0	9.0	9.5
10-10-49	1.0	0.8	1.0	1.9	11.0	8.0	10.0	9.5
	Concentration of boron — ppm.							
5-14-49	—	—	—	—	—	—	—	—
6- 1-49	0.34	1.63	4.27	8.25	0.45	1.88	2.80	6.40
6-16-49	0.23	3.50	25.68	6.70	1.02	0.80	4.03	7.27
6-30-49	0.35	0.90	3.25	6.00	0.45	1.35	4.15	5.05
7-15-49	0.15	0.80	2.40	4.97	0.05	0.65	2.20	—
7-30-49	**0.28**	—	2.70	**5.92**	0.35	0.90	2.70	**6.40**
8-16-49	0.13	0.90	2.70	5.50	0.30	0.90	2.60	6.30
9- 2-49	0.40	0.80	2.30	6.10	0.40	1.40	3.40	6.10

— Indicates no determination

Boldface indicates determination made by J. T. Hatcher of the U.S. Regional Salinity and Rubidoux Laboratory at Riverside, Calif. All other determinations were made at the citrus rootstock laboratory at Weslaco, Texas.

The actual time of irrigation was determined by the condition of the plants, which usually showed incipient wilting about every two weeks. Tensiometer cups, set to read cup tension in centimeters of water, were installed at a depth of 6 inches in plots number 1, 4, 5, and 8 in the same manner as described in the 1948 series (Cooper, 1948). The mercury in the manometer of the tensiometers in the plots registered approximately 500 mm. when incipient wilting of the leaves of the plants occurred. The control plants in plot No 1 usually showed wilting just as frequently and severely as the plants in the high salt plots. The control plants, however, were growing more rapidly than the salted plants and required more water.

The plants in the three plots of 1948 investigations at Weslaco (Cooper, 1948) required irrigating only approximately once in every three weeks. The need for more frequent watering in the present plots as compared to the Weslaco tests is accounted for by the lighter soil and a less extensive root system.

RESULTS

Concentration of Salt in the Soil

The upper two feet of soil of each plot was sampled a week or ten days following each irrigation. A salinity appraisal of the soil from each plot was made by procedures recommended by the U. S. Regional Salinity and Rubidoux Laboratories and described in detail by Cooper (1948). The actual salinity determination consisted of a reading of the electrical conductivity of a saturated extract of the soil.

It is seen from table 2 that the electrical conductivity of the saturation extract of the soil in the no-salt-added plots No. 1 to No. 4, inclusive, and No. 9 to No. 12, inclusive, was uniform and averaged 1.47 millimhos. The average figure for the irrigation water applied to these plots (derived from data given in table 1) was 1.24 millimhos.

In the case of plots No. 5 to No. 8, inclusive, and No. 13 to No. 16 inclusive there was a gradual increase in the salt concentration of the saturation extract from approximately 1.4 millimhos at the beginning of the test in May to approximately 6.0 millimhos on July 8. Following this date the salt concentration remained more or less constant up to including the September 8 determination. The October 10 determinations on all plots were considerably lower than those recorded on September 8. The greatest reduction in salt concentration occurred in plot No. 5 in which the electrical conductivity recorded was 1.5 millimhos per cm. which was the same value as at the beginning of the test before the salt treatment was applied. This reduction in salt concentration of the salted plots during September is attributed to the six inches of rainfall occurring during this period, which apparently leached much of the salt from the upper soil.

TABLE 2

CONCENTRATIONS OF SALTS IN SOIL AND pH OF SOIL OF TEST PLOTS*

Date of soil sample	Test Plot Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Concentration of salts in saturation extract — E.C., millimhos per cm.															
5- 9-49	1.5	1.7	1.4	1.5	1.5	1.7	1.2	1.3	1.1	1.5	1.1	1.1	1.1	1.0	1.3	1.2
5-24-49	1.1	1.4	1.2	1.3	2.3	2.9	2.2	2.6	1.1	1.2	2.0	1.2	1.8	1.7	2.1	1.3
6-10-49	1.7	1.9	1.5	1.8	3.7	4.2	4.0	4.3	1.4	1.7	1.4	1.3	3.5	3.5	3.9	3.8
6-23-49	1.5	1.6	1.3	1.4	4.2	5.0	4.3	4.8	1.5	1.3	1.9	1.1	4.2	5.3	4.6	4.3
7- 8-49	1.5	1.3	1.4	1.6	5.2	5.5	5.4	6.2	1.5	1.4	1.5	1.6	7.0	6.0	6.9	5.5
7-29-49	1.5	1.1	1.6	1.3	3.8	5.7	4.7	5.0	1.4	1.2	1.5	1.5	5.5	5.6	7.2	4.5
8- 8-49	1.4	1.2	1.3	1.5	4.5	5.5	5.0	4.0	1.8	1.4	1.4	1.5	5.5	7.0	6.8	3.5
8-22-49	1.7	1.5	1.7	1.6	5.0	6.7	5.5	5.5	1.6	1.1	1.5	1.2	5.6	5.6	5.5	4.7
9- 8-49	2.0	1.7	2.0	1.7	7.5	7.8	7.0	7.0	1.9	1.9	1.5	1.8	6.8	7.0	8.0	7.6
10-10-49	1.8	1.1	0.6	1.3	1.5	2.8	2.6	5.0	3.1	1.0	1.0	1.0	1.8	1.3	4.5	4.2
	pH of saturated soil extract															
5- 9-49	6.8	7.0	7.2	6.9	6.9	6.4	7.2	--	7.5	7.2	7.3	7.6	7.4	7.1	7.1	7.2
5-24-49	6.7	7.0	7.0	6.7	6.8	6.6	6.9	6.8	7.6	6.9	7.2	7.2	7.5	6.8	6.8	7.3
6-10-49	6.6	6.8	7.0	6.8	7.0	6.7	6.8	6.6	7.7	7.6	7.3	7.2	7.3	6.8	6.7	6.9
6-23-49	6.5	6.8	6.9	6.7	7.0	6.3	6.8	6.3	7.6	6.9	7.3	7.2	7.4	6.7	6.7	6.9
7- 8-49	6.7	6.8	7.0	6.8	7.1	6.3	6.8	6.3	7.5	7.0	7.1	6.9	7.2	6.7	6.8	6.9
7-29-49	6.5	6.9	6.9	7.0	7.2	6.5	6.7	6.4	7.6	6.8	7.1	6.9	7.5	6.8	6.6	6.9
8- 8-49	—	6.9	6.9	6.9	6.8	6.4	6.7	6.5	7.3	6.8	7.2	7.2	7.2	6.8	6.5	7.0
8-22-49	6.4	6.8	6.9	6.8	6.7	6.5	6.9	6.2	7.3	7.0	7.3	7.1	7.2	6.7	6.6	6.9
9- 8-49	6.7	6.9	7.0	6.8	6.8	6.5	6.8	6.3	7.3	7.1	7.4	7.3	7.4	6.6	6.9	7.0
10-10-49	6.7	7.1	7.2	7.2	7.4	6.8	7.3	6.4	7.7	7.0	7.4	7.5	7.8	6.9	7.0	7.2

* Upper two feet of soil in all instances except for 5-9-49 when only the upper one foot was sampled.

pH of the Soil

The data given in table 2 show that the pH of the soil of the various plots varied from 6.2 to 7.7, but these variations were inherent in the soil and not associated with the treatments. In fact there were no significant changes in the pH of the soil of any of the plots from the May 24 to the September 8 determinations. Plots that started with lower values showed the same values in September while those starting with the higher values also showed in the same values in September. Neither salt, boron, salt plus boron, nor canal water produced any significant change in the pH of the soil during the May to September test period. There was a small increase in pH in several of the plots following the September rains, but this increase is not associated with any of the irrigation treatments.

Symptoms of Salt Injury

The leaves of the trees of all plots were kept under frequent observation for indications of salt and boron injury. The leaves on all trees in the canal water control plots No. 1 and No. 9 remained healthy and deep green throughout the test period (see figure 2). On the other hand, trees of orange and grapefruit in the salt-added plots No. 5 and No. 13 showed certain leaf reactions which are classed as symptoms of salt excess. There was no boron added to these plots except traces occurring in the salt as an impurity, the final concentration of boron in the irrigation solution being approximately 0.4 p.p.m., which is considered nontoxic to citrus.

The first symptoms of salt excess observed was the development of an interveinal bronzing of the upper side of the older leaves. This coloration was brighter on the leaves of the grapefruit than on orange and was more intense in July and August than in October. This bronzing condition will be referred to in this paper as salt injury stage I and is illustrated in figure 3.

Salt injury stage II consisted of a collapse of the bronzed tissue, which at first gave the affected area a scalded appearance. Soon afterwards the affected areas became necrotic. These necrotic areas occurred anywhere throughout the whole leaf. This so-called necrosis or stage II is illustrated in figures 4 and 5.

Stage III consisted of the curling and dropping of the affected leaves,

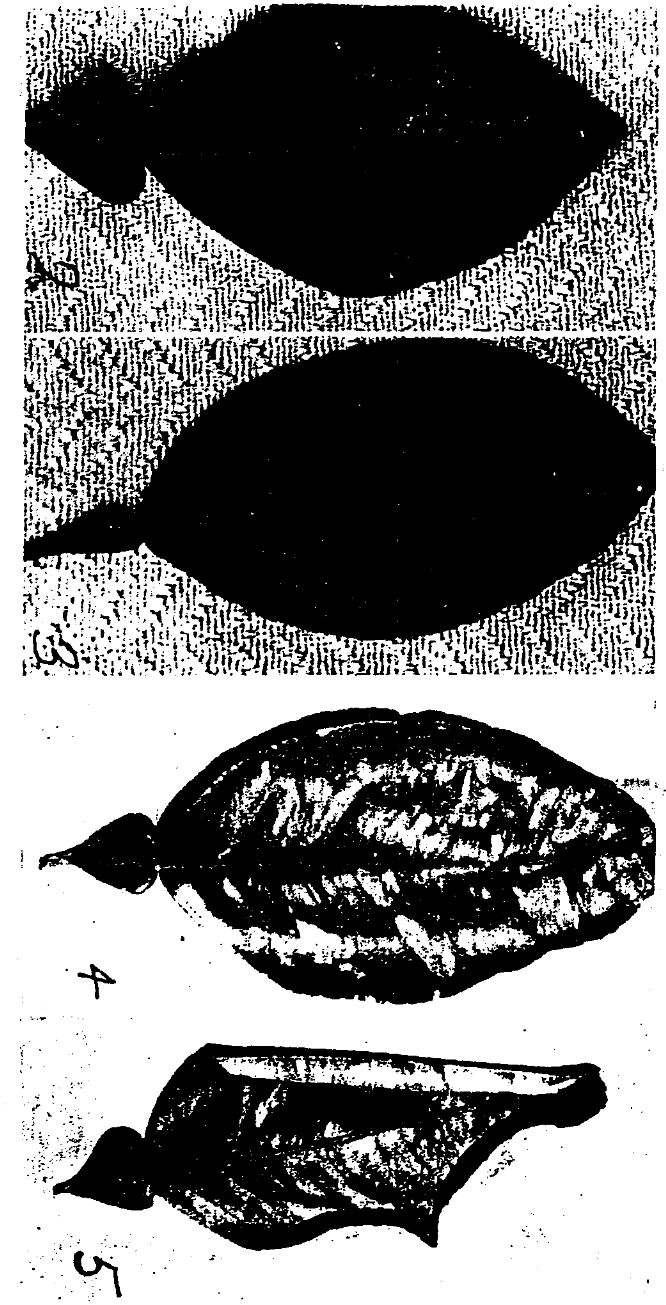


Figure 2. Normal green grapefruit leaf. Plot No. 1. October 10, 1949
Figure 3. Bronzing, or type I salt-excess symptom, on leaf of grapefruit on Cleopatra rootstock. Plot No. 5. October 10, 1949.
Figures 4 and 5. Necrosis, or type II salt-excess symptom, on leaf of grapefruit on sour orange rootstock. Plot No. 5. September 8. 1949.

leaving a tree stripped of most of its old leaves (see figure 6.).

In stage IV, necrosis and leaf drop continued until the trees were stripped of practically all the leaves. In some trees some new shoots grew out at this stage (figure 13). In stage V these new shoots and the long terminal growth became necrotic and died back. At stage VI the whole tree died (figure 7.).

The bronzing symptom (stage I) usually appeared following an extremely hot day. If the high temperatures persisted, stage II or necrosis soon followed. However, if the weather moderated, it was observed that necrosis did not always develop and occasionally the bronzing symptom disappeared from the leaves.

As noted above, the bronzing symptom was always confined to the upper side of the leaf. At no time during June, July, or August were any symptoms observed on the under side of the leaves. However, in October all bronzed leaves on grapefruit showed a russeting (figure 8) on the under side, but this russeting was readily distinguishable from the tiny pustules described for boron symptoms and illustrated in figure 10 and 11. Normal green grapefruit leaves on the same plant or on adjacent plants never showed this symptom. Also neither bronzed nor normal Valencia orange leaves showed russeting.

Another symptom observed in October on all varieties grown in the salted plots was a curling and puckering of the leaves (figure 9). This was not observed previous to the October 10 inspection. The curling and puckering was not confined to bronzed or necrotic leaves. In many cases otherwise normal green leaves showed this reaction. It occurred on grapefruit, orange and mandarin.

Symptoms of Boron Injury

The leaf symptoms observed on the plots receiving only added boron are classified in this paper as boron symptoms. The concentrations of salt in the irrigation water (1.2 millimhos) and in the saturated extract of the soil (1.4 millimhos) of these plots was practically the same as in the canal water control plots. Since this quantity of salt caused no injury in control plots No. 1 and No. 9 it is assumed that it caused no injury in the boron plots number 2, 3, 4, 10, 11 and 12. Furthermore, the symptoms observed in these plots differed distinctly from those in salt plots No. 5 and No. 13.

The stages of boron-excess symptoms are refered to by letters to distinguish them from the Roman numerals used for salt-excess symptoms. The symptoms for grapefruit, orange, and mandarin varied slightly from those for grapefruit and will be discussed separately.

With grapefruit, stage A (figure 10) consisted in the development of numerous small yellow spots all over the upper side of the older leaves, giving them a speckled appearance. On the under side of the leaf a tiny pustule or rough resinous excrescence appeared at each of the yellow spots. In stage B, the yellow spots became more numerous and coalesced into irregular yellow areas between the veins, along the margins, and at the tip. The yellowing was usually more intense at the tip.

Figure 6. Partial defoliation of old leaves, type III salt-excess symptom on grapefruit on sour orange rootstock. Plot No. 3. August 9, 1949.

Figure 7. Dead tree, type VI salt-excess symptom on grapefruit on sour orange rootstock. Plot No. 14. August 9, 1949.

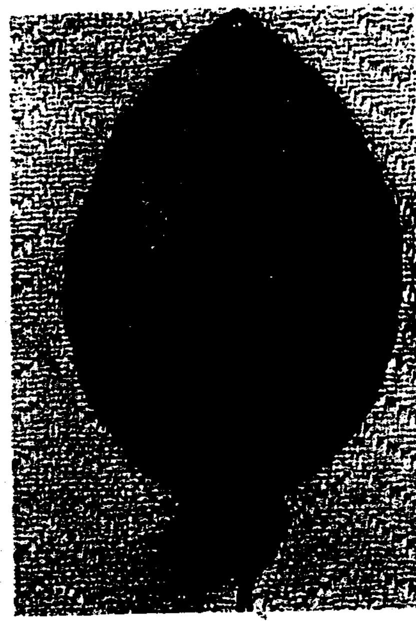


Figure 8. Russting of under side of bronzed leaf of grapefruit on sour orange rootstock. Plot No. 5. October 10, 1949.

Figure 9. Curling and puckering of leaves of Valencia orange on sour orange rootstock. Plot No. 5. October 10, 1949.

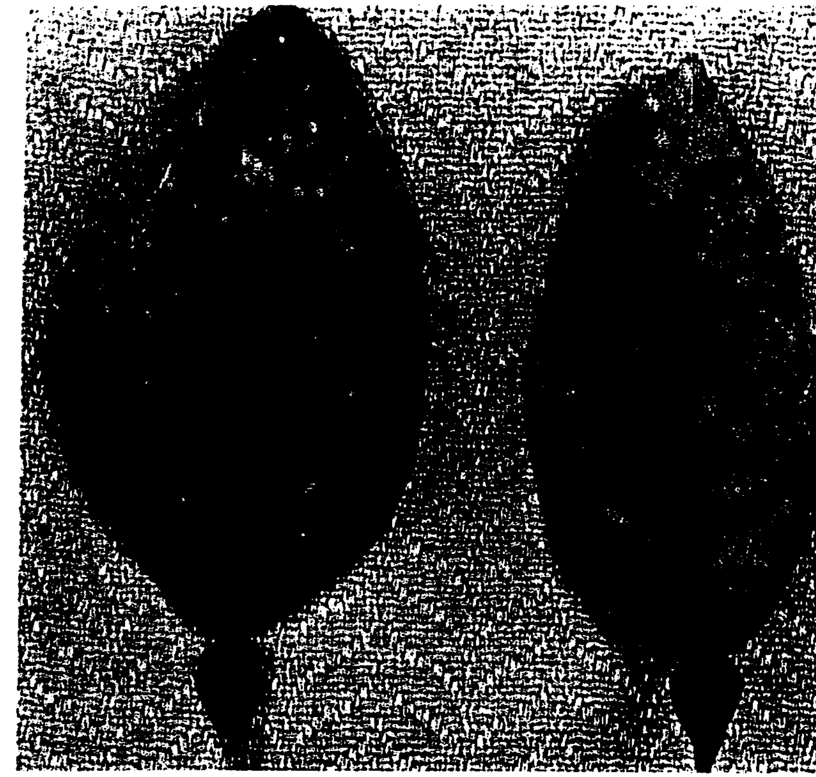


Figure 10. Yellow dotting of leaf, type A boron-excess symptom on leaf of grapefruit on Cleopatra mandarin rootstock. Plot No. 3. October 10, 1949.

Left side, yellow dots on upper side of leaf; right, small resinous spots on lower side of yellow dots. These symptoms are identical with those described by Camp and Fudge (1939) for boron symptoms on grapefruit.

the normal green color of the leaf persisting along the base of the mid-rib. An extreme case is illustrated in figure 11 in which the greater part of the leaf has developed a solid yellow color. The under side of the yellow portion of this leaf, as shown in figure 11, appears to be a series of small resinous spots and is very distinct from any symptom of salt excess. In stage C the tips and margins of the leaf became necrotic and in stage D the leaf dropped.

The symptoms of salt excess developed rapidly beginning about three weeks after the start of the experiment. Boron-excess symptoms on the other hand, were slower in developing. These symptoms were first observed three months after the beginning of the treatments. On none of the boron plots have the boron-excess symptoms progressed farther than partial defoliation.

In the case of the Cleopatra mandarin seedlings the numerous tiny yellow dots were not observed. The first stage (A) consisted in the development of irregular areas of a yellowish-orange tint between the veins and along the margins, and at the tip of the upper side of the leaf (figure 12). On the under side were observed the characteristic resinous excrescences or pustules. Stages B, C, and D resembled those observed on grapefruit. The symptoms on orange resembled those of grapefruit except that the yellow dots occurred most near the tip of the leaf and they quickly coalesced into irregular yellow areas at the tip (figure 12).

Symptoms of Combined Salt and Boron Excess

Those stock-scion combinations in the salt plus boron plots that showed no evidence of salt injury usually developed typical boron injury, beginning in August and becoming more apparent in October. Other trees that showed only bronzing and the mild necrosis type of salt injury usually developed typical boron toxicity symptoms on the same leaves. Thus in October many leaves on trees in these plots showed a combination of type I or II salt injury and type A or B boron injury.

In the case of grapefruit and Valencia orange on sour orange root in the salt plus boron plots, partial or complete defoliation of all old leaves from salt occurred in June or July. Usually the leaves on terminal growth remained for some time. These terminal leaves developed irregular areas of yellowish-orange tint at the tip. No tiny pustules were observed until the October 10 inspection, at which time some of these resinous excrescences were definitely visible on the under side of the yellowish areas. There was no development of yellowish areas at the tip of such leaves on terminal growth of partially defoliated trees in the plots to which only salt was added. Thus this symptom is attributed to the presence of boron in the irrigation solution.

Relation of Rootstock to Salt-Excess Symptoms

A record of leaf symptoms on the various stock-scion combinations by plots at monthly intervals is given in table 3. It is seen that bronzing (salt-excess type I) was the only symptom observed on any tree in the canal water control plots No. 1 and No. 9, and this bronzing was

TABLE III
RECORD OF LEAF SYMPTOMS OF VARIOUS ROOTSTOCK-SCION COMBINATIONS BY PLOT AT MONTHLY INTERVALS

Key to salt and boron leaf symptoms
Roman numerals indicate type of salt-excess symptoms as described in text.
Capital letters indicate type of boron-excess symptoms as described in text.
Arabic numerals indicate the number of plants of that particular stock-scion combination showing a particular symptom in that plot. The total number of plants of each stock-scion combination in each plot, with a few exceptions, was five. Where a plant shows both salt and boron symptoms it is recorded in both categories.

Date of Observation	Test Plot Number 1	2	3	4	5	6	7	8
			Grapefruit on sour orange					
6-10-49	0	0	0	0	I3II2	I3II2	I3II1	I3II2
7-11-49	I4	I2	0	I3	I2II3	I3III2	I1II2III2	II2III1V2
8- 8-49	0	0	0	A5	II1III4	II1III2V1	I1III3	III3V1A3
8-31-49	I2	0	A2	A5	II1III4	II1III2V2	II2III3A4	III3V1VI1B3
10-10-49	0	0	A2	A4B1	V1III4	III2V2A1	II1III3V1B3	II2VI3C2
			Grapefruit on Cleopatra mandarin					
6-10-49	0	0	0	0	I2	II2	I2II1	I3II1
7-11-49	I3	I2	0	I1	I5	I2III3	I4II1	I4II1
8- 8-49	0	0	A1	A2B3	I4	II3A2	I1II1A1	I1II1A3
8-31-49	I1	0	A1	A2B3	I5	II2III1A2	I3II1A1	I2II1A5
10-10-49	0	0	B1	A2B2C1	I2II2	II2III1A3	I3II1A4	II1A3B2
			Valencia orange on sour orange					
6-10-49	0	0	I1	0	I2	I3	0	I4
7-11-49	0	I4	0	I3	I4	I4III1	I3II1	I3II2
8- 8-49	0	0	0	A1	I2II2	II3III1	I1II2A1	I2III3A1
8-31-49	0	0	0	A1	I3II2		II3III2A2	I2III3A2
10-10-49	0	0	0	A3	II2III3	II3III2	II2III3B2	III3A2C2
			Valencia orange on Cleopatra mandarin					
6-10-49	0	0	0	0	0	I4	0	I1
7-11-49	0	0	0	I1	I3	I2II2	I4	I4
8- 8-49	0	0	A1	A3	0	I2II2	I1	I2A2
8-31-49	I2	0	I1A1	A3	I2	I1II3	I3A1	I4A2
10-10-49	0	0	A1	A2B1	I2	I2II3	I2A1B2	I3A2
			Cleopatra mandarin seedling					
6-10-49	0	0	0	0	0	0	0	0
7-11-49	0	0	0	A1	0	0	A1	A3
8- 8-49	0	A2	A3	B2C1	0	A1	A3II1B1	A4C1
8-31-49	0	A2	A4	A2C3	I1	A1	B5	B2C3
10-10-49	0	A2	A2B3	D5	I1A1	A4	C4D1	D5

TABLE III - (Con't.)
RECORD OF LEAF SYMPTOMS OF VARIOUS ROOTSTOCK-SCION COMBINATIONS BY PLOT AT MONTHLY INTERVALS

Date of Observation	Test Plot Number 9	10	11	12	13	14	15	16
Grapefruit on sour orange								
6-10-49	I2	0	0	I1	I3II2	I3II2	I3	14
7-11-49	I2	I3	I3	I4	I1II3III1	II2IV2VI1	II3IV2	I1II4
8- 8-49	0	A2	A1	A3B2	II2III3	III1V3VI1	IV5	I2III2A2
8-31-49	I4	I1A2	I3A1	A3B2	II2III3	IV1VI4	VI5	II3III2A2
10-10-49	0	A2	A2	B2C3	II1III3VI1	IV1VI4	VI5	III3IV1A3
Grapefruit on Cleopatra mandarin								
6-10-49	I2	0	0	0	I3	I2	I2	I2
7-11-49	12	11	I1	I4	I5	I3II2	I4II1	I3
8- 8-49	0	A1	A1	A3B2	I3	III2B1	II1IV1A2	I1A2
8-31-49	I3	A1	I1A1	A2B3	I5	I2III2B1	II1III2A3	I1A5
10-10-49	0	A1	A3	B4C1	12II2A1	III4II1A1	III3VI1B2	I2A1B4
Valencia orange on sour orange								
6-10-49	0	0	0	0	I4	I3	I3	I2
7-11-49	I1	0	I3	I2	I3II1	I3II2	I1II2	I3
8- 8-49	0	0	0	A1	I4II1	II4III1	I1II3A1	I2II3A2
8-31-49	0	0	I3	I1A2	I4II1	II2III2IV1	I1II1III3A1	I2II3
10-10-49	0	0	0	A3B2	13II1III1	I2III2VI1A1	I1III4B2	I4III2A2B2
Valencia orange on Cleopatra mandarin								
6-10-49	0	0	0	0	0	0	0	0
7-11-49	I1	0	I3	0	I2	I5	I1	I1
8- 8-49	0	0	0	A3	0	I1II2	0	0
8-31-49	I1	0	I1	A4	I5	I3II2	I2	II1A1
10-10-49	0	0	0	B3C1	I3	I4III1	I3A1	I1B4
Cleopatra mandarin seedling								
6-10-49	0	0	0	0	0	0	0	0
7-11-49	0	0	0	0	0	0	0	0
8- 8-49	0	0	A1	A2	0	A1	A1	A3
8-31-49	0	0	A3	B2C3	0	A2	A3	B5
10-10-49	0	0	B4C1	D5	A2I2	I1B3C1	B4C1	C3D2

Figure 13. Grapefruit on sour orange rootstock. Plot No. 13. August 9, 1949.

Figure 14. Grapefruit on Cleopatra mandarin rootstock. Plot No. 13. August 9, 1949. This plant was adjacent to the one shown in figure 13.

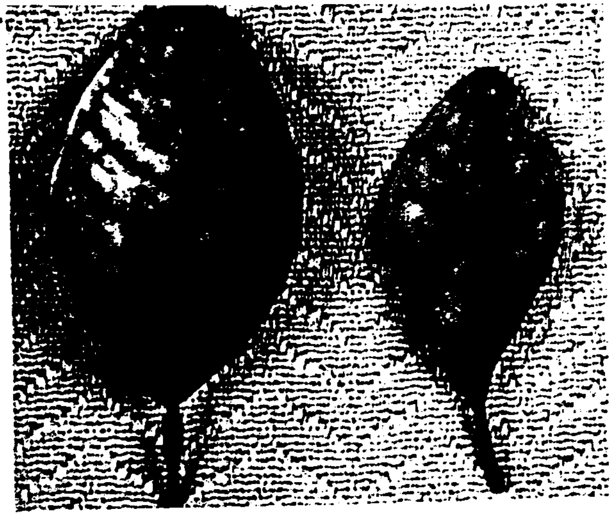


Figure 11. Yellowing of almost the entire leaf, type B symptom of boron excecss on leaf of grapefruit on sour orange rootstock. Plot No. 12. October 10. 1949.

Left side, coalesed yellow dots on upper side of leaf; right, mass small resinous spots.

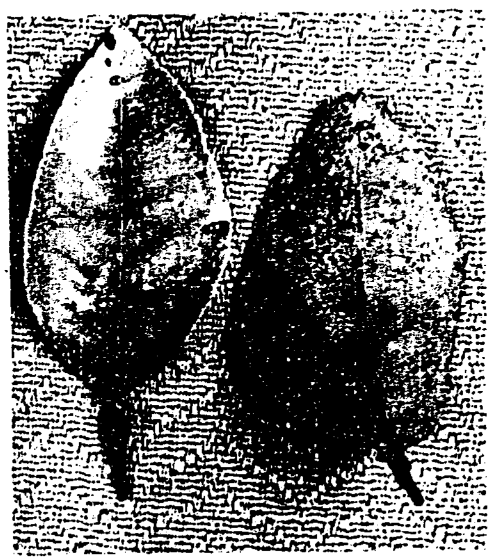


Figure 12. At left, type B boron-excess symptom on Valencia orange on Cleopatra mandarin rootstock. Plot No. 12. October 10, 1949. At right, type B symptom of boron-excess on leaf of Cleopatra mandarin seedling Plot No. 12. October 10. 1949.

ephemeral and did not persist in an tree in these plots at the October 10 observation.

In the salt-added plots No. 5 and No. 13 salt-excess symptoms varied with the stock-scion combination. Grapefruit on sour orange was the most susceptible combination, some plants being dead or nearly dead by October. Grapefruit on Cleopatra mandarin, on the other hand, showed much less severe salt-excess symptoms than occurred on grapefruit on sour orange (see figure 13 and 14). Bronzing was the only type of injury observed on leaves on grapefruit on Cleopatra through June, July, August, and September. Some necrosis was found in October.

In these same plots Valencia orange on sour orange rootstock showed more salt injury than Valencia orange on Cleopatra mandarin. Bronzing was the only type of salt-excess symptom observed at any time on the Valencia orange on Cleopatra mandarin rootstock, while defoliation (type III) injury occurred on Valencia on sour orange rootstock. Comparing the Valencia orange scion with the grapefruit scion on the same rootstock it is seen that with both the sour orange and the Cleopatra stocks Valencia orange was more resistant to salt injury than was grapefruit. Of all five combinations included in the plots, the Cleopatra mandarin seedling, i.e., Cleopatra top with Cleopatra roots, showed the most resistance to salt injury, the leaves showing only traces of bronzing.

In the salt-plus-boron plots the differences in salt injury symptoms for the different stock-scion combinations more or less paralleled those observed on the salt-only plots. The degree of salt injury, however, in plots number 8, 14, and 15 were more severe on most trees than occurred on trees of the same combination in plots No. 5 and No. 13. This is not attributed to the presence of boron, because plot No. 16 irrigated with salt plus 6 p.p.m. boron showed approximately the same degree of salt injury as plots No. 5 and No. 13. The variation between plots in salt injury also is not correlated with pH of the soils. Likewise it is noted that the solution applied had approximately the same salt concentration for all salt-plus-boron plots (table 1).

Relation of Rootstock to Boron-Excess Symptoms

In plots No. 4 and No. 12 which received 6 p.p.m. of boron with added salt, it is seen (table 3) that the Cleopatra mandarin seedling was more susceptible to boron injury than all other stock-scion combinations. Type A symptoms were observed in July, and by October all five plants in each plot were partially defoliated (type D). With the other combinations grapefruit on both rootstocks showed more severe boron-toxicity than Vallencia orange on the same stocks. In comparing grapefruit on the two rootstocks there appears to be no striking difference due to the stock. The same is true when comparing leaf symptoms of Valencia orange on the two stocks. There was observed on the October 10 inspection a large variation in the response of the five plants within a treatment; and as of that date it was concluded that the rootstocks in these tests had no effect on the boron toxicity symptoms. Boron-excess symptoms were slow in developing as compared with salt-excess;

but possibly after a longer test period some differences as a result of rootstock influence may develop.

In comparing the plant response of plots receiving 1, 3, and 6 p.p.m. boron it is seen that in all cases the injury was most severe from treatment with 6 p.p.m. boron. One p.p.m. boron induced only type A symptoms; and 3 p.p.m. induced principally A-type symptoms on orange and grapefruit, and B and C type on Cleopatra mandarin seedlings.

DISCUSSION

The results in which citrus was grown in soil under controlled concentrations of salt and boron, indicate that foliage symtoms of salt excess and of boron excess are clearly distinguishable; and it should be possible to apply these results in a practical way as a tool for the diagnosis of boron and salt injury in the field. The type I salt-excess symptom on grapefruit may at times develop a yellowiish-hue instead of the duller bronze color, and thus closely resemble the yellowish-orange of type A boron excess. However, presence on the under side of the leaf of characteristic tiny pustules will identify the boron-excess symptom. Likewise the zinc and manganese-mottling can be distinguished from the boron mottling by the lack of these tiny pustules on the under side of the leaf.

These results also indicate that the Cleopatra mandarin rootstock is more resistant to salt injury than the sour orange, and that the Valencia orange scion is more resistant to salt injury than the Shary red grapefruit scion. The grapefruit-sour orange combination that is most planted in the Valley is the combination found in these salt tolerance tests to be susceptible to salt injury; and this may well be a factor the short life of many grapefruit trees in the Valley.

The salt resistance of the Cleopatra mandarin rootstock is a point in its favor, but its possible susceptibility to other deleterious factors in this area is yet to be determined.

The tests to date show no consistent rootstock effect on boron tolerance. More time is required in these tests to determine this point, as the boron injury sumptoms have developed more slowly than the salt injury. There is no indication, however, that the Cleopatra mandarin is more resistant to boron injury than is the sour orange.

The boron results to date indicate that the extent of boron-excess leaf symptoms on any particular stock-scion combination is directly related to the concentration of boron in the irrigation water.

Growth measurements of the trees and analysis of the leaves for sodium, chlorides, and boron are in progress. A more complete understanding of the relation of the stock and scion combination to boron and salt tolerance of citrus awaits these determinations.

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Progress Report For 1949 On Inspection And Registration Of Psorosis Free Citrus Trees

CARL W. WAIBEL
Texas State Department of Agriculture

Mr. Waibel is doing Nursery Inspection in developing the program of providing a source of psorosis free citrus trees. He has had 13 years experience as a tree surgeon in New York state and spent 2 years with the U. S. Navy in this capacity. Mr. Waibel also served one and one-half years as Laboratory and Field Assistant in Plant Pathology at the Valley Experiment Station, Texas.

Psorosis, or Scaly Bark as we know it, is a virus disease that has caused great damage in Texas Citrus groves. It is increasing in importance because so many groves are only now coming to the age when bark lesions appear. When bark lesions appear, small fruit sizes and low tonage result, and finally death comes to the tree. Yield estimates in older groves show that the average affected trees were yielding about one-third less than healthy trees of the same age. As the disease becomes more severe, the yields become proportionately less. An additional reduction in total yields also results from the necessity of removing and replacing badly diseased or dead trees.

Today no one is to blame for the number of infected trees in a grove, because at the time these trees were propagated, no one knew about the virus nature of psorosis or its transmission through infected buds. Tomorrow's ignorance will be no excuse as we now know the method of prevention.

There is no known insect carrier of psorosis virus, and no known cure. There is only one known method of prevention and that is to be certain the buds used to propagate the trees come from trees that are not infected by the disease.

In 1946 three members of the Lower Rio Grande Horticultural club made a trip to California to study a registration program used there to eliminate psorosis and on their return to the Valley reported their findings to the club. Later that year Dr. J. M. Wallace, Associated Plant Pathologist of the California Citrus Experiment Station, addressed the Rio Grande Valley Citrus Institute on the psorosis disease and told what California was doing about it.

At the 1947 Citrus and Vegetable Institute Mr. S. B. Apple Jr., Extension Horticulturist of the Texas Extension Service, presented a survey of mature citrus trees at Rio Farms showing as high as 82% of the trees in some groves infected with psorosis as shown by bark lesions. At the same institute Dr. J. E. Coit of California pointed out the urgent need for registered citrus nursery trees in Texas.

In the spring of 1948 the late Dr. H. S. Fawcett, Ctirus Pathologist of the Caifornia Citrus Experiment Station, at the invitation of the Psorosis Committee of the Rio Grande Horticultural Club, made a study of psorosis in Valley citrus and drew up a program for its control. Thru the

cooperation of the Lower Rio Grande Valley Nurserymens Association. The Lower Rio Grande Valley Experiment Station and the Texas State Department of Agriculture, that program is now being carried out and is well underway.

This program calls for the inspection and registration of parent trees free of psorosis, and any other transmisable disease, as a source of budwood for propagation of citrus trees. This parent tree must be eight years old. Its parentage must be traced and as much information as possible be obtained as to variety, production, and quality of fruit. The tree is then examined from top to bottom for bark lesions of both psorosis and Rio Grande gummosis .It is then checked for bud mutations and spots, and finally the tender flush of new leaves are inspected from at least ten locations about the tree for leaf symptoms of psorosis. If the tree still shows no indication of psorosis or other diseases, such as stubborn disease, Rio Grande gummosis, footrot, or leprosis, the four adjacent tree are examined in the same manner. If all five trees fail to show any symptoms of the diseases named, the one selected is then charted and listed for possible registration. All five trees are then inspected for leaf symptoms of psorosis in all flushes of growth for the entire year plus an extra inspection of a second spring flush. At the first sign of leaf or bark symptom of psorosis on any one of the five trees under observation the selected tree is dropped from the program. If all five pass, budwood is taken from the selected tree and budded on four sour and four Cleopatra seedlings in a test plot at the experiment station, under the direction of Dr. G. H. Godfrey, Plant Pathologist, where daily observations are made. A tree that passes the test is then registered for three years and must be inspected again before it can be re-registered.

In the past twenty months 18,644 parent trees have been inspected and of these 692 were carried thru the last spring flush. In the spring flush 28 were discarded due to infection, 126 were discarded due to adjacent trees being infested, 159 were lost due to freeze damage, and 57 were dropped due to the limited number allowed each applicant. Five trees have been discarded after showing leaf symptom in the test plot in the summer flushes of growth, leaving 317 trees to be inspected in the coming spring flush before final registration.

Many people ask, "when will we be able to buy registered nursery trees? Why does it take so long to get them? We have been hearing about registered trees since 1946 and don't have them yet". All good things come slow. It was not until May 1948 that the machinery was set up so we could have them. It takes two years of inspection and test and careful selection to get them. It will be the spring of 1950 before there will be any trees registered and the spring of 1951 before nurserymen have any number of registered trees for sale.

It taxes the skill of a technician to determine that a citrus tree does not have scaly bark. Multiply the number of trees by five and you have an idea of the tremendous task involved in selecting a citrus tree for registration. No step can be omitted and a parent tree must pass all tests before it can be registered. The nurseryman is limited to the registration of only six trees of each variety and six trees will produce only a limited amount of budwood. Thirty thousand registered nursery trees will go on sale this spring after the parent tree has passed the final test in the spring flush.

The nurseryman is ready to supply the trees by order, but it is up to you to create a demand for them. Tax assessors, real estate salesmen, bankers who loan money, all must be made to realize that the value of the grove is greatly affected by the number of psorosis infected trees in it. Planting a grove is an expensive operation and a long term investment, so plan it well. Be sure the trees you plant are free of psorosis. This is insurance that they will not die about the time they should be in full production.

One must remember a nursery tree is not a registered tree unless it bears a state sealed tag stating that it is a registered tree. One should in- sist that the nurseryman from whom you purchase your trees shall how you his Texas State Registration Certificate. It is predicted that nursery- men who are in the business to say will use regisered buds exclusively.

Control Of Post-Harvest Decay In Citrus Fruit

Howard B. Johnson

Associate Pathologist, Division of Fruit and Vegetable Crops
Bureau of Plant Industry, Soils, and Agricultural Engineering
Agricultural Research Administration

Mr. Johnson is at present working on transit and storage diseases of citrus fruits and vegetables, and has further been associated with the U.S.D.A. as Associate Entomologist, Division of Control Investigations, Bureau of Entomology and Plant Quarantine.

Protection of citrus fruits against post-harvest decay organisms is desirable if the receiver, the retailer, and the consumer are to receive fruit that is in good condition upon arrival and will remain sound a reasonable length of time. It is particularly important that the amount of fruit the housewife has to discard because of decay be kept to a minimum to avoid discrimination in subsequent purchases against the production area concerned.

Fungi Responsible. — Four decay-producing fungi are largely responsible for the losses incurred during the marketing period of Texas citrus fruits; the common green mold, *Penicillium digitatum* Sacc.; blue mold, *P. italicum* Wehmer; and the stem-end rots caused either by *Diplodia natalensis* Pole-Evans, which is the imperfect form of *Physalospora rhodina* (Berk. & Curt.) Cke., or by *Phomopsis citri* Fawcett, the imperfect form of *Diaporthe citri* Wolf (3). *Phomopsis citri* also causes melanose of immature fruit and foliage.

The green and blue molds are easily distinguished, whereas in the case of stem-end rot it is necessary to make cultures to determine with certainty whether the causal agent is Diplodia or Phomopsis. The four fungi display differences in their physical characterictics, temperature relations, and response to protective measures. One practical difference between the Penicillium molds and Diplodia and Phomopsis stem-end rot is the manner and time the infections occur.

Penicillium mold infections occur usually through injuries to the peel although it may spread in the case of blue mold by contact from one fruit to another even though uninjured skin and the cut stem-end. Penicillium spores are air-borne and widely distributed (3). Accordingly, any mechanical injuries to the peel incurred during the harvesting, packing, or shipping operations favor green and blue mold infection.

Stem-end rot infestions occur, on the other hand, in the orchard before the fruit is picked. Incipient infections of the button tissue result from spores washed or splattered from dead limbs or twigs while the fruit is on the tree. Under favorable conditions (comparatively high temperatures and relative humidity), such as prevail in coloring rooms, the organisms rapidly advance into the fruit but usually do not become visible until several days after packing and sometimes not until after arrival on the market (17).

The control of post-harvest decay in citrus fruits has been a problem for years. Hume (9) states there has been trouble with blue and green mold decay ever since citrus fruits have been handled commercially. He quotes the following from a monograph on oranges written by Han Yen Chih in 1178: " - - after two or three evenings of frosts all the fruit should be clipped off with scissors. This should be done on a clear, sunny day. Small scissors should be used for removing the fruit from the branches, cutting them off even with the surface of the skin and carefully placing them in a basket. To protect them from injury one must be very careful not to cut the skins, thus causing the volatile oil to escape, when the fruit will easily spoil".

Careful handling of fruit is still the foundation of decay control, especially against the Penicillium molds and other wound organisms. Nevertheless one does not have to travel far to observe fruit being bruised in overfilled field boxs and indifference to sanitary packing house practices.

Many approaches to the problem of post-harvest decay control have been made. A review of literature reveals measures applicable to orchard practices as well as harvesting and processing methods. Several of these measuers are cited to illustrate the complexity of the problem. Removal of all dead wood and spraying with a fungicide for melanose control reduces the source of inoculum at the stem-end rot fugi (16). However, costs considered, the results are not effective enough to justify commercial application (17). Pulling the fruit instead of clipping reduces the amount of stem-end rot but may increase the incidence of blue and green mold because of injuries to the rind (11, 18).

Commercial Control Treatments

Decay control treatments which are used in commercial shipments of citrus fruits can be grouped as follows: (a) chemical dips; (b) fumigation; (c) chemically treated wraps; and (d) refrigeration. No single treatment is sufficient if the decay problem is serious, so all may be considered as supplemental to each other. Each group of treatments will be dealt with briefly in respect to experimental development, commercial usage, and limitations.

Chemical Dips

Hundreds of chemicals have been tested in Federal, State and commercial laboratories in the search for a material possessing the desired properties of the ideal dip for controlling decay in citrus. A desirable citrus dip should be: (1) effective against all post-harvest decay organisms attacking citrus fruits; (2) non-toxic to humans; (3) non-injurious to the fruit; (4) leave no objectionable odor, residue, or flavor; and (5) be available at a reasonable price. A material such as this has not been found and the search continues.

Borax—The use of antiseptic dips for citrus dates back to 1924 when Fulton and Bowman (4) recommended a heated 5-10 percent solution of commercial borax (sodium borate) as a means of reducing Penicillium rot in oranges and lemons and Phomopsis and Diplodia rot in oranges and grapefruit.

Winston (17) working with Florida grapefruit, oranges and tangerines found that borax, sodium metaborate, and other antiseptic dips ap-

plied before the fruit was placed in coloring rooms were more effective than when applied after coloring, as is the usual packing house procedure. Under commercial conditions the borax treatment before coloring resulted in increased protection against stem-end rot and Penicillium molds during the transit and marketing periods.

Godfrey and Ryall (5) in their work with lemons also showed that the effectiveness of an antiseptic dip treament was increased when applied before the coloring or degreening treatment.

Numerous proprietary materials are used either alone or in combination with wax to control citrus fruit rots. The effectiveness of these materials would be increased, as is the case with borax, if they could be used before gassing without interfering with the coloring of the fruit.

Many packing houses include borax or other fungicidal dips in the usual packing house routine after degreening the fruit; but because of the extra handling involved, fungicidal dips before coloring room treatment have not received industry-wide acceptance.

Fumigation

The advantages of using a fumigant with fungicidal properties as a post-harvest protectant for citrus fruits would be the ease of application in coloring rooms, refrigerator cars, or trucks and would provide a complete coverage of the fruit without leaving an objectionable residue.

Unfortunately ethylene does not have any fungicidal value. In fact, Brooks (1) found that the gas stimulates the germination of Diplodia spores and growth of the fungus.

Winston (17) in Florida reported that anhydrous ammonia, nitrogen trichloride, chloropicrin, and sulphur dioxide gases, applied before or during the coloring process, were inferior to borax in retarding dacay.

Klotz (10) working under California conditions reported satisfactory control of green and blue mold and some other decays of oranges with a gaseous mixture of nitrogen trichloride and air. The Phomopsis and Diplodia stem-end rot fungi were not included in his tests. Ryall and Godfrey (12) reported that nitrogen trichloride applied at intervals during the degreening period gave a significant reduction in the amount of stem-end rot as well as blue and green mold rots of Eureka and Meyer lemons. The effectiveness of the gas treatment was greater when it followed an immediate post-harvest dip in sodium metaborate solution.

Satisfactory dosage schedules have been developed for grapefruit, oranges, and lemons. The nitrogen trichloride treatment can be applied during the degreening process and again after the fruit is loaded in rail cars or trucks. This gas treatment is used quite widely in California and Texas, but has not proved satisfactory under Florida conditions.

Hopkins and Loucks (8) in Florida recently published the results of their exploratory experiments on the use of ozone gas in preventing decay in citrus fruits. A number of their experiments were conducted under the same conditions as commercial shipment. The exact concentrations of the gas were not determined but some of the treatments resulted in fruit injury and increased decay.

Schomer and McColloch (13) in carefully controlled storage experiments with apples reported that ozone did not reduce infection of inoculated wounds. However ,it did retard the rate of enlargemnt of the inoculated wounds.

Klotz (10) in California also reported negative results with ozone. Washington navel oranges which had been inoculated with spores of blue and green mold were not protected with decay by treatment with ozone for 16 hours. On the basis of the experiments to date, it is not possible to recommend ozone as a decay preventive for citrus fruits.

Chemically Treated Wraps,

Thompkins (15) was the first to show that diphenyl impregnated paper wraps were effective in reducing green mold decay of oranges. Following Thompkins' report Farkas (2) made extensive shipping tests from Palestine to England with citrus in diphenyl-impregnated paper wraps and found that six or seven times as much green mold occurred on fruit in plain as in treated wraps.

Godfrey and Ryall (5) in Teas found that both diphenyl wraps and pads greatly reduced the incidence of green mold and stem-end rot but that it was not sufficient by itself and should be preceded by a good dip treatment when decay is heavy.

Hopkins and Loucks (6) reported that diphenyl wraps and diphenyl box liners afforded good reduction of stem-end rot and mould infections. The failure of diphenyl paper bags to give good control was accounted for by the smaller amounts of diphenyl contained in the bags. Hopkins and Loucks confirmed observations of others that diphenyl imparts an "off" taste to citrus fruits and that certain other foodstuffs in close proximity to treated fruit might develop a diphenyl flavor. However they did not consider the "off" taste disagreeable enough to be objectionable and other foods were not affected unless almost in contact with the treated wrappers or fruit.

Diphenyl-impregnated wraps and box liners are widely used in commercial shipment, particularly for export ,with apparently good results. Bags also are used, but to a lesser degree. However, prolonged storage of grapefruit at low temperatures in diphenyl wraps often increases the amount of pitting.

Refrigeration

Chemical dips, nitrogen trichloride, and diphenyl are effective in arresting temporarily the development of stem-end rot and mold decay. Their use, however, does not preclude the later resumption of growth by the decay organisms or reinfection under favorable, temperatures and humidity conditions during the transit and marketing periods. Refrigeration in transit further checks the growth of decay organisms and thus extends the market life of the fruit.

It is generally agreed that fruit temperatires of 50 degrees F. or lower will check the growth of decay organisms. The success or failure of refrigeration as a control measure is largely dependent on the speed with which the fruit temperature is lowered after packing (19). If the fruit is warm when loaded the temperature of the fruit in the top of a load ship-

ped under standard refrigeration may never drop to 50 degrees during the transit period. With warm fruit, therefore ,precooling is important. This may be accomplished in precooling rooms, few of which are available, or by mobile units after the fruit has been loaded into refrigerator cars. In the modern fan car precooling is simplified, and it has many other advantages in the transportation of perishables.

The season of the year, maturity of the fruit, and destination of shipment are factors to be considered in determining the type of protective service required.

Recent Innovations with Commercial Possibilities

Winston (20) noted that ethylene gas treatments for 48-60 hours accelerated the development of stem-end rot but rendered the fruit less liable to green mold infection. In an extensive series of experiments Hopkins and Loucks (7) found that fruit subjected to coloring room conditions (86°F. air temperature and about 90% relative humidity), either with or without ethylene, developed much less mold infection than fruit not subjected to these conditions, and that the reduction was in direct ratio to the length of time the fruit was held in the coloring room. Even artificially wounded fruit that was cured 72 hours under coloring room conditions had only about 10 percent as much mold infections as wounded fruit that was not cured.

Hopkins and Loucks point out that the results of their experiments agree very well with what happens during the shipping season, as follows: "in the early part of the season, when fruit is being colored for from 60 to 70 hours, stem-end rot infections caused by *Diplodia natalensis* Pole-Evans are high because of the stimulating effect of ethylene, while mold infections are low, due to the curing effect of the coloring room treatment. Later when the coloring is discontinued or greatly reduced there is a sharp drop in stem-end rot and a marked increase in mold, — — ".

On the basis of these results they suggested that curing at the end of the ethylene degreening season should greatly reduce blue and green mold infections.

Stewart (14) in California reported very remarkable results with 2, 4-D, applied either as a dip or vapor, in reducing the incidence of black button and Alternaria decay in lemons. Black buttons on California lemons are a sign that Alternaria decay is already present or will soon develop. It has not been possible to kill the fungus with the usual fungicides and disinfectants except at concentrations which injure the fruit (3). Stewart's findings, although still in the experimental stage, offer promising possibilities of decay control by chemicals of this type.

A study of these chemicals and coloring room curing for decay control is being made at the U. S. Horticultural Fields Laboratory in Harlingen.

The value of applying a fungicidal treatment to the fruit immediately upon arrival at the packing house has been demonstrated under commercial conditions. Many packing houses in Florida are equipped to dip fruit prior to placement in the coloring rooms. However, regardless of the obvious advantages, the treatment is usually omitted unless the decay problem is very serious. In Texas, shippers of lemons have generally adopted the pre-coloring room fungicidal treatment as a necessary step in the packing house operation. There have been times in past seasons when Texas oranges and grapefruit also should have been given a pre-coloringroom treatment for decay control. This probably will be especially true in the 1949-50 shipping season when the effect of last winter's freeze is likely to be deflected by increased stem-end rot infections.

Under the present packing house procedure a pre-coloringroom fungicidal dip is an extra handling in an already complicated process of preparing fruit for market. However, the time may arrive when Rio Grande Valley shippers will be able to adopt the bulk method of handling fruit, as practiced extensively in Arizona. In the bulk method, details of which have been circulated in the Texas citrus district, a fungicidal dip can be readily applied during the movement of fruit from the unloading tank to the coloring room, without extra handling.

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The Citrus Fulgorid

George P. Wene

Texas Agricultural Experiment Station, Weslaco

Dr. Wene has worked on tobacco insect investigation in Virginia and on the control of potato insects in New York and since 1946 has been working on control of vegetable insects pertaining to vegetable crops as grown in the Lower Rio Grande Valley in particular.

The citrus fulgorid was first noticed by Paul Riherd in 1942. This insect was also noticed again in small numbers in few orchards scattered throughout the Valley during the spring of 1947 and again in the spring of 1948. In the spring of 1949 the citrus fulgorid was found in larger numbers than ever before in a large number of orchards throughout the Valley. As most of these orchards had suffered greatly from the January freeze, the growers were greatly concerned over these heavy infestations, especially those appearing on the new growth. Actually, there have been more requests for information about this insect than on all the other citrus insects.

Life History Notes. — The citrus fulgorid has been identified as oremsis pruinosa Say. The adult is a wedged shaped insect about 9 mm in length. The wing-covers are broad, truncated and held together in a vertical position. The body is light greyish-brown in color. The anterior portion of the wing is light greyish-brown in color with the posterior half being slightly darker. The adult stage is usually of short duration, appearing around the middle of May and lasts approximately 10 days.

The nymphal stage is passed in a white flocculent waxy-like material located on the underside of succulent leaves or on the terminals of branches as is shown in the picture. As many as 70 nymphs have been found on the terminal 2 inches of an infested twig. These fulgorids are often mistakenly identified by growers as either mealy bugs or cottony cushion scale. They are easily identified by the fact that when a pencil point is placed at the caudal end, the fulgorid jumps like a leaf hopper nymph. The young fulgorid is similar to a leaf hopper nymph in appearance and may attain a maximum size of approximately 12 mm in length. The nymph also secretes a honey dew which will in many cases drop on either the fruit or leaves below it. Heavy honey dew secretions on leaves and fruit were attacked by a sooty mold which gave leaves and fruit the same black, sooty appearance as that resulting from a severe cottony cushion scale infestation.

Very small fulgorid nymphs were found March 1, 1949, on young shoots or buds in a lime orchard which had been completely defoliated by the recent freeze. A survey conducted on March 15 showed that this insect was very abundant on the new shoots of all varieties of citrus. In the Mission area the fulgorid was found on the new succulent growth and also on the terminal twigs of trees which had not been injured much by the recent freeze.

A survey conducted on June 13 and 14, 1949, showed that 20 out of 50 orchards were infested with the fulgorid nymph.

Economic Importance. — Citrus orchards infested with the citrus fulgorid

during 1947 and 1948 were closely examined for insect injury. These infestations, which were light when compared with the 1949 infestation, did not affect the color of leaves and did not cause any fruit drop.

The citrus fulgorid did cause a considerable amount of injury in a lime orchard during the spring of 1949. This orchard had been completely defoliated by the January freeze. When the new buds were only a quarter of an inch or so in length, they became infested with two or three fulgorids whose feeding killed the buds in a short time. However, in many orchards the fulgorids did not appear until the succulent shoots were from 6 to 15 inches in length; and heavy infestations, such as 20 fulgorids per leaf, did not apparently affect leaf or shoot growth.

On April 26, 1949, two orchands in the Mission area which had a considerable amount of fruit drop were examined. It was noticed that all this fruit had dropped from terminal twigs having heavy fulgorid infestations. On June 13 and 14 of the same year 20 severely infested orchards were examined in order to determine whether fulgorids caused fruit dropping. The fulgorids had disappeared by this time but one could tell that these insects had been there by the white flucculent material still remaining on the terminal twigs. One hundred infested and non-infested terminal twigs were examined in each orchard. In this survey the presence of a fruit button was taken as indicating that a fruit had dropped recently. There was no drop of fruit from the non-infested twigs. The drop of fruit in relation to fulgorid infestations was as follows: 35 per cent or more of the fruit had dropped in three of the orchards; six of the orchards showed noticeable fruit drop, although less than 35 percent; while the infested twigs in the remaining orchard showed little or no fruit drop. Fruit drop in the orchards examined was probably due to a combination of two factors: 1) a weakening of the tree as a result of the recent freeze and, 2) unusually heavy fulgorid infestations.

Control Experiments — In experiment 1, the treatments, as shown in Table 1, were applied with rotary hand dusters. A single infestation on a tree was marked, and then the tree was dusted at the rate of 0.75 pound of insecticide per tree. Each treatment was replicated 4 times. Three days later the marked twigs were examined and the number of surviving nymphs on the terminal two inches of the twigs determined. As can be seen by the data in Table 1, ordinary dusting sulphur had no effect on the fulgorid population. A 1.0 percent parathion dust gave much better control than did either a 0.5 percent parathion dust or a dust mixture containing 5.0 percent DDT and 82 percent sulphur. Seven days later this orchard was airplane dusted with 1.0 percent parathion at 30 pounds per acre. The untreated trees of experiment 1 were examined three days after the airplane dusting. The data showed that the airplane dusting of 1.0 percent parathion had reduced the fulgorid population from 29.0 to 0.8 fulgorids per terminal two inches of twig.

In the second experiment the buffalo turbine was used in applying tetraethyl pyrophosphate both as a dust and as a spray. Five heavily infested twigs on each of 12 trees were marked. Then a group of four trees each received the treatments shown in Table 2. Two days later the marked twigs were examined for the number of surviving fulgoid nymphs. As can be seen by the data in Table 2, tetraethyl pyrophosphate applied as either a dust or a spray with the buffalo turbine was effective in controlling the citrus fulgorid.

Summary. – Heavy infestations of the citrus fulgorid were found in many of the orchards during the spring of 1949. Fulgorid infestations are characterized by the presence of a white flocculent waxy-like material on the terminals twigs and succulent growths. The nymphal state is passed in this waxy-like material.

The fulgorids were found destroying very small buds in a lime orchard which had been completely defoliated by the recent freeze. A considerable amount of fruit drop was notice in a few heavily infested fulgorid groves which had been injured by the recent freeze.

A 1.0 percent parathion dust applied with either a rotary hand duster or airplane gave good control of the citrus fulgorid. Tetraethyl pyrophosphate applied as either a dust or a spray with a buffalo turbine also gave good control.

Table 1. Effectiveness of various insecticides applied with rotary hand dusters in controlling the citrus fulgorid.

Treatments	Ave. No. fulgorids per terminal 2 inches of twig 3 days after dusting
Sulphur	30.0
5% DDT – 82% Slphur	4.8
0.5% Parathion	5.4
1.0% Parathion	0.4
Untreated	29.0

Table 2. Effectiveness of tetraethyl pyrophosphate applied with a buffalo turbine in controlling the citrus fulgorid.

Treatments	Ave. No. fulgorids per terminal 2 inches of twig 48 hours after treatment
Spray: 1 pint of 20% tetraethyl pyrophosphate in 10 gallons of water applied to 6 trees	0.1
Dust: 0.66% tetraethyl pyrophosphate applied at the rate of 1.0 lb. per tree	0.1
Untreated	7.0

Fulgorid infestation on terminal branch of grapefruit.

Developments In Citrus Blackfly Control

J. F. Cooper *and* C. C. Plummer, *U. S. D. A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine*

Mr. Cooper has been associated with the U.S.D.A. for 20 years in the Bureau of Entomology and Plant Quarantine. He first worked on Blackfly research in Key West in 1932 and was sent to Mexico two years ago on this problem with headquarters in Mexico City of the Division of Fruit Fly Investigations.

Dr. Plummer has spent 20 years in the Bureau of Entomology and Plant Quarantine of the U. S. D. A. at the Division of Fruit Fly Investigations headquarters in Mexico City in research work.

Development of any insect control presents 4 problems:—mortality of the insect, freedom of injury to the crop treated, safty to man and animals, and cost in keeping with returns on the crop. Due consideration has been given to each of these in investigations on the control of the citrus blackfly, *Aleurocanthus woglumi* Ashby.

Few studies had been made on the control of the citrus blackfly by means of insecticides previous to the invasion of Mexico by this pest. In Jamaica Ashby (1915) tried kerosene emulsion while Ritchie (1916) sprayed with Florida citrus scale emulsion prepared with parafin oil and whale-oil soap. Dietz and Zetek (1920) tried krosene emulsions and nicotine oleate for controling the insect in the Canal Zone. Bruner (1931) tested oil emulsions in Cuba at about the time the valuable parasite *Eretmocerus serius* Silv. was being introduced. Later the citrus blackfly was eradicated in Key West, Florida by repeated applications of oil sprays (Newell and Brown 1939).

Plummer and Shaw (1947) began their studies in Cuernavaca, Morelos, Mexico, early in 1945 by testing kerosene emulsion alone and also with DDT added. This led to the testing of refined spray oils of the kind commonly used to control various insects on citrus trees. It was not until derris extractives were mixed with spray oils by means of mutual solvents, as developed by Ebeling (1945), that improved toxicity was noted. Further research, also preceded by studies in California (Ebeling *et al.* 1944), led to the mixing of powdered derris root directly in the oil. Continued experimentation revealed that 1.67 per cent light-medium emulsive or soluble oil containing per gallon 4.5 ounces of powdered derris or cube root with a rotenone content of 5 per cent was very toxic to larvae and pupae of the citrus blackfly. Later unpublished studies by the same investigators showed that while eggs were not killed, a very high percentage of the larvae emerging from treated eggs failed to survive.

By April 1947 many of the newer insecticides had been studied. The cube in oil formula just discussed was the most promising from the standpoint of (1) toxicity, (2) cost, (3) freedom from harmful residues and (4) absence of danger to spray operators. It was therefore recommended to the Mexican authorities in April 1947 for the control of the citrus blackfly in Cd. Valles, San Luis Potosi. Shortly thereafter it was applied suc-

cessfully by Woglum (1948) to control the citrus blackfly in Empalme and Guaymas, Sonora. Subsequently, this formulation was applied extensively on citrus trees in many parts of Mexico.

DDT.—Studies on the toxicity of emulsions prepared with high concentrations of DDT in xylene and kerosene indicated that this preparation was not so effective as cube root in oil for killing pupae of the citrus blackfly (Plummer and Shaw 1947). Investigations on this compound were resumed early in February 1948 at Los Mochis, Sinaloa, in cooperation with the California-Arizona growers, and the United Sugar Companies. These studies emphasized the high residual value of a spray prepared with 2 pounds of DDT in 3 gallons of ordinary kerosene, 4 ounces of blood albumin spreader, and water to make 100 gallons when applied on orange and grapefruit trees at an opportune time of the year (Woglum, Plummer and Shaw 1949). At one time DDT appeared to be superior to the standard formulation of cube root in oil, probably because of its residual value. Studies in Cuautla, Morelos, however, showed that high concentrations of ordinary kerosene caused marginal blanching of the leaves. Similar damage was observed when a highly refined horticultural kerosene from California was substituted. Much research was done to find an emulsion of DDT that would not damage the trees. This led to studies on a formulation composed of 1.75 pounds of DDT dissolved in 2 quarts of xylene and 2 quarts of ordinary kerosene and mixed with water to make 100 gallons of emulsion using 4 ounces of blood albumin spreader for emulsification. One application of this insecticide was found to be very effective in controlling the citrus blacckfly when applied on sour lime trees in a small grove in Cuautla, Morelos, in the fall at the end of the rainy season, a time when there were few blackflies in the pupal stage. There was no apparent damage to trees when this formulation was applied 12 times on the same trees at intervals of one month between applications. Recent data have indicated that the toxicity of this formulation to pupae is not so high in the summer months as we would like to have it. Attempts are now being made to improve the formulation. Whether improved or not, it is believed that DDT in xylene and kerosene may find a place in citrus blackfly control practice; possibly in the winter months of the year. Kill of beneficial insects would also be minimized at that season.

A number of other formulations containing DDT and related compounds have been considered. Repeated experiments have shown that nothing is gained by adding DDT to spray oil. The oil carries the DDT into the leaves and there it remains. The para para isomer was also tested at the time injury to leaves by kerosene was under investigation and it showed no superiority ever technical DDT. TDE (DDD) was not so toxic as DDT. Difluoro DDT and methoxyolor will be tested in the near future.

Parathion.—Parathion in oil and water-dispersible preparations were tested in 1947 by workers of the United States Department of Agriculture and were found to be very toxic to the citrus blackfly. Shortly thereafter large plots at Los Mochis, Sinalon were sprayed once with 1 pound of wettable 25-percent parathion and 1 to 2 pints of an oil spreader per 100 gallons of water. The initial kill with this insecticide was much greater than the other 4 insecticides tested (Woglum *et al.* 1949). Subsequently 1 per cent and also 2 per cent of parathion dust were tested and found to be very toxic to larvae and pupae of the citrus blackfly under field conditions in Ticuman, Morelos (Plummer and Shaw 1949). Both 10 and 20 per cent DDT dust were tested at the same time and were found to be relatively ineffective in killing pupae. Reduced percentages of parathion dust are now being tested. Parathion is extremely poisonous to spray operators and its general use in the field is questionable at this writing.

Chlordane.—This was first tested as a substitute for rotenone in spray oil at the rate of 0.9 ounce of pure chlordane per gallon of oil and mixed with water at the rate of 1.67 per cent. It was relatively ineffective (Plummer and Shaw 1947). Chlordane at the rate of 1 pound in 0.6 quart of Velsicol AR-60, 11.4 quarts of kerosene, 4 ounces of blood albumin spreader and water to make 100 gallons was also ineffective (Woglum *et al.* 1949). A commercial preparation of chlordane in oil mixed with water at concentrations to give 0.25 and of 0.5 pound of actual chlordane, respectively, per 100 gallons also showed low toxicity. The conclusion was that chlordane did not offer much promise for the control of the citrus blackfly.

Toxaphene.—This is another product first tested in spray oil (Plummer and Shaw 1947). Later an experiment with 1 pound of toxaphene dissolved in 3 gallons of kerosene and mixed with 4 ounces of blood albumin spreader and water to make 100 gallons showed that only a few pupae were killed.

Benzene Hexachloride.—This was employed only in oil and was not very effective. Further studies are being pursued with water dispersible products.

Other Insecticides.—A considerable number of other insecticides and adjuvants have been tested and abandoned as being less toxic than those mentioned above, more dangerous to use, or too expensive for commercial use. These include numerous oils, emulsifiers, solvents, and water conditioners; commercial preparations of rotenone, nicotine, pyrethrum, piperonly cyclohexanone, and piperonyl butoxide. A few fungicides have also been tested in combination with insecticides.

Fumigation.—In Los Mochis, Sinaloa, a few grapefruit trees were fumigated using calcium cyanide and following standard commercial practice in California. A few pupae survived the standard dosage while none was found alive on trees fumigated with 1.25 times the standard dosage (Woglum *et al.* 1949).

Large Scale Field Studies.—An appropriation in early 1948 provided funds for conducting large scale spraying experiments in control of citrus blackfly in Mexico. The objective of this work was to establish the effectiveness of the sprays on large areas, the number of applications necessary and their timing, the methods of application, the effect the required number of applications may have on trees, the size of the area that has to be treated to effect control is areas of light infestation, and the thoroughness of spray coverage required. These tests were expected to serve also as demonstrations of the effectiveness of the con-

trol methods. One project headquarters was established at Guaymas, Sonora, for tests under conditions on the arid west coast and that second at Cd. Valles, San Luis Potosi, for tests under conditions in eastern Mexico which were more comparable to the Texas growing area.

The program at Guaymas followed up the work conducted from November 1947 to April 1948 by the California-Arizona citrus growers with the $25,000 fund set up by them and a contribution of 26,000 pesos ($5,360 U. S. cy.) by the Guaymas growers. An unusually severe drought in that area so weakened the trees that only two spray applications could be made during the year's operation, but that sufficed to reduce the population to a very low level so that the ground gained in the earlier program was held and some progress made in suppressing the infestation.

In March 1949, 8 trees were found lightly infested at Mayorena and 3 at Ortis, 10 and 24 miles, respectively, north of Empalme. All citrus trees in these two villages were sprayed 3 times at 30-day intervals with the cube in oil formula and then once with the DDT formula. No living citrus blackfly was found after the second spray application. Very thorough inspection of all citrus in these two villages in August and again in October did not disclose infestation. An inspection of all citrus in the Hermosille, Sonora, area in September and October failed to reveal citrus blackfly. A reinspection in Hermosillo on December 3 revealed one infested leaf. Steps were immediately taken to initiate a spray program to eliminate this infestation as was done at Ortz and Maytorena. Spraying in the Guaymas area, which was suspended in July owing to heat and drought, was resumed in October.

The program in the Valles area, where approximately 300,000 trees are infested, followed a somewhat different plan than that on the west coast. Available funds would not permit consideration of a general spray program. Six groves were therefore selected for carrying out the tests. Spraying began in October 1948 and 6 applications were made to 7,700 trees within one year. Half of the trees were limes and half were oranges. All trees were sprayed 4 times with cube and oil. After that half of the blocks were sprayed with cube and oil and half with the DDT formula. These blocks had practically no fruit production last year owing to the heavy infestations of citrus blackfly but all have fruit this season, although the crop is still below normal. The limes have not come back into production as well as have the oranges. Observations have shown, however, that trees have come back after one thorough application. Experiments, too, have indicated that two properly timed applications a year, in the absence of extensive drift, will give commercial control.

In a series of phytotoxicity tests the cube in oil formula was applied on 25-tree blocks of oranges 4 times at 20-day intervals, 7 times at 30-day intervals and 10 times at 40-day intervals before appreciable tree injury was noted. In a similar study of the DDT formula 14 applications were made at 20-day intervals before injury was noted. Chaff scale *Parlatoria pergandii* Comst.[1] developed on the DDT plots sprayed at 40, 50, 60 and 70-day intervals but the frequency of applications on the 20 and 30-day interval plots appeared to prevent scale development.

[1]Determined by R. S. Woglum.

The infestation of citrus blackfly was practically eliminated by 3 applications of DDT at 20, 30, or 40-day intervals when these began early in January.

The tests at Valles have added proof that both the cube in oil and the DDT fromulae are highly efficient for control of the citrus black fly when thoroughly applied with proper equipment. They have also shown that repeated applications can be made with safety to the trees. The two formulae can be alternated to avoid scale development with DDT. While additional studies are necessary, the formulae for both eradication of incipient infestations and commercial control of the citrus blackfly are available.

Summary.—Studies on the toxicity to the citrus blackfly of many present day insecticides have shown that three of them are more effective than the others. One of these, parathion, is highly toxic to man. The other two are as follows, the amounts being in water to make 100 gallons of emulsion: (1) 1.67 gallons of light-medium emulsive spray oil containing per gallon 4.5 ounces of cube root with a rotenone content of 5 per cent, and (2) 1.75 pounds of DDT, 2 quarts of xylene, 2 quarts of ordinary kerosene and 4 ounces of blood albumin spreader.

In the Guaymas-Empalme area two applications of the cube in oil formulation within one year reduced the blackfly infestation to a very low level. Three applications of this formula at 30-day intervals followed by one of the DDT-xylene-kerosene formula eradicated light blackfly infestations in two locations in Sonora. These results are in keeping with other exprıments that have indicated that two properly timed applications a year should give commercial control.

Studies on continued applications have resulted in trees in the Valles area coming again into production after 6 applications but trees have actually been brought back by one thorough application of either cube in oil or DDT in xylene and kerosene.

Cube in oil was applied 4 times at 20-day intervals, 7 times at 30-day intrvals and 10 times at 40-day intervals before appreciable injury to trees was observed. Fourteen applications of the DDT formulation were made at 20-day intervals before injury was noted. Scale developed on DDT plots sprayed at intervals of 40, 50, 60, and 70 days, respectively, but the frequency of application on plots treated at intervals of 20 or 30 days appeared to control infestation by scale insects.

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Control Of Vegetable Aphids In The Lower Rio Grande Valley

GEORGE P. WENE
Texas Agricultural Experiment Station, Weslaco

Dr. Wene has worked on tobacco insect investigation in Virginia and on the control of potato insects in New York and since 1946 has been working on control of vegetable insects pertaining to vegetable crops as grown in the Lower Rio Grande Valley in particular.

Aphid control has been considered one of the most critical problems in the production of vegetables in the Lower Rio Grande Valley. Such crops as turnips, radishes, lettuce, cabbage, cantaloupes, blackeye, peas and broccoli were often plowed under when found heavily infested with these insects. The threat of aphid infestations has discouraged attempts to increase crop yields by the application of fertilizers or other expensive cultural practices.

Good control of the cabbage aphid, *Brevicoryne brassicae* (L.), was obtained by Bronson and Hall (1946) in the laboratory with a 3 percent hexaethyl tetraphosphate dust and a finely atomized aqueous 2 percent hexaethyl tetraphosphate spray. Wene (1948) obtained good control of cabbage aphids infesting broccoli with a 5 percent hexaethyl tetraphosphate dust applied by helicopter at 40 pounds per acre. Bronson et al. (1949) in field tests found that a 5 percent hexaethyl tetraphosphate was superior to a 3 percent nicotine dust as a control for cabbage aphids. The same workers obtained better control with hexaethyl tetraphosphate as a spray, 1 part to 800 parts of water, than with nicotine used at the rate of 1 part to 400 parts of water. Hervey (1946) obtained good control of cabbage aphids with a 3 percent gamma benzene hexachloride dust applied at approximately 17 day intervals.

In controlling the melon aphid, *Aphis gossypii* Glov., on cucurbits, Wene (1948) found that O.5 and 1.0 percent parathion dusts were more effctive than either a 3 percent nicotine dust or a 1 percent Lindane dust. Wylie (1949) using sprays for the control of melon aphids on celery found than 1 pint concentrations of nicotine sulphate and Vapatone gave good control. He also found that benzene hexachloride applied at a rate of 4 pounds of 4 percent gamma benzene hexachloride dust per 100 gallons of water was erratic in controlling this aphid.

Harrison and Allen (1943) obtained good control of the turnip aphid, *Rhopalsiphum pseudobrassicae* (Davis), with 3 percent nicotine and 1 percent rotenone dusts. The nicotine dust was effective for only a short period after application whereas the rotenone dust gave good control for a period of one week. Hayslip (1948) in experiments on the control of turnip aphids on chinese cabbage showed that a 1 percent parathion dust and a 1.5 percent gamma benzene hexachloride dust were outstanding in controlling this insect. Wene (1949) obtained good control of turnip aphids with 1 percent concentrations of parathion and gamma benzene hexachloride. The data also showed that a 3 percent nicotine dust was not very effective in controlling turnip aphids during the regular turnip season because of the low temperatures.

This paper summarizes tests for the control of vegetable aphids during the 1948 and 1949 season. During this period emphasis was placed on the evaluation of recent aphicides applied with rotary hand dusters and commercially applicators, such as ground dusters and airplanes.

Cabbage Aphid, *Brevicoryne brassicae* (L.)

A 20-acre broccoli field was divided into 4 equal sections. Ten plants heavily infested with the cabbage aphid, *Brevicoryne brassicae* (L.), were marked. The following treatments were applied the next day: Section 1) an airplane application of 3 percent gamma benzene hexachloride dust at about 30 pounds per acre; Section 2) an aiplane application of 1 percent tetraethyl pyrophosphate dust at 30 pounds per acre, using a diluent knowns as "Phosphodust" and being applied nine hours after manufacturing; Section 3) an airplane spray application of one pint of 20 percent tetraethyl pyrophosphate in five gallons of water; Section 4) check, or untreated area.

The plants were examined 48 hours after treatment application. A heavily infested plant was one having 200 or more aphids. The insecticides were considered to be effective if the treatment application reduced the aphid population to 5 or less per plant. The results showed that 3 percent gamma benzene hexachloride dust controlled the aphids on 7 out of 10 plants. The 1 percent tetraethyl pyrophosphate killed all the aphids on the 10 marked plants. The tetraethyl pyrophosphate spray had no effect on the aphid population, and the untreated plants were as heavily infested as before. These data indicate that a 1 percent tetraethyl pyrophosphate dust is superior to both benzene hexachloride dust and the tetraethyl pyrophosphate spray as a control for the cabbage aphid.

Cowpea Aphid, *Aphis medicaginis* Koch

In this experiment the plots of young blackeye peas, infested with the cowpea aphid, *Aphis medicaginis* Koch, were 0.02 acre in size. The treatments, shown in Table 1, were applied with rotary hand dusters at approximately 20 pounds per acre, and replicated four times. Efficiency

TABLE I

Effectiveness of various insecticides in controlling the cowpea aphid, *Aphis medicaginis* Koch

Treatment	Average number aphids per terminal 2 inches of plant after 1 day	3 days
0.25% parathion	0.8	3.6
0.5% parathion	0.2	0.3
1% Lindane	7.1	11.0
3% nicotine	0.9	4.2
5% DDT	17.7	34.0
0.1% pyrethrins plus 1% DDT	17.6	38.8
Untreated	15.0	65.2

of the various insecticides was determined by selecting 10 plants at random in each plot and counting the surviving aphids on the terminal 2 inches of the plants 24 and 72 hours after dusting.

As shown by the data in Table 1, parathion, Lindane and nicotine dusts gave good aphid control immediately after application. Counts made 72 hours later indicated that the 0.5 percent parathion dust was the only material with a good residual effect.

Melon Aphid, *Aphis gossypii* Glov.

In the first experiment the 0.02 acre sized plots of young squash were infested with the melon aphid, *Aphis gossypii* Glov. The treatments, shown in Table 2, were applied with rotary hand dusters at approximately 20 pounds per acre, and replicated four times. The efficiency of the various insecticides was determined by selecting 10 squash leaves at random from each plot and counting the surviving aphids 1 and 4 days after application of the treatments.

The data in Table 2 show that parathion and Lindane dusts were superior to the 3 percent nicotine dust as a control for the melon aphid. These data also show that a 0.25 percent parathion dust gave better control of aphids than did the 1 percent Lindane dust.

In the second melon aphid experiment, 0.5 percent parathion and 3 percent nicotine were applied at approximately 20 pounds per acre by a tractor drawn duster to cucumber plots, one-half acre in size. The check or untreated areas, were similar in size. Each treatment was replicated three times. Five days after treatment applications, 10 leaves were selected at random from each plot and the surviving number of aphids counted. The aphid counts revealed the following results: the 0.5 percent parathion dusted plots had an average of 3.8 aphids per leaf; the 3 percent nicotine dusted plots had an average of 12.0 aphids per leaf; and the aphid population averaged 19.6 aphids per leaf in the untreated plots. These data also show that parathion is much more effective than nicotine in controlling the melon aphid.

In the third experiment, 0.25 and 0.5 percent parathion dusts were applied at approximately 25 pounds per acre by airplane to two acre blocks in an aphid infested squash field. The area between these two blocks was used in determining the population of an untreated plot. These airplane applications were applied at the same time the treatments

TABLE II

Effectiveness of various insecticides in controlling the melon aphid, *Aphis gossypii* Glov.

	Average number aphids per leaf after	
Treatment	1 day	4 days
0.25% parathion	1.1	7.0
0.5% parathion	0.8	6.4
1% Lindane	1.6	8.7
3% nicotine	4.6	28.2
Untreated	22.8	40.0

in the previously mentioned hand dusted plots were applied. Twenty four hours after treatment applications 20 leaves were selected at random from each plot and the surviving aphids counted. The results showed that the aphid population averaged 22.1 aphids per leaf on the 0.25 percent parathion dusted plots; the plot receiving the 0.5 percent parathion dust averaged 0.7 aphids per leaf, while the untreated, or check plot area, averaged 39.4 aphids per leaf. This indicates that parathion is an effective aphicide for airplane dusting operations.

An interesting point which is brought out in these melon aphid control experiments is that airplane dusting requires a higher percentage of parathion in the dust for effective aphid control than does a dust application with the conventional rotary hand duster.

Pea Aphid, *Macrosiphum pisi* (Kltb.)

Parathion and hexaethyl tetraphosphate were applied as a spray for the control of the pea aphid, *Macrosiphum pisi* (Kltb). The treatments shown in table 3, were applied with an eight row crop spray machine at the rate of 80 gallons per acre. The plots were an acre in size and each treatment was replicated three times. The effectiveness of the various treatments was determined by counting the number of surviving aphids on the terminal 2 inches of 10 plants selected at random in each plot.

As shown in Table 3, both materials gave good control 2 days after treatment applications. Data taken 9 days after treatment applications showed that the parathion spray still gave good control, whereas the hexaethyl tetraphosphate had lost its residual effectiveness. The parathion sprays were still showing good residual control 2 weeks after treatment applications; however, since the experiment was conducted during the coolest part of the growing season, the reliability of the data may be questioned.

Red Lettuce Aphid, *Macrosiphum ambrosiae* Thomas

In the first experiment, an 8-acre section of a 10-acre lettuce field infested with the red lettuce aphid, *Macrosiphum ambrosiae* Thomas, was airplane sprayed with 50 percent hexaethyl tetraphosphate at the rate of 1.5 pints in 6 gallons of water per acre. Two days later 50 lettuce leaves were pulled at random from both treated and untreated portions of the field and the aphid populations determined. These counts showed an average of 2.0 aphids per leaf on the untreated area while the sprayed section only averaged 0.2 aphids per leaf, which is a 90 percent reduction.

TABLE III

Control of the pea aphid, *Macrosiphum pisi* (Kltb.)

	Average number aphids per leaf after		
Amount of insecticide per 100 gallons of water	2 days	9 days	14 days
1 lb. 25% parathion	0.5	.05	6.3
1.5 lb. 25% Parathion	0.1	0.3	10.3
0.7 qt. 50% H.E.T.P.	10.3	38.3	91.0
Untreated	54.4	95.8	135.8

In the second experiment, a 10-acre section of a 12-acre field was sprayed with hexaethyl tetraphosphate at the same rate as in the first experiment. Data was taken 48 hours after treatment in the same manner as in the first experiment. The untreated portion of the field averaged 7.1 aphids per leaf, whereas the population of the treated plants averaged 0.4 aphids per leaf, which is approximately a 99 percent reduction. These results indicate that airplane spraying with hexaethyl tetraphosphate may be a means of controlling aphids on lettuce that was not formerly available to growers.

Turnip Aphid *Rhopalosiphum pseudobrassicae* (Davis)

The first experiment was conducted in a field of radishes infested with the turnip aphid, *Rhopalosiphum pseudobrassicae* (Davis). The radishes had been sown in rows spaced about 4 inches apart. The plots were 0.02 acre in size. The treatments shown in Table 4, were applied with rotary hand dusters at approximately 30 pounds per acre. Each treatment was replicated 4 times. The efficiency of the insecticides in controlling this aphid was determined by selecting 10 plants at random from each plot and counting the surviving aphids.

The data in Table 4 show that 1 percent concentrations of parathion and gamma benzene hexachloride were more effective in controlling aphids on radishes than the same concentration of rotenone 24 hours

TABLE 4

Effectiveness of various materials in controlling the turnip aphid *Rhopalosiphum pseudobrassicae* (Davis)

Treatment	Average number aphids per plant after 1 day	7 days
1% parathion	0.1	9.1
1% gamma benzene hexachloride	1.9	14.4
1% rotenone	15.1	4.4
0.5% rotenone plus 3% lethane	17.2	75.9
0.1% pyrethrins plus 1% DDT	15.1	90.6
3% nicotine	18.3	73.9
Untreated	46.8	76.8

TABLE V

Effectiveness of various insecticides in controlling the turnip aphid, *Rhopalosiphum pseudobrassicae* (Davis), on mustard greens

Treatment	Average number aphids per leaf after 1 day	6 days
1% parathion	0.0	18.2
1% gamma benzene hexachloride	0.5	25.4
1% rotenone	43.2	9.8
0.1% pyrethrins plus 1% DDT	81.3	85.1
3% nicotine	32.2	79.2
Untreated	83.3	98.2

after application. Data taken one week after treatment application show that the 1 percent rotenone dust was superior to the same concentration of parathion or gamma benzene hexachloride. The 3 percent nicotine dust gave a good reduction of the aphid population immediately after treatment applications but had no residual effect. Substituting 3 percent Lethane for half of the rotenone in the dust mixture proved to be of little value as can be seen by the data taken 7 days after treatment applications.

The second turnip aphid control experiment was conducted in a field of small mustard greens sown in double rows spaced 3 feet apart. The plots were one-sixtieth of an acre in size. The treatments shown in Table 5, were applied with rotary hand dusters at approximately 20 pounds per acre. Each treatment was replicated 4 times. Efficiency of the various materials was determined by selecting 10 leaves at random from each plot and counting the surviving aphids.

The result of this experiment was similar to that of the first. One percent concentrations of parathion and gamma benzene haxachloride were more effective than the same concentration of rotenone immediately after treatment application. However, as shown by the data in Table 5, the rotenone was more effective 6 days after treatment application. The data from these two experiments warrant further work as rotenone is non-toxic to warm-blooded animals.

The third experiment was conducted in a young cabbage field infested with the turnip aphid, *Rhopalosiphum pseudobrassicae* (Davis). An 8-acre section of a 20-acre field was airplane sprayed with 50 percent hexaethyl tetraphosphate at the rate of 1 pint in 66 gallons of water per acre. An hour before and 24 hours after the spray application, 30 plants were selected at random from both the treated and untreated portions of the field and the aphid population per plant determined. The untreated plants averaged 2.5 aphids before and 2.8 aphids after spraying. The treated plants averaged 9.3 aphids per plant before the spray application and only 1.9 aphids after the spray application.

Summary

A 1 percent tetraethyl pyrophosphate dust was superior to both a 3 percent benzene hexachloride dust and tetraethyl pyrophosphate spray as a control for the cabbage aphid. A 0.5 percent parathion dust, a 1 percent Lindane dust and a 3 percent nicotine dust gave good control of the cowpea aphid immediately after application, but the data indicated that the parathion dust had the best residual effect. In small plot work, 0.25 and 0.5 percent parathion and 1 percent Lindane dusts were effective in controlling the melon aphid on squash. Both hexaethyl tetraphosphate and parathion sprays were effective in controlling the pea aphid. The red lettuce aphid was effectively controlled with hexaethyl tetraphosphate applied at the rate of 1.5 pints per acre by airplane. One percent concentrations of rotenone, parathion, and gamma benzene hexachloride were effective in controlling the turnip aphid.

Since the organic phosphates, parathion, hexaethyl tetraphosphate, and tetraethyl pyrophosphate are very toxic to warm-blooded animals,

the Te..as Agricultural Experiment Station is not recommending these materials for use in controlling aphids until more is known about the dangers inherent in using such materials.

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Insects And Disease Control For Vegetable Crops In The Lower Rio Grande Valley (1949-50)

by

Herman S. Mayeux, Associate County Agent—Entomology, Lower Rio Grande Valley
George P. Wene, Entomologist, Valley Experiment Station
G. H. Godfrey, Plant Pathologist, Valley Experiment Station

Mr. Mayeux is interested in economic entomology and at present is doing educational work with Valley farmers on insect control problems. He came to the Valley about a year ago from Louisiana where he was Extension Entomologist, Louisiana State University, Agricultural Extension Service.

Dr. Wene has worked on tobacco insect investigation in Virginia and on the control of potato insects in New York and since 1946 has been working on control of vegetable insects pertaining to vegetable crops as grown in the Lower Rio Grande Valley in particular.

Dr. Godfrey has been Plant Pathologist at the Valley experiment Station at Weslaco since 1937. He was previously associated with Oregon State College, U.S.D.A., the Bayer Co., and the Hawaiian Pineapple Canners in Hawaii. His work has been in the fields of nematode diseases of plants, seed and soil disinfectants, and vegetable, cotton and citrus Pathology. He also collaborated in a sulphur problem under a program supported by the Texas Gulf Sulphur Company.

The following recommendations for the chemical control of insects and diseases destructive to vegetable crops in the Lower Rio Grande Valley are based upon the best information available from research, county agents, growers and insecticide agencies.

Correct identification of the insect or disease is necessary before control measures are used. For additional information and for identification of insects and diseases see your county agent at Edinburg, Raymondville or San Benito.

ALL TREATMENTS ARE DUSTS UNLESS OTHERWISE NOTED

VEGETABLES (In Alphabetical Order)	INSECTS	TREATMENT	NOTES
Beans Snap and Lima	Aphids	Spray: 1 pt. 20% Lindane or 1 pt. 20% TEPP concentrate per acre or Dust: 3% nicotine.	Spray several times at 5 to 7 day intervals beginning when aphids first appear. Use new low volume sprayers on tractor or airplane at 2 to 5 gals. of water per acre. See TEPP in remarks below.
	Flea beetles & Leafhoppers	5% DDT *	Less than one beetle per plant can ruin the stand of seedlings. Examine crop often. Protect new growth as needed. Look for movement into field from outside. Leafhoppers suck leaves and stems with piercing mouthparts. Dilute 1 qt. of 25% DDT emulsifiable concentrate with 2 to 5 gals. of water per acre when using new low-volume sprayers on tractor or airplanes.

* OR spray with 1 qt. 25% DDT emulsifiable concentrate per acre.

VEGETABLES	INSECTS	TREATMENT	NOTES
Beans Snap and Lima	Thrips	5% Chlordane	May attack seedlings and older beans. Repeat as needed. Flea beetle and leafhopper control will usually control thrips also. Do not use within 10 days of harvest.
	Corn earworm	5% DDT—50% sulphur	The earworm and some other caterpillars and beetles feed upon leaves. Avoid using DDT within 10 days of harvest.
	Rust	Sulphur (325) mesh)	Use 1 to 3 weekly applications beginning when rust appears, often before blooming.
Beets	Beet webworm Flea beetles	5% DDT-50% sulphur 5% DDT	Both insects attack young plants. Fewer than one per plant often ruin the stand of seedlings. Examine crop often and protect new growth if needed. Watch for movement of beetles into field from outside.
Broccoli	Aphids	Spray: 1 pt. 20% Lindane or 1 pt. 20%, TEPP concentrate per acre	Spray several times at 5 to 7 day intervals beginning when aphids first appear. Use new low volume sprayers on tractor airplane at 2 to 5 gals. per acre. Do not use Lindane nearer than 10 to 14 days to harvest. See TEPP remarks below.
	Cabbage webworm	5% DDT-50% sulphur	When needed. Do not use DDT nearer to harvest than 10 to 14 days.
	Hornworm	5% Chlordane or 5% Rhothane	When needed in seedbeds.
	Cabbage worms	5% DDT	Every 7 to 10 days if needed. Do not use DDT nearer to harvest than 10 to 14 days.
	Southern cabbage worms	1% Lindane Dust	When needed. Lindane (purified gamma isomer of BHC) should not be used nearer to harvest than 10 to 14 days.

VEGETABLES	INSECTS	TREATMENT	NOTES
Brocolli	Downy mildew Black spot	*See cabbage (below)* *See cabbage (below)*	
Cabbage	Aphids	Spray: 1 pt. 20% Lindane or 1 pt. 20%, TEPP concentrate per acre or Dust: 3% (gamma) BHC	See aphids under Broccoli (above). Do not use BHC or Lindane nearer to harvest than 10 to 14 days. See TEPP remarks below.
	Cabbage worms	5% DDT or Spray: 1 qt. 25% DDT concentrate per acre	Every 7 to 10 days if needed. Do not use DDT nearer to harvest than 10 to 14 days. Dilute 1 qt. of 25% emulsifiable concentrate with 2 to 5 gals. of water per acre when using new low-volume sprayers on tractors or airplanes.
	Southern cabbage worms	3% (gamma) BHC	Do not use BHC nearer than 10 to 14 days to harvest.
	Thrips	5% DDT-1% (gamma) BHC	Make several applications at 7 to 10 days intervals.
	Cabbage webworm	5% DDT-50% sulphur	When needed.
	Downy mildew and Black spot	5% insoluble copper expressed as metallic or 10% Dithane Z-78 or 10% Parzate	Control downy mildew in seed-beds. Repeat in field if spots appear on wrapper leaves. Use three or more weekly applications if black spot appears.
	Black rot	Soak: 1 grain tablet bichloride of mercury in 1 pt. water or 1 oz. in 7½ gals. water	Soak seed 20 minutes, rinse, dry surface of seed, and plant.

VEGETABLES	INSECTS	TREATMENT	NOTES
Cantaloupes	Darkling beetles	5% Chlordane	As needed on seedlings.
	Aphids or Thrips	1% Lindane Dust or Spray: 1 pt. 20% Lindane or 1 pt. 20%, TEPP concentrate per acre	LINDANE is the purified gamma isomer of BHC. Do not use nearer than 10 days to harvest. Use Lindane emulsifiable concentrate in new low-volume sprayers on tractors or airplanes in 2 to 5 gals. water per acre. See TEPP in remarks below.
	Melon worms	40% Cryolite or 5% Methoxychlor	Begin dusting at 7 day intervals when injury first appears.
	Cucumber beetles	40% Cryolite or 5% Methoxychlor	When needed. Methoxychlor is similar to DDT but has not injured cucurbits.
	Downy mildew	10% Zerlate or 10% Dithane Z-78 or 10% Parzate	Use weekly if mildew is present.
	Beetles, melonworms, and downy mildew	40% Cryolite or 5% Methoxychlor with one of the fungicides listed above for mildew	A mixture which will control diseases and most insects is usually best. Lindane may be added to the methoxychlor for aphid control.
Carrots	Flea beetles	5% DDT or Spray: 1 qt. 25% DDT concentrate per acre	Less than one beetle per plant can ruin the stand of seedlings. Protect new growth as needed and watch for movement of beetles from outside the field. Dilute 1 qt. of 25% DDT emulsifiable concentrate with 2 to 5 gals. water per acre when using new low-volume sprayers on tractors or airplanes.
	Beet webworm	5% DDT 50% sulphur	When needed on seedling beets.

VEGETABLES	INSECTS	TREATMENT	NOTES
Carrots	Leaf blight	Spray: 5-3-50 Bordeaux or Dust: 5% basic copper or organic fungicides	At first appearance and every 10 days as needed. Use dusts when leaves are damp. Include sticker in dust.
Cauliflower	*See broccoli above*		
	Sooty mold	Control Aphids	(See broccoli above)
Celery	Leaf spot	10% Dithane Z 78 or 10% Parzate	Apply weekly as needed.
Cucumbers	*See cantaloupes above*		
Eggplant	Yellows (virus disease)	Sulphur dust or 5% DDT-50% sulphur	Dust seed-beds weekly. Repeat applications after transplanting.
	Flea beetles	5% DDT or Spray: 1 qt. 25% DDT concentrate per acre	A few beetles can ruin a stand of seedlings. Dilute 1 qt. of 25% DDT emulsifiable concentrate with 2 to 5 gals. water per acre, when using new low-volume sprayers on tractors or airplanes.
	Hornworms	5% Chlordane 5% Rhothane	When needed. Do not use chlordane near than 10 days of harvest.
	Leaf and fruit spots	5% insoluble copper or organic fungicides	Apply weekly if diseases are present.

VEGETABLES	INSECTS	TREATMENT	NOTES
Lettuce	Aphids	Spray: 1 pt. 20% Lindane or 1 pt. 20%, TEPP concentrate per acre or Dust: 0.1% impregnated pyrethrins with 1% DDT	The red lettuce aphid is often incorrectly called a "red spider". It must be controlled before heading. Shippers often cull entire fields or heads that have red aphids. Airplane dusters and ground machines with less than two nozzles per row, are general unsatisfactory. Spray or dust several times at 5 to 7 day intervals beginning when aphids first appear. Use Lindane in new low-volume sprayers on tractors or airplanes at 2 to 5 gals. water per acre. Do not use Lindane within 10 to 14 days of harvest.
	Loopers and beetles	5% DDT	When needed. Dusters with 2 or 3 nozzels per row are superior to single nozzle machines. Do not use DDT within 10 days of harvest.
Mustard	Aphids, worms, and beetles	1% Rotenone	Rotenone may be used just before harvesting without danger to the consumer. Begin dusting every 5 to 7 days when aphids first appear. Several applications are necessary. Use dusters having 2 or 3 nozzels per row. Less than one aphid per plant often ruin the stand of seedlings.
	Loopers	5% DDT	Do not use DDT within 10 to 14 days of harvest. Aphids may increase following DDT.
Okra	Aphids	Spray: 1 pt. 20% Lindane or 1 pt. 20%, TEPP concentrate per acre.	Spray several times at 7 day intervals using new low-volume sprayers on tractors or airplanes beginning when aphids first appear. Mix the Lindane into 2 to 5 gals. water per acre. Do not use Lindane nearer than 10 to 14 days to harvest. See TEPP in remarks below.
	Corn earworm	5% DDT	Do not use DDT within 10 to 14 days of harvest.

VEGETABLES	INSECTS	TREATMENT	NOTES
Peppers	Flea beetles and cucumber beetles	5% DDT	Less than one beetle per plant can ruin a stand of seedling peppers or seriously damage older plants. Protect new growth as needed and watch for move- of beetles form outside the field.
	Darkling beetle	5% Chlordane	Injury is similar to cutworm damage, especially to seedling plants.
	Weevil and fruitworm	1% (gamma) BHC-5% DDT	Use the first application when fruit begins setting. Dust at least 3 times at 7 day intervals for initial weevil control. Repeat later if needed. DDT is needed for fruitworm control. Do not use this dust within 10 to 14 days of harvest. Add fungicide for disease control.
	Leaf miner	5% Chlordane	Use every 7 days as needed beginning when mines first appear in the leaves.
	Hornworm	5% Chlordane	Do not use Chlordane within 10 to 14 days of harvest.
	Leaf and stem blight and bacterial spot	Any fungicidal dust	Weekly if needed until dry weather. Combine with insecticidal dusts.
Potatoes (Irish)	Thrips	5% Chlordane	One or more applications when needed.
	Blights (early and late)	Spray: 2 qts. either liquid Dithane or Parzate and 1 lb. zinc sulphate per 100 gals. Dusts: 10% Dithane Z-78 or 10% Parzate or 5% copper	Weekly and after each rain. Begin when blight is *first reported in the Valley area.*

VEGETABLES	INSECTS	TREATMENT	NOTES
Onions	Thrips	1% (gamma) BHC-5% DDT or Spray: 1 qt. 25% DDT concentrate per acre	Weekly applications beginning when 5 thrips are found per plant (January-early February). Most farmers start too late. Badly damaged onions can seldom be "brought back" to make a good crop.
	Leaf blight	Spray: 2 qts. either liquid Dithane or Parzate and 1 lb. zinc sulphate per 100 gals. water or 10% Dithane Z-78 or 10% Parzate dusts with sticker	Apply weekly after first lesions appear. Combine with insecticide for thrips control. Add 3 lbs. 50% DDT wettable powder to Dithane or Parzate sprays for thrips. Apply dusts to moist leaves. Low-volume sprayers are not satisfactory for disease control.
Peas English	Aphids	Spray: 1 pt. 20% Lindane or 1 pt. 20%, concentrate per acre	Spray several times at 7 day intervals using the new low-volume sprayers on tractors or airplanes beginning when aphids first appear. Mix Lindane into 2 to 5 gals. of water per acre. Do not use Lindane within 10 to 14 days of harvest. See TEPP in remarks.
	Thrips	5% Chlordane-50% sulphur	Two or more weekly applications.
	Cabbage worms	5% DDT-50% sulphur	When needed, usually on seedling peas.
	Powdery mildew	Sulphur (325 mesh)	Every 7 days if mildew is present.
Black-eye or Cowpeas	Aphids	1% Lindane Dust	Begin dusting every 7 days when aphids first appear. Dusters with 2 or 3 nozzles per row are superior to the single nozzle types.
	Curculio	5% DDT-50% sulphur	The adult weevil must be killed before it lays eggs in the pods. Dust once when pods are about 1 inch long. Repeat after 7 days. A single dusting is of little value.
	Rust	Sulphur (325 mesh)	Make 1 to 3 weekly applications before blooming if needed. Follow with curculio treatment.

VEGETABLES	INSECTS	TREATMENT	NOTES
Radishes	Aphids	3% (gamma) BHC dust or 1 pt. 20% TEPP per acre	Best results obtained with dusts using 2 or 3 nozzles per row. Dust several time at 5 to 7 day intervals beginning when aphids first appear. Do not use BHC within 10 to 14 days of harvest. See TEPP in remarks.
	Worms and beetles	5% DDT	When needed. Do not use DDT within 10 to 14 days of harvest.
Spinach	Flea beetles and worms	5% DDT	A few flea beetles and worms can ruin the stand of seedlings or the quality of older spinach. Do not use DDT within 10 to 14 days of harvest.
	White rust and Blue mold	Fungicidal dusts	There is no really good control known. Fungicidal dusts offer some promise if used at first appearance of the diseases.
Squash	*See Cantaloupes above*		Weekly if needed. Use when leaves are dry. Sulphur is not safe on other cucurbits.
	Powdery mildew	Sulphur (325 mesh)	
Sweet Corn	Corn earworm	Obtain special leaflet	
	Flea beetles	5% DDT	When needed on young plants.
	Bud worms	Spray: 2 qts. 25% DDT concentrate per acre	*Dusts are not effective.* The low-volume sprayers on tractors are satisfactory when used every 5 to 7 days with at least ten gals. of water per acre.
Tomatoes	Fruitworm	5% DDT or 5% Rhothane	Dust 3 times at 7 day intervals beginning when fruit begins to set. Examine buds for small worms and eggs and continue if necessary.

VEGETABLES	INSECTS	TREATMENT	NOTES
Tomatoes	Flea beetles and Darkling beetles	5% Chlordane	Less than one flea beetle per plant can ruin a stand of seedling tomatoes or damage older plants. Darkling beetles cut plants off above ground level similar to cutworm damage.
	Garden fleahopper	0.1 impregnated pyrethrins with 50% sulphur	When needed. Usually severe on old fall tomato crop.
	Hornworms	5% Chlordane or 5% Rhothane	When needed. Do not use Chlordane within 10 to 14 days of harvest.
	Blossom Thrips	5% DDT	Use when there is certainty that thrips are the cause of blossom fall.
	Suckfly	5% Chlordane or 5% Methoxychlor on young plants, 5% DDT-75% sulphur or 5% Methoxychlor on old plants	Use heavy applications (30 to 40 lbs. per acre) every 7 days when needed.
	Blights and grey leaf spot	10% Dithane Z-78 or 10% Parzate or 5% insoluble copper	Early seed-bed treatment if leaf spot is present followed by 3 to 5 applications in field at 7 day intervals. See remarks on blight under 'Potatoes" above.
Turnips	See Mustard (above)		
Watermelons	See Cantaloupes (above)		

VEGETABLES	INSECTS	TREATMENT	NOTES
Any Vegetable	Cutworms	40% Cryolite in citrus meal	Dust or sprinkle upon ground around plants. Use heavy poundages.
	Fall armyworm	5% DDT	When needed except upon cucurbits. Do not use DDT within 10 to 14 days of harvest upon crops that are to be eaten.
	Darkling beetles	5% Chlordane	Destructive to seedlings.
	Grasshoppers	10% Chlordane	Do not use Chlordane within 10 to 14 days of harvest upon crops to be eaten.
	Ants	5% Chlordane	Do not use Chlordane within 10 to 14 days of harvest upon crops to be eaten.

All of the poisons listed above are dusts unless otherwise indicated.

SEE REMARKS ON FOLLOWING PAGES

REMARKS

APPLICATION OF INSECTICIDES:

DO THE JOB RIGHT OR NOT AT ALL!

Pounds of dust: Use a minimum of 20 pounds of dust per acre with a ground machine or hand duster. Airplane dusting requires at least 30 pounds per acre for the best results. Use 40 pounds on rank vegetation such as large potato and tomato plants.

Ground Operated Dusters: Valley farmers, when buying tractor dusters, should obtain those especially designed for vegetable crops having powerful air blowers and two or three nozzles are beneficial, especially for disease control.

Rotary hand-dusters are very useful in small plots and on areas which cannot be covered properly by airplane dusters. Run hand dusters so that each row is dusted from both sides.

Airplane Dusting: The lack of cooperation between the grower and the duster pilot is the cause of most failures to obtain good control by airplane dusting. The width of swaths should not be wider than the wingspread of the airplane. Pilots cannot accurately estimate swath widths, and need ground help for best results. Use flagmen to mark each swath for the duster pilot. Place one flagman at each side of the field. Have them hold up white panels about 3 feet square, which the pilot can see. The pilot can then line up the two flagmen and fly a swath between them. As soon as the plane passes overhead, the flagmen should move over the desired number of rows or paces to mark the next swath. Remember that the drift will be blown back over the area already dusted.

Airplane dusting has failed in the control of aphids on cauliflower, broccoli, turnips, lettuce and some other low-growing leafy crops.

Sprays: Low volume, low pressure sprays of emulsifiable concentrates applied by ground machines and airplanes at 5 gallons (or less) of water per acre are in the experimental and field trial stage at this time. They show great promise for insect control, but not for disease control. Where the full recommended rates per acre of active ingredients are applied with good uniform coverage, results may usually be satisfactory, if the concentrates used are not injurious to the plants.

INSECTICIDAL POISONS: CAUTION!

Parathion, TEPP (tetraethyl-pyrophosphate) and HETP (hexethyl-tetraphosphate):

The poisons are extremely dangerous to handlers. Very small amounts cause illness or death. Workers may obtain fatal doses through contact with the skin, by breathing vapors or drift, and accidentally by way of the mouth (for example, by smoking). Parathion has caused several deaths to handlers outside the Valley. Several Valley people have been made ill. Parathion has caused illness to harvester crews at work in crops treated at least 12 days previously. It is absorbed by plant fissues and may be dangerous to the consumer. Parathion is not recommended for use as an insecticide.

The following precautions regarding phosphate compounds must be observed but may be inadequate to prevent illness or death. Do not breathe dust or mist or enter drift; wear Bureau of Mines approved respirators; have shirt sleeves rolled down; change clothes and bathe immediately after finishing work. Follow all precautions printed on container labels. Do not use parathion within 21 days of harvest.

DDT: ***It is toxic to warm blooded animals*** and should not be used on crops, that are to be eaten nearer than 10 to 14 days before harvest. It is a slow acting poison and takes about 48 to 72 hours to kill most of the insects which it will control. It will usually kill insects in the field for about 7 days. DDT may stunt the growth of young cucurbits.

Methoxychlor and *Rothane*: These two new chemicals are similar to DDT and kill many of the insects that DDT controls. They are less toxic to humans and their use is encouraged, especially near harvest time.

BHC: Benzene hexachloride (BHC) severely burns all cucurbits and sometimes burns young snap beans. It may give an ***objectionable odor or taste***, to sweet corn, potatoes, English peas, black-eye peas, beans and tomatoes. It probably will not affect the flavor of cabbage, onions, carrots, and peppers. *Many canneries will not buy produce known to have been dusted with BHC.* Do not use nearer than 10 to 14 days of harvest.

Lindane: Pure gamma isomer of benzene hexachloride has not injured cucurbits and may not produce an objectionable odor or taste when used on vegetables. This material is expensive. Do not use nearer than 10 to 14 days of harvest on crops to be eaten.

Chlordane: Do not use nearer than 10 to 14 days of harvest on crops to be eaten.

Rotenone: This chemical is the active ingredient in the ground roots of cube and derris plants. It does not leave residues dangerous to the consumer and can be used effectively and safely for turnip aphids, beetles and worms on many crops only a few days before harvest.

Sulphur: Insecticides containing sulphur should not be used for the control of insects on cucumbers, cantaloupes, and watermelons and young tomatoes since plant injury may result from its use.

Nicotine: **Dusts containing nicotine are very effective against aphids if applied when the temperature is above 72 degrees and when the air is calm. Nicotine will kill for only a few hours and must be brought in contact with the aphids. Avoid breathing dust drift and avoid contact with the skin.**

Seed Certification

R. V. Miller

State Department of Agriculture, Austin, Texas

Mr. Miller is in charge of administering the Field Seed Certification Program in the State of Texas. His main interest is crop improvement and seed certification. Mr. Miller has been working on seed certification for the past 26 years and is at present a member of the State Seed and Plant Board, Texas Seed Council, associate member of the International Crop Improvement Association, and Secretary-Treasurer of Texas Certified Hybrid Seed Corn Association.

I was somewhat reluctant to accept a place on this program since it seemed more concerned with fruits and vegetables than field seed. I wrote Mr. Baxter along this line pointing out this fact and suggesting that Seed Certification as such might not be of interest to the group. However, he assured me that the group would be interested as the Horticultural Club was endeavoring to enlarge the scope of the activities of the Institute and discussions of allied interests pertaining to agriculture would be a definite part of the program, so with this bit of encouragement from him, together with my enthusiasm for talking "Certified Seed", I am with you today.

Seed Certification in Texas dates back to 1924 and has a long and interesting history which we will not give in detail, but merely point out that the Legislature passed the original law in 1923 which applied only to cottonseed. This law was amended in 1929 extending the authority to provide standards for the Certification of all field crops. Several minor amendments followed, but the law is basically the same as passed in 1923. It is interesting to note that of the 18 original seed producers as appeared on the first list in 1924, 10 are still producing Registered and Certified seeds—26 years later.

I wonder if we fully realize the magnitude of the seed business in Texas. When we pause to think of the vast number of acres planted each fall and spring in this State, an amazing figure of acres, bushels, pounds, and dollars appear, and when we consider that each year seed must be available for seven million acres of wheat——one and one-half million acres of oats, barley, and rye——one-fourth million acres of flax——ten million acres of cotton——three and one-half million acres of sorghums——two and one-half million acres of corn—one-half million acres each of rice and peanuts—plus several million acres in grasses, legumes, vegetables, and miscellaneous crops, we can begin to appreciate the scope, value, and importance of the seed industry.

It is the seed breader and grower and the seed dealer's responsibility to furnish the farmer the seeds to plant their acreages and farm prosperity may be measured in terms of the quality of the seed he secures together with his intelligent application of sound farming practices, but we hold to the premise that the use of quality seed is basic to successful farming. Hence the Dealer, Breeder, and Grower's responsibility cannot be considered lightly. His part in our agricultural economy is vital.

The overall value of the seed which the farmer puts in the ground each year runs into many million dollars. In supplying this demand there seems to be three specific sources: first, seed which the farmer saves himself for his own planting, breeders and growers stocks of Registered and Certified seed and seed both Certified and non-Certified supplied by the seed dealers throughout this and other states. This latter group, by far, supplies the major portion of the seed which are used.

The amount of Registered and Certified seed while occupying an important position in the overall picture, actually furnishes a rather small proportion of the seed used each season, yet the retail value of Registered and Certified seed produced in 1949 exceeds $6,000,000. The availability of Registered and Certified seed with reference to the normal requirements for planting might be shown in the two extremes. In the case of wheat, of about seven million acres planted this year, only sufficient Certified seed were available to plant approximately 10% of this acreage. In the case of Hybrid Corn, the other extreme, Certified seed were available to plant 65% of the acreage; in Sorghums about 55%, and the figures for the other crops would fall well above the wheat percentage but below the figures given for Corn and Sorghum.

I often wonder if the farmer or seed buyer, when purchasing a sack of seed, is aware of the tremendous amount of work and care that has been done in his behalf in the matter of breeding, growing, testing, and selection of the particular lot of seed which he secures. Perhaps he merely accepts this as a matter of fact, or maybe he is aware that quality seed do not "just happen", but result from carefully planned and well executed seed production projects. Selection of foundation stocks through a knowledge of the pedigree and performance, planting, growing, harvesting, storing and processing in accordance with recognized standards. After the seed are harvested and in the "Bag" it is difficult if not impossible to determine varieties or varietal purity by casually examining a handfull of seed, hence the importance of knowing what is "behind" a sack of seed, and this information is best determined through actual inspection of the growing crop which is emphasized in all seed certification programs.

The basic principles of pure seed production are substantially the same for all crops, however an intimate knowledge of the habits of particular crops, is essential so that the requirements for pure seed production may be prepared in detail and embody any special requirements peculiar to the crop in question.

Since the subject of my remarks is Certified Seed we might leave the overall picture and discuss briefly with this group some of the salient features of seed certification or crop improvement work.

Some 38 states in the United States have seed certification programs or possibily better designated as Crop Improvement Associations. These 38 states along with two Canadian provinces form the International Crop Improvement Association and much has been accomplished by this organization in solving mutual problems, providing recommended minimum standards for various crops, suggesting a system of Inter-State Certification, Seed Dealer cooperation, and in bringing about more uniformity in the standards for certified seeds—one state with another. I am happy

to report substantial progress in this program.

In an analysis of seed improvement and work there appear to be two general methods of organization. The first is an organization of growers incorporated under marketing or non-profit charters and sponsored usually by the Extension Service. In many instances the Exetnsion Agronomist is the Secretary of the Association. The Board of Directors is made up of individual growers of the different crops and representatives of the Experiment Station and College Staff; such organizations are recognized as the official seed certification agency under the provisions of the Federal Seed Act. The other type of program in effect in some states, also recognized as official, is the type of program made possible through statutes or enabling acts. Only one official certifying agency is recognized in each state, and conformity to the agreed minimum standards is a prerequisite for recognition.

There is, of course, variation in each of the types of programs, but in general the procedure is the same and the purpose or objectives are indentical. Flexibility is a desired characteristic and is essential to smooth operation. International standards definitely recommend Experiment Station approval of any variety sought to be Certified regardless of the type of program, and this recommendation is closely adhered to in the case of the Texas program.

The Texas program falls into the latter catagory or certification under a statute, and is different in many respects to the program in other states, but as pointed out, its objectives are the same.

Just how does the Texas Program operate? I think most of you are familiar with the purple and blue official tags but might be interested in the "mechanics" shall we say of seed certification; what makes it tick and the other factors and ramifications of a program of this nature.

As pointed out, seed are certified in Texas under a law and in the caption of the law the purpose is set forth——

> To create and make available pure bred seed, true to varietal name, and having merit for the benefit of the purchaser.

The other provisions of the law merely set up general requirements for Registered Plant Breeders and Certified Seed Growers and Registered and Certified Seed; creates a State Seed and Plant Board and charges this Board with certain responsibilities, prescribes the duties of the Commissioner of Agriculture, sets a maximum fee which may be charged for inspections, and provides penalties for violation. Briefly the State Seed and Plant Board is the policy forming unit of the Program and the Commissioner of Agriculture is the enforcement agent.

It should be pointed out that operation under the program is entirely optional on the part of the seed Breeder or Grower, however when he elects to qualify, then he is subject to all the rules and regulations concerned with the production of Registered and Certified seeds.

The standards for Texas registered and certified seed are set forth in booklet form and are available to interested parties and in the preparation of the standards a definite pattern is followed, whether it be for grass crops, grain, legumes, or cotton, modified to fit the particular crop and approved along the lines that are practical from a Grower's standpoint and yet embodying scientific principles of sound seed production.

In the establishment of standards for Registration and Certification and in passing on the merits of a particular applicant for license to produce Registered and Certified seeds, the following general outline is followed:

a. Reputation of applicant
b. Land ownership or possession of land under leases or contract
c. Equipment for processing and packaging seed
d. Ability to comply with Federal & State Quarantine Laws

Specific requirements are prepared for each crop along the following line:

a. Varieties approved for inspection, based on recommendations of the Texas Agricultural Experiment Station.
b. Requirements for different classes of seed
   1. Foundation
   2. Registered
   3. Certified
   4. Certified No. 2
c. Land requirements such as regulation pertaining to previous cropping
d. Field requirements, such as varietal purity, freedom of mixtures, weeds, noxious weeds, and other crop seeds, and diseases
e. Seed requirements—Germination, purity, inert, weeds, other crop seeds, noxious weeds, etc.
f. Isolation requirements, if necessary
g. Providing for actual grower supervision and rogueing of seed acreages
h. Rigid standards for harvesting, storing & processing

This is the outline followed by the Board in the preparation of all standards, and the specific requirements are as a general rule are higher than similar standards, in orther states and well above the minimum requirements recommended by the International Crop Improvement Association.

At the present time it might be pointed out that Certification standards have been prepared and adopted for twenty-two field crops, the two most recent crops being rice and peanuts, and tentative standards have been prepared and are in the process of being adopted for additional crops including Yellow beardgrass, King Ranch bluestem, Alta & Kentucky 31 Fescue, and the Auburn and Dixie strains of reseeding Crimson Clover. We hesitate to mention these newer crops as it will likely be several years before foundation seed can be increased to significant proportions, however the programs have been started and the expansion or increase of seed stocks will depend on availability of foundation seed stocks, and seasonal conditions.

Very little has been done under the program toward standards for vegetable crops for the very good reason that Texas produces little, if any, vegetable seeds, and the authority under the Certified Seed Program does not extend beyond State lines. There are, however, standards for onions, both seed and bulb crops, cantaloupes, and Irish potatoes, but at present only the onion program is active and this to a limited extent. The potato and cantaloupe programs have been inactive for several years due to lack of grower interest.

In summing up the Certification work, I have mentioned that 22 crops are under Certification standards with several additional being qualified. There are throughout the State very close to 3,000 individual farms, producing Certified seeds, either by qualified growers or contract growers. The acreage inspected on those farms each year exceeds 200,000 and 134 different varieties or strains of the different crops are involved, and each crop is inspected in the field one or more times. These acreages extend throughout the entire length and breadth of the State, and a force of five full-time men and some eight to twelve part-time men are needed to complete all inspections; in addition valuable assistance is given by County Agricultural Agents and Vocational Agriculture Teachers in reaching out of the way places and in rechecking previous inspections. In connection with the inspections, and I think typically "Texas", we took to the air this season in a chartered plane and very effectively made inspections of the detasseling of Hybrid Seed Corn blocks submitted for Certification. We found this type of inspecting was actually more economical than ground inspections and equally efficient; as far as we know, it is the first time an airplane has been used in connection with Certification inspections.

With the mention of so much man power, airplanes, and expense of travelling, you no doubt have reached the conclusion that Certification is expensive. However, when we divide the overall expense of operation by the number of acres Certified, we have a cost figure of about 14c per acre. When this is expressed in terms of bushels or pounds it becomes almost insignificant.

During the past season just slightly under 1,000,000 bags of seed passed into the channels of trade bearing the familiar purple and blue tag of Registration and Certification.

We in the Department of Agriculture feel a keen responsibility in the duties imposed upon us in the matter of enforcing seed laws, whether it be the Tested Seed Law or the Certification Program, and so long as we can continue to merit the confidence of other agricultural agencies, the Seed Trade and last, but not least, the Farmer-Seed Buyer, we will continue our efforts toward the end of "Better seeds for the farmer."

While we are concerned with the enforcement of seed laws, rules and regulations, we have tried to be guided by that logic expressed in the old story of the Negro woman in church who was very prominently occupying the "amen" corner. This particular Sunday Reverend Jones had chosen as his topic, "Sin and its different Forms", and was waxing eloquent. He started out at the top of the list and denounced each sin and at each pause a loud "amen" from the good sister in the corner. As he proceeded on down the list of sins his text was almost exhausted, but as a parting shot he strongly denounced snuff dipping. At this point the good sister was heard to make the remark: "Now he has done quit preaching and gone to meddling."

I presume this to be true particularly in her case, but the story does offer this logic and I think it is well to consider in the matter of enforcing laws, rules, and regulations. Preach your subject, carry your message to the public, and insist on conformity to the law and requirements, but "don't meddle".

The Problem Of Domestic And Industrial Waste

C. L. SHREWSBURY and E. R. STRONG
Southwest Research Institute
San Antonio, Texas

Dr. Shrewsbury is interested in the fields of animal nutrition, agricultural and waste disposal. He has served as chairman of agricultural and Chemical Research of the Midwest Research Institute, as Associate Professor, Agricultural Chemistry at Purdue University and as Instructor, Agricultural Chemistry at the University of Missouri.

I. *INTRODUCTION.*

The purpose of this paper is to give a picture of some of the pertinent facts of waste disposal, especially as they affect industrial waste from vegetable and citrus sources.

II. *HISTORY.*

When Industrial Waste Treatment and Disposal are discussed, Sewage Treatment and Disposal must also be mentioned because of the similarity in the handling of the two wastes. Sewage should come first because this problem was in existence long before there was any thought of Industry.

A. *Early Recorded Rules of Sanitation.*

No animal can survive when too intimately surrounded by its own body wastes. Some of the lower animals bury their waste; others seek new quarters when their old ones become foul. The earliest man followed the example of the animal. Moses (1) in his instructions to the children of Israel stated,

> "Thou shall also have a place without the camp, whither thou shall go forth abroad:
> And thou shalt have a paddle upon thy weapon; and it shall be, when thou wilt ease thyself abroad thou shalt dig therewith; and shalt turn back and cover that which cometh from thee."

Improper disposing of human waste would have resulted in the spread of many communicable diseases. Knowledge of disease prevention through sanitary measures has advanced greatly since the time of Moses, but, as will be pointed out, further advancement and additional knowledge is still needed today.

B. *Industrial Waste Treatment and Disposal.*

When industries first began there was no waste treatment problem; the waste volume was small and less complex and was emptied into the sewer or nearby stream and thereby forgotten. However, as the amount of industry increased and as the complexity of the waste increased pollution of streams and water ways occurred and the need for industrial waste treatment processes became apparent. This need was felt early in Great Britain, with its high density of population and industry and much pioneer work was done during the nineteenth century to develop methods of treatment of sewage and industrial wastes. According to Southgate (2), the Royal Commission of Sewage Disposal during the years 1898-1915 made a comprehensive study of methods of treatment and disposal of polluting liquids in Great Britain. In the United States, the field of industrial waste treatment is comparatively new and received very little attention prior to 1920. Eldridge (3) records that reports of the Massachusetts Board of Health in 1898 and 1900 as being among the earliest written records in this country.

The art of canning is one of the older industries; Eldridge (4) credits the beginning of this art to Nicholas Appert of France. Appert first preserved food in glass in 1804 and founded a cannery, House of Appert, which is still a famous organization in France. Eldridge further lists Ezra Dagget as the first canner in the United States; and, the Wm. Underwood Company of Boston, founded in 1817, was the first cannery established in this country.

In 1947 there were well over 3000 canneries operating in the United States. Here again, the need for more efficient waste treatment processes had become more acute with the increasing volume of produce handled.

III. *IMPORTANCE OF TREATMENT AND PROPER DISPOSAL OF WASTES.*

A. *Sewage.*

The reason we treat our sewage is very effectively put forth in the words of Mahlie (5), "Today we destroy our wastes, not alone for our own comfort and well-being but to prevent discomfort and injury to our neighbors, not merely because the law demands it, but because our common spirit of decency, which makes the law, demands it." However, Parran (6) has recently (May 1947) published the appalling fact that our sewerage systems today only serve about 71,000,000 people; and that approximately 40 percent of the total domestic sewage is discharged untreated into streams. This practice is endangering the health and lives of all who live in the area near this untreated sewage.

Walker and Kellersberger (7) state that practically all water-borne diseases are diseases of the gastro-intestinal tract, and include typhoid fever, paratyphoid fever, amoebic and bacillary dysentery, asiatic cholera, and possibly poliomyelitis, or infantile paralysis, and many others; and that such contamination might enter a stream through sewage. Any amount of disease-causing or pathogenic organisms present in a stream would be objectionable.

This situation which is admittedly bad is further aggravated by industrial and canning waste which are usually added to the already overburdened sewerage systems.

B. *Industrial Wastes.*

The essential problem in the reduction of any waste is to decompose by some manner the organic matter to harmless elements such as carbon dioxide and water.

Some industrial wastes are similar to domestic sewage in that they

contain essentially decomposible organic matter and can eventually be biochemically oxidized in a stream to carbon dioxide and water. Among wastes of this nature are cannery and dairy wastes. In this case, even as in sewage, if the amount of organic matter discharged requires more dissolved oxygen than is present in the flowing stream, the dissolved oxygen in the stream will be used up. Fish and other aquatic life which must have dissolved oxygen for survival will leave or be suffocated, and aquatic plants will die. Anaerobic bacteria, which do not need dissolved oxygen to consume organic matter, will begin to predominate. These bacteria will utilize the combined oxygen in any organic or inorganic compound present. Offensive odors are present during anaerobic decomposition; *ie.,* if H2SO4 were present, the bacteria removed 04 and liberate H2S. Splitting of other compounds will cause other disagreeable odors. This explains the many cases of undesirable odors that occur in streams where industrial waste is dumped.

Some industrial wastes, such as preservatives used in canning, may be decidedly toxic, and, if discharged untreated into a stream, are rapidly lethal to all forms of aquatic life including those necessary for stream self-purification. Pollution of a stream resulting from the discharge of toxic compounds causes somewhat permanent damage to stream banks and beds.

The discharging of more sewage or non-toxic trade wastes than a stream can handle or the dumping of toxic effluents will eventually destroy necessary recreational facilities and thereby lower the living standards in areas adjacent to the unsanitary stream or lake. According to Parran (6) fifty to sixty million people depend on these streams for their drinking water. The greater the pollution, the more difficult and costly it becomes to make such waters fit for human consumption. Pollution affects industry also, because they too need good water for boilers, coolers, etc. The necessary utilization of impure water entails higher equipment maintenance costs, reduced quality of product, and lower margin of profit.

C. *Conservation*

Not to be overlooked as an important reason for proper waste treatment and disposal is the conservation of water, a natural resource. In the arid Southwest, water is the very basis of existence; every drop should be utilized.

During the past 30 years people living on or near the Gulf Coast of Texas have seen most of the artesian wells cease flowing as a result of the desending water table. Rainfall has not kept up with water consumption. The water table in San Antonio area, for example, is said to have been lowered 40 feet since 1900.

Recently engineers of the Celanese Corporation at the Bishop, Texas plant warned their supervisors that if the use of the water from their wells continued at the present rate, the water table would be lowered to a point where there would be a danger of sea water encroachment. Following this disclosure by their engineers, the Celanese Corporation constructed a 22 mile pipe line to the Nueces River in order to obtain the water needed for their production.

In order to conserve the vital natural resource: water, sewage and industrial effluents should be treated and re-utilized for irrigation and industrial purposes whenever practical. Veatch (8) reports that municipalities such as Herington, Kansas sells sewage effluent from its activated sludge plant to an industrial consumer and paid for the cost of treatment. In the case cited, the effluent was delivered to the softening plant of a railroad for eventual use in their steam locomotives.

Travaini (9) states that sewage effluent from the Phoenix activated sludge plant, when chlorinated, passed the U. S. Public Health Service bacterial standards for drinking water. The chlorinated effluent was sold to the Roosevelt Irrigation District, at a net profit of $1.50 per acre-foot.

Cannery waste water after lagooning should be a good source of irrigation water, and, since good water for irrigation is needed in the Valley, careful attention to the possible recovery and use of canning waste water should be kept in mind.

IV. *THE VALLEY SITUATION.*

The situation that is of primary concern to the group assembled today is that which exists in the lower Rio Grande Valley and what to do about it. We can say at once that we are faced with a very real problem; state agencies are seriously concerned and progressive, forward-looking people in the Valley are anxious for a solution. Municipal authorities and industrialists are groping for an answer.

The problem in the Valley is seasonal and peaks and depressions occur throughout the year. It also varies from year to years depending on the vagaries of the climate. The problem following the freeze of last year is not as great as in years of high production. This variable situation tempts an operator to try to just get by for a few months since time will be the answer until the next season comes around.

At present the Valley problem is not confined to one town, one area or one community but is the concern of all and should in most cases be approached as a joint cooperative effort. There are probably exceptions to this statement where an acute problem requires immediate attention, but in general it is a joint problem requiring joint action. This condition comes about because a goodly portion of the waste, both domestic and industrial, is discharged into the Arroyo Colorado. Some of this waste is properly treated and suitable for discharge; other waste is not properly treated, the net result being that pollution is the result all along the line. It's like mixing one quart of good engine oil with three quarts of used oil which make four quarts of used oil. The Arroyo Colorado starts as little more than a ditch in the upper part of the Vallev and gradually enlarges to a sizeable stream as it goes thru the Valley. Pollution from waste probably increases with size of the stream. The degree of pollution is not known by the writer but reports of odors and threats of suits in various locations indicates the seriousness of the problem.

The Valley problem is concerned not alone with domestic and cannery waste but also citrus waste. The problem is three-fold: First, the ultimate objective is to turn the product that is now discarded into in-

dustrial products that would yield additional revenue; the Second, is to find a way to render the present waste harmless so that it can be disposed of by dumping into streams, lakes, and arroyos; the Third, is to conserve or recover the large amounts of water needed for disposal into industrial or irrigation channels. There are no entirely satisfactory methods presently available for any of these problems. It is a sad commentary that the final solution for the disposal of domestic waste has not yet been found. A great deal of research is now underway on this problem. When we come to chemical and cannery waste, the situation is even worse. Each waste is a special problem which requires a special solution. This means research on each individual situation. The answers will probably not come easy and their solution will be costly.

V. *Solution to the Problem.*

The most desirable solution to the problem is, of course, to treat all domestic and industrial effluents and reclaim as much of the water as possible.

A. *Legislation*

Before complete treatment of all wastes is achieved, legislation may have to be passed to encourage universal treatment. It is human nature not to want to spend money on something that is going to be thrown away. In the past 50 years, more than 100 bills have been introduced into Congress in an effort to establish federal regulation and control of stream pollution. None of these bills became laws. Because some rivers involve interstate commerce, federal regulation of steam pollution due to industrial wastes should be re-considered.

At present, treatment of domestic waste is the duty of a municipality with the police power vested in the State Health Departments. In 1947, a Public Health Survey (10) of nation-wide sanitation needs indicated that the cost of water supply and waste disposal facilities needed would amount to $7,834,581,000. The public should be educated as to the facts so that they will go to the polls and vote intelligently.

B. *The Need for Additional Data.*

Legislation alone is never the complete answer and moreover in the case of some complex industrial effluents there is no effective treatment known that is economically feasible. Such effluents should be lagooned and disposed of by solar evaporation until a treatment is developed that will render them harmless for discharge into a stream or possible re-use.

Many data are needed to develop more economical treatment methods for some industrial wastes. This research should be financed largely by Industry.

VI. *What is Being Done.*

A. *Private Industry.*

Some industries, realizing the necessity of waste treatment, have d veloped methods of treating their waste and have found it quite profitable to re-utilize the effluent.

Most f the more successful industrial waste treatment methods are biological processes which have been patterned after standard s wage treatment practice; namely, the trickling filter and the activated sludge processes.

Generally industrial effluents fall into classes, but some are definitely individual problems. Sometimes industry must seek the aid and cooperation of an outside organization to find the satisfactory solution to their problem. The Celanese Corporation of America has retained the Southwest Research Institute to certify the chemical and biological condition of the blowdown water from the boilers and cooling towers which is presently entering a creek and, also, to assist them in developing a process whereby they can treat their toxic effluent which is now being disposed of by solar evaporation in many acres of ponds.

B. *Government Work.*

The United States through the U. S. Public Health Service is in the process of issuing grants to universities and research organizations to study more effective methods of waste control and minimum allowable concentrations of many toxic compounds common to trade wastes.

Many university students are doing research of this type as partial fulfillment of the requirements for masters and doctorate degrees.

C. *State Agencies.*

Practically all states through their health departments are conducting research on waste disposal in addition to their regulatory functions. We also cooperate with federal agencies and private industries in various phases of waste disposal research.

VII *CONCLUSION*

It is not an easy matter to get attention to waste disposal problems, especially industrial problems for the very human reasons that the main objectives of production have been reached, profit or loss has been realized and what is left as waste is looked upon only as a nuisance to be disposed of in any way that comes to mind. Yet a broader view both from an economic and aesthetic standpoint indicates the short-sightedness of this approach. First it frequently happens that many dollars are lost by discarding material that could be converted into industrial products. Second the conservation of our fish and wildlife and recreational resources are of great importance. It has taken years to awaken farmers ... the need for land conservation and as a result our country was head... disaster. Conservation of other natural advantages while not as ...s are nevertheless worthy of consideration. The results of ... roseate spoonbill along the gulf coast in regions of in... is a small example. Here the oil industry, state ..., and research organizations have worked to... ncrease these birds. Those who have seen these ...ed birds and have enjoyed their beauty no doubt ... which is really the most important—beauty or oil. ...res arch on better ways to handle the many waste ...ve us both.

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Citrus Objectives and Accomplishments of Research and Marketing Act of 1946

CHARLES A. ROGERS

Mr. Rogers is a citrus grower and shipper and has been Secretary-Treasurer of the Texas Citrus and Vegetable Growers and Shippers Association for five terms, Chairman of their Citrus Division from 1942 to 1949 and was elected president in 1949. He is a member of the Executive and Legislative Committees of the Texas Citrus Advisory Council and was formerly a member of the Finance Committee. Mr. Rogers is also a member of the Citrus Division of the National Freight Container Bureau and has been a member of the National Citrus Research and Marketing Act since its organization in 1947.

Mr. Chairman & Gentlemen:

When I was invited to make a short talk here today on the Research and Marketing Act of 1946, I considered it not only a privilege and honor but also an opportunity — an opportunity to explain to the grower of the Rio Grande Valley the purposes and accomplishment of this very important piece of agricultural legislation.

It is highly essential that as many growers as possible realize its true objectives, and what has been done and what can be done under this law, which has been described as the most comprehensive act for agricultural research that has as yet been placed on the books of any nation.

This act provides for the expenditure of $9,500,000 in 1947; $19,000,000 in 1948; $33,500,000 in 1949; $48,000,000 in 1950; and $61,000,00 in 1951, or a total of $171,000,000 during the first five years.

We are actually a year behind in getting this work under way.

First, I should like to stress that the Research and Markting Act is a research program—a long range program—with emphasis on marketing and utilization and new uses, although a fairly substantial amount of money is available for production.

The Department of Agriculture has taken the definite position that, barring freezes and hurricanes, we can reasonably expect future supplies to be ample, and the interest of the producer will best be served by improving marketing practices; expanding our present outlets, both domestic and foreign; finding new outlets; discovering new uses that will utilize present wastes; and improving present quality and thereby increasing sales.

This research work can be done through federal, state or private agencies whichever appear to the Secretary of Agriculture to be the most advantageous to use.

In many cases, money is alloted to states on a basis of "matching funds." This presents a difficult problem, as some states have more than $1,000,000 of matching funds, while others have only $2,000. Texas citrus funds for matching purposes are less than our competitor states.

Present Texas members of the National Citrus Fruit Advisory Committee of the Research and Marketing Act of 1946 are Lorne S. Hamme, Stanley B. Crockett and myself.

The committee has been meeting once or twice a year, but commencing this year and from now on, will meet twice a year, once in Washington and once in one of the producing areas.

To explain all of the projects we have been working on would take too long, but in the short time I have available today, I should like to mention very briefly just a few of them so that you may have some idea of the kind of work that is being done.

UNDER MARKETING

1. *Determining freeze damage by electronic instruments.* This would enable the packer to separate frozen fruit accurately and economically. At the present time, there is no sure way of segregating frozen fruit so as to keep it off the market. Satisfactory progress is being made on this work.

2. *Development of Electronic Apparatus which sorts citrus by size and color, and also machinery which will wrap the fruit.* With rising labor costs, these machines could result in substantial reductions in labor costs. Good progress is being made.

3. *Development of improved maturity standards for all kinds and varieties of citrus as a basis for delivering better quality fruit to the consumer and processor.* Present maturity tests and standards vary in the different producing states and at times have been severely critized. If we are to increase the demand for citrus, we must ship only fruit that will satisfy the consumer and create conifdence in our products.

4. *Cold storage tests for the purpose of lengthening the marketing season of citrus.* This work is being done in Texas by A. L. Ryall at the Horticultural Field Laboratory in Harlingen. The relative merits of different kinds of wrappers and liners and boxes, as well as different coloring treatments, different picking dates and different temperatures, are being tested. Some excellent results are apparent.

5. *Prevention of decay and spoilage of citrus fruit in transit.* This is an investigation of all practical methods for reducing and controlling decay, rot, mold and other causes of spoilage during the marketing process. The wholesaler, retailer and consumer quit buying when citrus does not remain sound and free from decay, and the grower suffers losses.

6. *Elimination of barriers between states on trucks transportation.* The volume of truck shipments is increasing each year, and we should have regulations that are uniform, reasonable and workable in and between all states. The load limit in Texas is 48,000 pounds against California's 68,000 pounds and Florida's 64,650 pounds. Some state through which we must pass have load limits as low as 42,000 pounds. Other regulations are just as consistent.

7. *Development of foreign outlets as well as being kept informed on the expansion of citrus production in competing areas such as Spain, Italy,*

Morocco, Algeria, Palestine and Tunisia. Their groves were seriously neglected during the recent war, but they are recovering and growers in those areas ar improving their cultural and processing practices, and this together with the fact that European buyers have no dollars, with the exception of Belgium and Switzerland, does not present an optimistic export picture. But the situation is far from being hopless, and every opportunity for expanding our export business should be explored.

8. *A citrus tree count in Texas by varieties and production.* A great change has taken place in the last few years on account of the freeze and the planting of new varieties, and we should have some accurate information on this subject so that we will know how to plan our marketing programs for the future.

9. *Costs and mark-ups of citrus prices from the grower to the consumer.* In other words, how much of the consumers dollar goes to the grower, how much for picking and packing, for transportation, for selling, for terminal cartage, and for the wholesaler and the retailer. This study has received highest possible priority. There is a feeling that frequently when grower prices decline sharply, wholesale and retail prices do not drop fast enough and to the same extent. Considerable work will be done on this study.

10. *Customer preferences to ascertain what the consumer actually wants.* In other words, what does the consumer prefer. Can he get the size, quality and variety he wants. Does he prefer natural color or color-added oranges. Does he prefer to purchase by the pound, dozen or consumer size bag. Does he prefer canned or fresh products, etc. There is frequenty a difference between what he actually wants and what he is able to get from his local grocer.

UNDER UTILIZATION AND NEW USES

1. *Determining the substance resopnsible for flavor, good or bad, in processed citrus.* A study will be made of how, and why, flavors change during processing, and what can be done to prevent undesired changes.

2. *Production of more attractive canned juice from Pink and Red grapefruit.* This work will be in charge of Clifford Scott at the Fruit & Vegetable Products Laboratory in Weslaco. Pink and Red grapefruit produces a "muddy" color, which is objectionable. Canners will take only a limited amount of Pink and Red cull fruit to blend with larger quantities of white juice. But with the production of Pink and Red grapefruit in Texas destined to exceed white in the near future, a good Pink and Red juice will be necessary to avoid wasting the culls. This is an important study for Texas.

3. *New and improved uses.* An example of the great strides made along these lines is the new frozen orange concentrate which has revolutionized the orange business. This new product utilized 4,000,000 boxes of Florida oranges alone two years ago, 8,000,000 last year and it is estimated will use 20,000,000 this year. The demand has exceed the facilities to supply it. It is an excellent product, and a striking example of what can be done in discovering new uses through research.

UNDER PRODUCTION

1. *Citrus Rootstock Projct.* This work in Texas is being conducted by Dr. William C. Cooper, in cooperation with the Texas Experimental Station in Weslaco. One hundred or more different kinds of rootstocks are being tested on different kinds of soil to determine which are most resistant to Quick Decline, soil salinity, gummosis, psorosis, boron and also which ones produce the best quality as well as bear the heaviest crops. No project has received a higher priority than this rootstock work, and some very satisfactory research is being carried on by Dr. Cooper.

2. *Suppreessive and eradicative measures for the control of Black Fly and Mexican Fruit Fly in Mexico.* The Black Fly program includes four entomologists in South Africa, India and Malaya who are searching for parasites of the blackfly. Also, extensive spraying and quarantine suppressive measures are in force in Mexico, together with some parasitic work already going on. On the Mexican Fruit Fly, progress has been made in shortening the sterilization period, and research is going on now to determine whether the fly can be killed by x-ray or electronic treatments.

These are just a few of the many projects on which work is being done.

In closing, I want to emphasize again the the Research & Marketing Act program is one of research—research to devise ways and means of marketing and utilizing present production to better advantage, and to protection of present investments from disease and pest damage, rather than research on how to produce more citrus. But whether it is on marketing, utilization, new uses or production, it is all research work.

Any substantial amounts of money for production research will have to come from what is called regular state and federal funds.

At the same time, the Research and Marketing Act committee has established a very high priority on some production problems such as Dr. Cooper's rootstock work, and the control work in Mexico on Black Fly and Mexican Fruit Fly, and these high priorities have been of great assistance in securing money for them from these regular state and federal funds.

The Frozen Citrus Concentrate Industry in Florida And What The Industry Wants In The Way Of Quality In Citrus Fruits

W. R. Roy, *Chief Chemist*
Minute Maid Corporation
Plymouth, Florida

Dr. Roy is particularly interested at this time in the field of concentrates. He is Director of Research for the Minute Maid Corporation and has previously been associated with U.S.D.A.

In the past four years, a new industry has been developed in Florida which has grown to a point where it is fast becoming a major part of the citrus industry. In 1946, less tnan 100,000 boxes of oranges were utilized in the manufacture of frozen concentrated orange juice in the state. One plant produced practically all of that product. The following season, three plants produced some 500,000 gallons. In 1947-48, five plants produced 1,935,000 gallons and in the season just completed, 1948-49, a total of 8,216,000 gallons were produced by ten plants. For the 1949-50 season, fourteen plants are expected to produce from twenty to twenty-five million gallons of the product.

Concentrating of citrus juices is not new. Concentration under high vacuum at ambient temperatures, quick freezing, and handling in the frozen state are new features which have contributed to the success of this product.

Only fully ripe, carefully graded fruit can be used to produce a high quality product. Each load of fruit is sampled by automatic devices which take a representative aliquot from the unloading conveyor, The sample is analyzed on the spot for its solids and acid content, and juice yield. Since only one truck load is placed in a bin, regardless of size, the identity of each analyzed load is maintained.

From the analyses, combinations of binfuls are blended to yield juice with a designated ration of solids to acid. This blending is a very important part of the control of quality in the process and requires constant vigilance.

The fruit is next washed and sterilized in a succession of steps; it then undergoes a final careful grading and is juiced in stainless steel extractors. The juice is pooled in stainless steel surge tanks, from which samples are drawn at frequent intervals for analysis. It is then pumped into concentrators, where, under a vacuum of 10 to 15 MM (absolute pressure), it boils at temperatures in the range of 55° to 70° F. After sufficient water has been removed to increase the concentration to 52° to 55° Brix, the product is pumped to a blending tank, where it is diluted to 42° Brix, using fresh juice as a diluent. This operation performs a duofold purpose: it restores to the product some volatiles which are lost in the high vacuum, while at the same time,it serves as a means of fixing the concentration of the finished product.

After the blending, the concentrate is "quick frozen" to 18° F. by passage through efficient heat exchangers. The slush-frozen product is then

pumped to postive-action filling machines and canned. The sealed cans are passed through blast-freezing tunnels or freezing liquids, emerging at a temperature o 0° to -10° F. They are then cased and stored at -10° F. Shipment is in super-insulated cars or by truck held at or near 0° F. by ice-salt mixtures or by mechanical compressor units, and the final dispensing is from the grocers' frozen food cabinets.

Since the concentrated material is never subjected to heat, it is necessary that rigid precautions be observed in maintaining as low a microbiological population as possible. Several ninovations in the citrus processing field have been introduced to achieve near-sterility. Fruit washing is done stepwise, the final step consisting of immersion of the whole fruit in a germicide bath of a quaternary ammonium compound, chlorine or bromine, which is rinsed off before extraction. Conveyor belts are sprayed continuously with chlorinated water. Frequently scheduled cleanups insure against bacterial buildups, and the overall bacterial picture is kept under constant surveillance by bacteriologists, who, as members of the control laboratory, constantly checek fresh juice and finished product, and spot check the production line for evidences of any contamination.

The finished product is prepared for use by adding three volumes of water to one volume of concentrate. In numerous taste tests, frequently preference has been shown for the reconstituted concentrate over freshly expressed juice. This is particularly true in the northern markets where the "fresh juice" is obtained from oranges which are ten days to two weeks off the tree.

Recently,[1] it has been shown that no ascorbic acid is lost in the concentrating process, and storage tests indicate there is no detectable loss in the vitamin when the concentrated product is stored for a year at -10° F.

It is interesting to note that the addition of pulp cells, which are considered "defects" in single strength juice, is judged almost a necessity in concentrate by popular demand.

Since concentrate is not subjected to heat, enzymes are still active, particularly those causing separation. Because of enzyme action, juice reconstituted from concentrate is not as stable as canned (pasteurized) single strength juice. However, the stability of the reconstituted concentrate is somewhat greater than that of freshly epressed juice. In some manner, the pectin hydrolyzing enzymes are partially inactivated in the concentrating process, so that separation is much slower in the reconstituted concentrate than in the juice from which it was made.

To date, major emphasis has been in the production of frozen concentrated orange juice. Several concentrate manufacturers have put up experimental packs of grapefruit concentrate and of grapefruit-orange blends as well as frozen concentrated lime, tangerine and lemon juices. These juices have met with only moderate reception, although, in all fairness, it must be pointed out that hardly enough product has been marketed to establish them on their own merits. It is believed that sufficient grapefruit concentrate will be made in 1949-50 to determine to what extent it will be packed in the future. Recently, technical representatives from each of the major concentrate plants met and agreed on tentative specifications for grapefruit concentrate.

In large measure, the generous public acceptance of frozen concentrate orange juice has been due to the conscientious and concerted effort on the part of processors to produce a product of consistently high quality. Obviously, for maintenance of quality it is essential that the raw material, the fruit itself, meet certain requirements.

Since the term "quality", as applied to fruit designated for concentrating, might differ from the term applied to fruit earmarked for the fresh fruit market, or to that intended for single strength canned juice, it might be proper at this time to discuss some of the factors which concentrators look for and want in the way of quality.

At the outset, it should be strongly emphasized that utilization of fruit for manufacture of frozen concentrate is definitely not a salvage operation. While it is true that some fruit is suitable for concentrate manufacture which, due to certain external features would be considered unsuitable for fresh fruit channels, the same internal standards apply equally to both, and under some conditions it is possible that certain fruit considered unacceptable for concentrate purposes could be shipped to the fresh fruit market.

Fruit freshly picked and hauled directly from the grove to the plant is highly desired. Fruit less than twenty-four hours off the tree usually retains its fresh flavor; beyond that time, particularly in warm weather, stale flavors begin to develop when can be detected in the finished product by a trained taster. Fruit which has remained in the packing house several days, and particularly that that has remained in coloring rooms at elevated temperatures for long periods of time, is not desirable, in fact, is often unacceptable.

Standards for U. S. Grade A frozen concentrated orange juice require that the solids-to-acid ratio lie in the range 12-to-1 to 18-to-1. Most concentrators attempt to produce a product in the center of that range; that is, between 14-to-1 and 16-to-1; experience has indicated that optimum consumer acceptance is experienced with product having that ratio range. Accordingly, it simplifies the processing procedure to receive fruit whose juice has a solids-to-acid ratio in that region. However, since it is impossible or impractical always to procure fruit of this type, fruit varying in range from 9-to-1 up to 20-to-1 is blended to obtain uniformity in the finished product.

At times, all of the available fruit is either too low or too high in its citric acid content to blend properly. When such a condition arises, concentration is continued, but the finished product is packaged in bulk containers, is frozen and stored at -10° F. When the other extreme condition occurs, the stored product is defrosted and blended with its complement to make a satisfactory finished product.

There are limits, however, to the range of ratios that can be used in blending. Juice whose initial ratio is lower than 9-to-1 is often subject to bitterness or to an immature flavor, which is transmitted through the processing and appears in the finished product as an undesirable component of the flavor. Moreover, flavors of this type, even when barely perceptible in a newly processed concentrate, become more pronounced

on storage thus the least trace of bitterness in freshly made concentrate is regarded with suspicion for that reason.

The other extreme, that is, juice whose ratio is above 20-to-1 is prone to taste flat or insipid: it rapidly develops aged or over-ripe flavors and may be undesirable from that standpoint.

Since finished frozen concentrated orange juice is always adjusted to 42° Brix, the manufacturer and distributor of the product sell it essentially on a fruit solids basis. Concentrate always reconstitutes to approximately 12° Brix. Since, therefore, it requires four gallons of 12° Brix to make one gallon of concentrate, it requires 4.35 gallons to make a gallon of concentrate from 11° Brix juice, 4.80 gallons per gallon from 10° Brix juice, 5.35 gallons of 9° Brix juice, and over 6.0 gallons of 8° Brix juice to make one gallon of concentrate.

It is quite obvious, therefore, that it is highly desirable for the concentrate manufacturer to obtain, for processing, fruit whose juice yield is high, and which contains as high a solids content as possible, for economy of operation. It also is quite obvious that the processing cost of concentrationg low Brix juice is higher than that of high Brix juice, because of the fact that considerably more of the former must be handled, more water must be removed from it, and production rate is slower than when high Brix juice is used. All of these factors add up to higher cost of production of concentrate from low Brix juice, hence the demand for fruit whose juice contains a higher solids content.

It has been found that the consuming public desires concentrate having a deep orange color. It is desirable, therefore, that fruit for concentrating purposes be that whose juice is well pigmented. Early fruit, in Florida, is somewhat pale in color. In order to utilize as much of this fruit as possible, at least one manufacturer has adopted the practice of carrying over a quantity of late Valencia concentrate packed in bulk, for the purpose of blending with the juice from early fruit. This practice has been very successful in overcoming the prejudice against the juice from early fruit, and has done much to make the product more uniform the year around.

Most exterior or surface defects which are responsible for elimination of fruit from fresh fruit channels have no effect on the interior quality of fruit for concentrationg, and their presence is not at all undesirable on fruit for such purpose. Surface defects or insect damages such as melanose, rust mite injury, scab, spray burn, sunburn and the like, are of littl concern to a concentrate operation. On the other hand, insect or thorn punctures are highly undesirable, since it must be remmbered that punctures or injuries which penetrate the flavedo and albedo into the juice sacs will afford entry of bacteria, yeast and mold. Neither juice nor concentrate are pasteurized; hence the presence of excessive numbers of micro-organisms in the fruit itself will, of course, be reflected by a similar condition in the micro-flora of the concentrate. The final product is closely checked at frequent intervals for bacterial count, and tolerances have been established which represent a normal population of such organisms. The presence of abnormally large numbers of bacteria, or the presence of pathogenic types of micro-organisms constitute reasons for condemnation of the product. Consequently, cracked or split fruit, creased or plugged fruit, that having insect or thorn punctures, or which is soft or spongy, fruit whose exterior is permeable to bacterial invasion for any reason is culled out of the grading table and discarded as unfit for concentrating purposes.

Aside from insect damage that results in punctures, the only other undesirable insect infestation is scale. Scale is extremely difficult to remove from fruit by any known commercial fruit washing procedure. When it is present on fruit, there always exists the possibility that the scale armour will be present in the juice, particularly since coarse screens are used in finishing the juice. The presence of scale in the juice constitutes a defect; hence scale infested fruit is very undersirable for concentrate purposes.

Fruit sizes are of little concern to a concentrate operation. The smaller sizes yield, as a rule, somewhat more juice per box than the larger sizes, thus might be more desirable from that standpoint. Some processors use certain types of juice extractors which handle a certain number of oranges per hour, regardless of size, in which case, a predominance of small sizes would tend to hamper production rate to a considerable extent.

Because of the increasing importance of concentrate production, I would like to make a few predictions of things to come, predicted on production of fruit earmarked for concentrate. I believe some saving can be made in cost of production of fruit intended for such purpose. For instance, it is entirely probable that within a relatively short time, insect control schedules will be formulated which are aimed at control of only these insects which render fruit undesirable for concentrate and, of course, for control of insects which damage trees and resulted in decreased fruit yield.

It is also within the realm of possibility that fertilizer programs may be developed which are devoted to development of higher solids fruit, better colored juice, and possible smaller and more numerous fruit per trees.

I am sure that it is inevitable that Florida fruit for processing will eventually be sold at a price which takes the yield factor into consideration. With this thought in mind, several Florida concentrators are studying development of formulae which will adequately reward suppliers of fruit of high solids in accord with its true value. In addition, it is quite probable that the new plantings of trees will lean toward varieties that yield fruit of high solids, specifically for concentrate purposes.

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Prospects For A Frozen Concentrate Industry In Texas

E. M. Burdick
Director of Research
Texsun Citrus Exchange

Dr. Burdick is in charge of research of all phases of Citrus Processing and Quality Control, and, in particular, is interested in enzymes, development of new citrus products, naringen and waste utilization. Dr. Burdick was formerly Research Chemist with the U.S.D.A. at the Northern Regional Research Laboratory and at the U. S. Fruit and Vegetable Products Laboratory before becoming associated with the Texsun Citrus Exchange.

In attempting to forecast future developments one always places himself in a precarious position. This is especially true in the Citrus Industry. However, it appears quite certain that Texas will have a Citrus concentrate industry in the very near future. Moreover, the quality of its products should be unsurpassed because of the superior flavor of Texas citrus. Several concentrating plants would probably be operating in the Valley right now were it not for last winter's severe freeze.

To anyone who has watched or studied this amazing frozen concentrate development it is obvious—"The Texas citrus processing industry either will pitch in and help expand and develop this new industry, or it will soon be forced by competetion to do so for survival."

Texas must overcome several difficulties before it can boast a flourishing frozen concentrate industry. More problems exist than the mere construction and operation of a plant. To begin with, the present frozen concentrate deal is based almost entirely upon oranges and there are just not enough suitable oranges available this season to justify the immediate capital expenditure required for the construction and operation of even a single efficient plant. This limitation should vanish with the return of normal production, but it must be kept in mind that high quality concentrates can be made only from quality fruit.

Next, it is rather well recognized that the quality of the grapefruit concentrates so far produced in Florida leaves much to be desired. Considerable research has been done in grapefruit and orange blends as well as sugar-added products in attempts to improve the poor flavor of their raw materials. The Texas citrus industry feels confident it can produce superior grapefruit concentrates from its naturally sweeter and better tasting fruit. The possibility of producing a "red-grapefruit concentrate", something branded by nature as a superior product, is intriguing to say the least.

You have just been told the kind of fruit best suited for the production of orange concentrates. The same applies to grapefruit and it is plain to see the frozen concentrate industry is not a salvage proposition. In Florida most of the oranges are made to order for the concentrates, that is, their oranges have thin skins which do not make good shipping and their appearance does not make for good consumer acceptance. These factors along with the excellent natural flavor of the concentrates are probably the things most responsible for the rapid development in that state. California on the other hand has been limited by its large proportion of navels which are unsuited for processing since they develop bitter flavors, while Texas has been restricted by its small proportion of oranges.

In many respects the amazing growth of the frozen concentrates has paralleled the expansion of the single strength juices and some of the lessons learned from it may well serve as guiding lights for this young industry. It should not be forgot that only a few years back Florida was processing over two-thirds of its grapefruit crop, while Texas was processing about one-third of its grapefruit. Consumer acceptance of frozen orange concentrates has been considerably better than in the case of the single strength juices. For example, four years ago less than one percent of the Florida crop was processed into concentrate, while present estimates indicate approximately one-third of the present crop will be used for concentrates. In fact, the industry has grown so rapidly even the experts conducting surveys have been unable to keep up with it and are reluctant to make estimates on how much and how long it will continue to grow in the near future.

There is no doubt as to the success of the frozen orange concentrates, but Texas is and must be more concerned with the future possibilities of grapefruit concentrates. The necessity of spending a minimum of onehalf million dollars for an efficient plant to produce an unproven product is another factor limiting Texas. In view of the highly competitive situation which is rapidly developing, it appears unwise to consider anything short of the most efficient installation possible. Fortunately this requirement has so far successfully eliminated the small inefficient operators. Thus four or five large companies have been able to control not only production and distribution, but also quality which is essential for continued success.

Recent surveys have indicate dapproximately 85% of the housewives of this country have not yet learned of these frozen concentrates and probably just as many of those present do not know the general procedures used in making them. Good quality juice is first evaporated under high vacuum so that the boiling temperatures are never above 80 degrees. Evaporation continues until a five-fold concentration is reached. This concentrated material is then diluted with fresh untreated juice back to a four-fold concentration which is frozen to a slush, sealed in tin cans, and finally frozen for storage. At least four different types of high vacuum evaporators are commercially available for concentrating citrus juices.

Initial plant cost is directly related to plant capacity, which in turn is directly related to production costs. These factors must be considered before a satisfactory appraisal of the overall economics can be made and a reasonable return on the capital invested assured. In general, small plants are the most inefficient and uneconomical since they require relatively greater proportions of labor and skilled operators, while excessively large plants require too large a ninvestment and often become unwieldy. The one-half million dollar figure mentioned as a minimum initial investment can be reached by giving due consideration to these factors along with other engineering economics connected with a citrus concentrate plant. It thus turns out that such a plant should process about

200 tons of fruit per day and operate at least 150 days per season. The initial cost for such a plant will run from $500,000 to about $1,000,000 or slightly less than $1.00 per gallon of capacity per year, depending upon the type of equipment installed. Before investing this much money, a clear idea should be had as to the possible market, production costs, raw material costs and the profit or returns to be expected from such a plant.

When considering the market and raw materials it is necessary to keep in mind the frozen concentrate deal is definitely not a salvage proposition. Frozen concentrates compete directly with fresh fruit, not only at the point of consumption but also at the point of production. This fact cannot be stressed too strongly for herein lies the key to the all important question "how much money can the citrus grower expect for his fruit when processed into frozen concentrates?". Last season Florida growers received from $10.00 to $80.00 per ton for their oranges. The average was close to $25.00 per ton. It appears quite certain now that the returns to the grower will be something more than is returned for canning fruit, but less than for good quality fresh fruit. The frozen concentrators compete with the fresh fruit buyers for their raw materials and the frozen concentrates compete with the fresh fruits for consumer acceptance.

Since most oranges are consumed as juice and most grapefruit are eaten from the half-shell, it would appear that concentrates will cut more deeply into the fresh oranges market than the grapefruit market. In addition, they will undoubtedly cut into the canned juice market because they offer flavor comparable to the fresh products. It will be necessary for the processors of single strength juices to maintain ever increasing standards of quality if they are to retain even a fair proportion of their present market. Economically the concentrates can never compete with single strength juices, but disregarding costs, consumer preference is almost 100% in favor of the concentrates. This is more noticeable in the case of orange juice which has never been too satisfactory from a quality viewpoint.

The size of both the orange and grapefruit crops here in Texas has effectively curtailed development of the concentrates by almost eliminating the supply of raw material. The demand for frozen orange concentrate has steadily increased and production has constantly lagged behind. As a result the market price has fluctuated considerably. The quantity of grapefruit concentrate so far produced has been insufficient to establish a price level. However, it seems logical to assume the usual price differential of 40% prevail between grapefruit and orange concentrates just as it does between most grapefruit and orange products.

If this price differential prevails, and present information indicates it will, a brief look at the possible production costs and returns to the grower should be of interest.

By assuming a total production cost exclusive of raw material to be $2.50 per case for grapefruit and and $2.60 for oranges; along with a selling price of $4.00 and $6.60 per case for grapefruit and orange concentrates respectively; it is easy to see the picture is much more favorable for the oranges. To be specific, under such conditions the processor could pay or return to the grower approximately $40 per ton for his oranges and only about $14.60 for his grapefruit. This is considerably less than the $24 indicated by the 40% price differential assumed in those calculations. This important point should not be overlooked by prospective grapefruit processors. This anomoly results from the fact that processing costs are about the same for both grapefruit and orange, but the relative proportion of the total cost is much greater for the grapefruit or cheaper product.

In summary, although there are several limitations and difficulties to be overcome before Texas can boast a flourishing frozen concentrate industry, there is little doubt the Rio Grande Valley will soon be producing the finest frozen citrus concentrates in the World.

Distribution of Naringin In Texas Grapefruit

ROBERT H. MAURER, EVERETTE M. BURDICK,
Research Laboratory Texsun Citrus Exchange,
and
CARL W. WAIBEL, *Texas State Department of Agriculture*

Mr. Maurer is interested in soil fertility and fertilizers. He previously was associated with the Texsun Citrus Exchange where he spent two years in the Research Laboratory. He came to the Valley as a graduate of Georgia Tech in Chemical Engineering. Dr. Burdick is in charge of research on all phases of Citrus Processing and Quality Control, and, in particular, is interested in enzymes, development of new citrus products, naringen and waste utilization. Dr. Burdick was formerly Research Chemist with the U.S.D.A. at the Northern Regional Research Laboratory and at the U. S. Fruit and Vegetable Products Laboratory before becoming associated with the Texsun Citrus Exchange.

Mr. Waibel is doing Nursery Inspection in developing the program of providing a source of psorosis free citrus trees. He has had 13 years experience as a tree surgeon in New York state and spent 2 years with the U. S. Navy in this capacity. Mr. Waibel also served one and one-half years as Laboratory and Field Assistant in Plant Pathology at the Valley Experiment Station, Weslaco, Texas.

In spite of the fact that much of the characteristic flavor of grapefruit is due to the bitter principle naringin, only very meager data concerning its distribution throughout the harvesting season in various varieties can be found in chemical literature. Naringin, a bitter testing glucoside, is found only in the grapefruit and its closely related pummelos and shaddocks, which are considered by many authorities as belonging to the same species. It is considerably more bitter than quinine. According to McNair (6) it imparts an intense bitterness to water in as low a concentration as one part per eight thousand. Zoller (8) was probably the first to record the observation that "pink spots" and "certain flavors" developed simultaneously with a decrease in naringin content which occurs upon maturation. The naringin content of grapefruit rinds at various stages of development and storage has been reported on by Harvey and Rygg (4) and Zoller (8). It is quite well known that as maturity is approached the naringin content and bitterness decrease. There are man references on the relative bitterness of grapefruit varieties according to taste tests. The possibility of using the naringin content as a measure of maturity was investigated by Baier (1) and Wood and Reed (7), but without much success. The analytical methods available to these early workers left much to be desired and probably accounts for the lack of more extensive information on naringin in the literature. For example, Zoller (8) found it necessary to resort to direct crystallization of the naringin, while Harvey and Rygg (3,5) were obliged to use either an hydrolytic method or a colorimetric method both of which were of limited value because of interfering materials. However, during the past couple of years the more convenient and reliable method of Davis (2) has been available for naringin studies.

The discovery and development of bud mutations which produce pink and red meated grapefruit is undoubtedly the most important advance in the development of grapefruit varieties since that of the Marsh seedless. These red meated grapefruit are highly valued not only for their appearance but also for their flavor, which has been variously attributed to a higher sugar content, a lower citric acid content, or a combination of both of these factors. Previous data accumulated by this Laboratory on commercially packed grapefruit juices indicated rather convincingly that those juices from pink or red meated grapefruit contained considerably less naringin or bitter principle than the juices from more common white grapefruit. It has been suggested that the apparent milder flavor of grapefruit grown in the Rio Grande Valley is due to the presence of less naringin than is present in grapefruit grown elsewhere. Likewise it has been claimed that certain mechanical extractors incorporate less naringin in the juice than do others. These facts coupled with the rapid expansion of the red meated grapefruit industry has prompted us to make a preliminary survey of the naringin content of the several varieties presently known.

All of the known sport or bud mutations producing red meated grapefruit in the Rio Grande Valley were included in this survey. The Marsh Pink and the Foster Pink are the common commercial varieties of pink meated grapefruit, while the Henninger (Ruby Red) and the Webb (Red Blush) are the most common red meated varieties. The only white meated grapefruit included were the Duncan (seedy) and the Marsh (seedless), which are the varieties in largest production at present. In collecting the samples due care was used to make sure the fruit was representative of the majority of the fruit then on the trees, so far as outward appearance and size were concerned. The number of samples of each variety taken for analysis was too few to warrant broad conclusions, but certain generalizations seem to be apparent and should encourage further work along these lines. The trees from which the samples were taken were of known and true varieties. The locations of these trees are given in the table. The samples were divided into the component parts, weighed portions were immediately extracted with warm water, and after making up to a definite volume the naringin content was determined according to the method of Davis (2). The results are given in Table I, entitled Distribution of Naringin in Texas Grapefruit. Naringin is expressed as grams per 100 grams as is weight in all parts except the juice, where it is grams per 100 milliliters.

From these results it is apparent that the most significant change in the naringin content during the harvesting season occurred between October 13th and November 17th in 1948. During which time the naringin decreased on the average; 66% in the flavedo or outer layer of the peel; 60% in the juice; 54% in the core; 53% in the section membranes; and 45% in the albedo or inner layer of the peel. All of the fruit tested met the usual legal maturity standards for acid and Brix, yet those samples whose juice contained more than 0.070% naringin still possessed an immature bitter taste. Grapefruit juices containing less than 0.050% naringin seem to have a superior flavor, that is milder and more pleasing. It would thus appear that as the naringin content decreases the flavor increases or improves so that when the naringin content is at a minimum the flavor is at a maximum. It should be pointed out, however, that flavor is not entirely dependant upon naringin or any other single factor.

since several factors are known to contribute substantially to the flavor of citrus and probably just as many unknown. Some of the better known factors are sugar content, concentration of citric acid, total solids, pH, sodium and potassium concentrations, pulp content, and oil content.

The naringin content of grapefruit rind grown in Califorina was found to average 7.3% by Harvey and Rygg (4). This is considerably higher than found for the Rio Grande Valley fruit. These same workers found the flavedo layer to average 6.38% (4.17 lowest to 7.87% highest) and the albedo layer to average 8.26% (5.96–10.35%) for the Marsh variety grown in the Corona-Fontana area during the regular harvesting season which extends from March to September. This area corresponds to the western part of southern California. Their data for the flavedo layer averaged 4.80% (3.01%–8.24%) and for the albedo layer 8.15% (6.85% –10.17%) for the same variety grown in the Oasis area during the regular harvesting season there which extends from November to April. This area corresponds to the Imperial and Coachella Valleys of California. The only information available on the naringin content of grapefruit grown in Florida is that of Zoller (8). These data are believed to be of little value because of the inadequate methods then available. The flavedo of the Marsh grapefruit grown in the Rio Grande Valley averaged only 1.08% naringin (0.61%–1.73%) while the albedo averaged only 3.11% (2.04%–5.35%) for the early part of the harvesting season. One should expect the average for the whole season to be somewhat lower than this since the naringin content decreases during the season. The Duncan variety grown in the Rio Grande Valley averaged even less than the Marsh; the flavedo averaged only 0.83% (0.45%–1.73%); and the albedo averaged only 2.50% (1.49%–4.00%). (This survey was prematurely ended by the severe freeze of January 30-31, 1949.)

A few naringin values for the various parts of grapefruit grown in California have been published by Davis (2), but the variety or varieties used were not stated. His value of 0.014% naringin for whole juice ic sonsiderably higher than those herein reported for grapefruit picked after the middle of November in Texas. The reported values of 0.068% for fresh juice and 0.102% for canned juice from California grapefruit are likewise much higher than those found for fresh or canned juice from Texas grapefruit. Our tests failed to reveal any change in naringin content during commercial processing, and checks made on the three most widely used mechanical extractors failed to show any significant difference in the amount of naringin in extracted juice. As previously stated grapefruit juices containing 0.070% or more naringin are considered to be of poor flavor so far as Texas commercially canned juices are concerned.

Further work correlating naringin content with maturity and respiration during storage are in progress.

TABLE I

DISTRIBUTION OF NARINGIN IN TEXAS GRAPEFRUIT

Date picked	Flavedo %	Albedo %	Sec. Mem. %	Core %	Juice %
DUNCAN (white, seedy), Texas A&M Expt. Station, tree 6, row 6.					
10/13	1.73	4.00	2.92	3.51	0.095
11/17	0.56	2.52	0.89	1.13	0.049
12/23	0.57	2.00	0.79	1.20	0.035
1/27	0.45	1.49	0.69	1.28	0.015
DUNCAN (white, seedless), Texas A&M Expt. Station, tree 1, row 0.					
10/13	2.38	5.35	2.91	2.42	0.130
11/17	0.61	2.04	0.74	0.97	0.043
12/23	0.67	2.69	1.35	1.07	0.054
1/27	0.67	2.37	1.38	1.67	0.019
THOMPSON PINK, Texas A&M Expt. Station, tree 4, row 0.					
10/13	5.45	4.90	2.05	1.34	0.095
11/17	0.77	2.43	0.68	0.74	0.035
1/27	0.57	2.11	0.90	1.00	0.013
FOSTER PINK, Texas A&M Expt. Station tree 7, row 8.					
10/13	1.40	4.12	2.10	2.60	0.133
11/17	0.67	2.30	0.93	0.92	0.035
12/23	1.05	3.32	1.41	1.68	0.031
1/27	0.57	2.04	0.84	1.17	0.019
BALLARD (red), Ballard Grove, tree 1, row 4.					
10/13	3.50	9.58	4.38	3.44	0.113
11/17	0.90	3.34	1.32	1.32	0.019
12/23	0.91	3.46	1.09	1.05	0.035
1/27	0.92	2.50	1.11	2.00	0.020
CURRY (red), J. L. Crump Grove, tree 1, row 4.					
10/13	1.36	2.60	1.90	2.00	0.058
11/17	0.58	2.58	1.56	1.87	0.020
12/23	0.91	2.80	1.56	1.41	0.019
1/27	0.79	1.75	1.14	1.59	0.016
HENNINGER (ruby red), Goodwin Grove, tree 4, row 9.					
10/13	1.25	4.02	3.07	5.42	0.074
11/17	0.41	2.46	1.15	1.48	0.019
12/23	0.51	4.10	1.16	2.24	0.019
1/27	0.59	2.75	1.27	1.58	0.039

Table I (continued)

Date picked	Flavedo %	Albedo %	Sec. Mem. %	Core %	Juice %
LANGFORD No. 1, Langford Grove, tree 1, row 1.					
10/13	3.15	4.86	2.85	3.83	0.188
11/17	0.93	2.76	0.91	0.86	0.039
12/23	0.50	2.32	0.97	1.24	0.028
1/27	0.57	3.03	1.19	1.73	0.018
LANGFORD No. 2, Langford Grove, tree 2, row 2.					
10/13	1.48	3.90	1.75	2.26	0.059
11/17	0.65	2.80	0.83	0.93	0.036
12/23	0.74	2.34	0.95	0.97	0.033
1/27	0.41	2.42	0.94	0.81	0.014
RIDDLE, Harrington Grove tree 2, row 2.					
10/13	1.39	3.86	1.63	1.92	0.078
11/17	0.45	2.17	0.82	0.87	0.040
12/23	0.58	2.63	1.24	1.18	0.033
1/27	0.51	2.27	0.99	1.44	0.018
SHARY (red), Muecke Grove, tree 1, row 4.					
10/13	2.91	4.95	2.55	1.39	0.100
11/17	0.71	4.00	1.19	2.06	0.026
12/23	0.86	3.86	1.92	1.18	0.047
1/27	1.22	2.54	1.40	1.25	0.026
WEBB (red blush), Webb Grove, tree last, row 1.					
10/13	2.43	4.95	1.70	2.92	0.086
11/17	0.55	2.53	1.26	2.06	0.023
12/23	0.71	3.75	1.56	1.56	0.019
1/27	0.54	1.88	0.99	1.19	0.016

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A Brief Summary of the Current European Citrus Situation Together with Excerpts from Recent Department Publications on the Dried Fruit and Deciduous Supplies For European Markets

E. L. BURK, *U. S. D. A.*

Mr. Burke is the citrus specialist in the Division of Fruits, Vegetables and Sugar of the Office of Foreign Agricultural Relations, USDA, Washingtin D. C.. He is an authority of the citrus situation in the various citrus producing areas of the world.

The recent wave in devaluation in Europe has not materially influenced the citrus marketing situation in reference to United State supplies. Switzerland and Belgium will continue to be our primary purchasers.

With the large supplies of good quality fruit on the winter market coming from Spain, Italy, North Africa, Cyprus, and Israel, Europe will not accept large volumes of United States winter fruit. As was the case before the war, the primary fresh citrus market for oranges in Europe is a summer market.

Since the war, European citrus consuming habits are changing and from the evidence of consumption from countries who have had an abundance of citrus exchange as Switzerland, Belgium, and Sweden there is a general trend to consume approximately 25 percent more citrus than before the war. There is also a tendency to consume more grapefruit, and both Texas and Florida plans are meeting expectations on both the Belgium and Swiss markets. Importers in both countries expressed to me their appreciation of the fine quality of Texas and Florida grapefruit and they look forward to the time when sufficient supplies will be available to permit the resumption of foreign sales. The United States grapefruit is highly competitive during the winter months since no other world citrus area can offer fruit of equal quality at this time.

From limited observation in 1949 at the Antwerp auctions, the price of red or pink grapefruit was higher than that of white. For example, on January 6, 1949 size 112 grapefruit sold at the average price of 2.97 cents per United States pound and red grapefruit at 5.94 cent per pound. On January 31 in the same size white grapefruit sold for 6.79 cents per pound and red grapefruit at 7.68 cents per pound. These prices are approximate and represent observations from small samples only, but they are indicative of Europe's market acceptance.

On November 25, 1948 at Antwerp the following average orange prices were observed for size 252 fruit:

	Approximate price, U.S. cents per pound
Cyprus Ovales	11.00
Texas Navels	8.60
Moroccan	12.88

For the same sized fruit the following average prices were observed on January 6, 1949:

	Approximate price, U.S. cents per pound
California Navels	9.59
Texas Navels	6.27
Spanish Blond	9.66
Spanish Navels	8.73

Also, on January 31 for the same sized fruit the following prices were noted:

	Approximate price, U.S. cents per pound
California Navels	8.65
Texas Valencia	6.86
Spanish Blood Ovales	8.60

The majority of the Texas and Florida fruit is lettered in the above; also, color added, and some of it shipped in Bruce boxes. The color added fruit which has been observed in Europe has been universally in very unsatisfactory condition. However, Florida pineapples have been seen in Europe in excellent condition. The Bruce box does not appear to be a satisfactory export container.

The European winter supply of oranges will be somewhat smaller this season than in recent past. Spain has a somewhat smaller crop than last year as does Algeria and Italy. Due to the civil war the production of citrus from Palestine has been drastically reduced, and production for several years to come will be about one-half that of recent years, probably not exceeding 7 million boxes. Of the immediate European area, Morocco alone will have a considerable increase in production due to the rapidly expanded planting which are now coming into bearing. From recent reports, it would seem that the Spanish citrus crop has been disposed of through compensation agreements with western European countries including France, the Netherlands, Belgium, Switzerland, Norway, Denmark, and a recent purchase by the British Ministry of Food.

The difficulty of selling American citrus products abroad remains the same, with European governments continuing to regulate the control of foreign exchange and directing their expenditures toward hard commodities only and seeking to obtain supplies of citrus from soft currency areas.

The future of Texas in the European market is fresh fruit, and the development of outlets for processed citrus through advertising and merchandising. The American Citrus Industry is competitive with most others in both the quality and price of processed produce, and by efforts to break down the tradtional European distrust of tin products and by educating them to drink juices, a considerable increase could be made in the market of both Belgium and Switzerland.

The following are quotations from recent O.F.A.R. reports which set forth the situation regarding the supplies available of both dried and fresh deciduous fruits:

"The 1949 preliminary estimate for the production of dried prunes in the 8 leading foreign producing countries is 52,200 short tons, compared with 39,000 tons (revised) in 1948 and 36,500 tons (revised) in 1947. The estimate is 61 percent above the 5-year (1943-47) average of 32,400 tons and 35 percent above the 10-year (1938-47) average of 38,700 tons. This year's estimate is the largest since the record high in 1939.

"The 1949 preliminary estimate of raisin production outside of the United States is 196,200 short tons compared with 238,400 tons in 1948 (revised) and 158,700 tons in 1947 (revised). The present estimate is 4 percent below the 5-year (1943-47) average of 204,800 tons and 8 percent below the 10-year (1938-47) average of 213,400 tons.

"Imports of bananas into Europe amounted to 20.6 million bunches in 1948, the United Kingdom, France and Spain receiving 18.2 million or 89 percent. Imports into the United Kingdom of 6.6 million bunches were 41 percent higher than during 1947 but were only about half of the prewar total of 13.1 million. Bananas came chiefly from British Wst Indies, Nigeria and the Canaries, with 3.0, 2.1, and 1.5 million bunches respectively. Imports into France amounting to 6.3 million bunches in 1948 were 67 percent above the 1947 export of 3.8 million but 16 percent below the prewar average of 7.5 million. Most of the imports into France are supplied by French possessions. Spain's imports come chiefly from the Canaries and are estimated to be 5.3 million bunches in 1948. Belgium imported in Spain's imports come chiefly from the Canaries and are estimated to be 5.3 million bunches in 1948. Belgium imported in 1938, 1.3 million bunches, about half million less than during 1947 but more than it had imported prewar.

"European apple production, is indicated to be 311.4 million bushels, 12 percent higher than the 1948 crop of 279.0 million bushels but 7 percent below the prewar average of 333.8. Production, excluding cider apples, is indicated to be 232.1 million bushels compared with 202.7 for the previous year and 176.4 prewar. Pear production for the principal European countries is indicated to be 97.5 million bushels, 36 percent above the 1948 crop of 71.5 and 15 percent higher than the prewar average of 85.0. The total production, excluding cider, is indicated to be 86.1 million bushels compared with 60.1 for 1948 and 63.0 prewar.

"The European production of cherries estimated at 727,828 tons is 13 percent above the 1948 crop of 645,141 but 11 percent lower than the 815,387 produced prewar. The largest producer of cherries in Europe is German. Production, because of

good growing conditions, is indicated to be 120,000 tons, 8 percent higher than the 1948 crop of 110,865 and 26 percent below the prewar average of 163,240.

"Peach production in Europe totaled 19.9 million bushels, with Italy, France and Spain producing 85 percent or 4.5, 9.2, and 3.3 million bushels respectively. The current crop in Italy, indicated to be 9.2 million bushels, compares with 8.8 for 1948 and 11.0 prewar. Frost damage to peach trees in France was not serious and the current crop will probably be 50 percent higher than the 1948 crop or the prewar average of 3.0 million bushels. Spain with 3.3 million bushels indicated, is a little higher than last year's crop of 3.0 million and the 1935-39 average of 2.6 million.

"In most European countries a larger crop of plums and prunes were harvested in 1949. The indicated crop of 1.8 million tons is 11 percent higher than the 1948 crop of 1.6 million, and is almost equal to the large crop of 1.9 million in 1946 and to the prewar average. Indications are that Czechoslovakia, Germany, Rumania, United Kingdom and Yugoslavia produced 63 percent, or 1.1 million of the 1949 crop; this compares with 50 percent for 1948 and 74 percent prewar.

"Apricot production in Europe, estimated at 215,107 tons compares with 139,603 for 1948 and 182,865 for the 1935-39 average. France, Hungary, Italy and Spain accounted for 85 percent, or 182,247 tons, of the total European production this year Production in France of 39,165 tons is 80 percent above last year's small crop of 21,780, but more than double the average production of 17,867 tons before the war. Hungary has a bumper crop of 51,808 tons, compared with 18,841 for 1948 and 26,560 prewar. Italy's crop of 21,274 tons is about 1,000 tons more than last season's crop but 23 percent below the prewar average of 27,594. Spain, Switzerland, and Yugoslavia each had increased production this year."

Treatment of Rose Bushes When Harvested from Commercial Fields

E. W. LYLE, *Plant Pathologist*
Texas Rose Research Foundation, Inc.
Tyler, Texas

Dr. Lyle is interested in ornamental plants and is principally working on culture of roses, storage, varieties, etc., at present. Dr. Lyle has also held positions with the U. S. Dept. of Agr., the New York Florist's Club Fellowship of Cornell University and with the Texas Agricultural Experiment Station.

The phase of rose investigations that is herewith described goes a little beyond the ordinary conception of rose culture. It should, however, be appropriate for horticultural interests, and involves the care of bushes after they are mature and ready for digging in the commercial fields. It includes getting the bushes ready for storage or for shipment and sale in stores or directly to the individual customer.

One of the first problems in harvesting rose bushes is to prevent drying as they are dug and removed from the soil. This drying comes from exposure of the roots, continued transpiration from leaves which remain on the bushes, and also there is some loss of moisture through the canes themselves. Roses can tolerate considerable drying, fortunately, but such loss of moisture is not beneficial and can reach the stage of injury.

The need for rapid handling and protection of the roots at digging time is evidenced from the rapid decrease in weight of bushes following removal from the soil even under optimum conditions. This occurs even when the weather is cool and the atmosphere very humid. In the experment cited in Table 1, the roses were dug on December 11, 1946, and the day was cool and rainy. The bushes were weighed in the field and carried immediately into a packing shed, where they were sprinkled one time with water just as they were placed in the shed. Next day (28 hours after digging) the bushes were reweighed in the shed prior to placing in a railroad refrigerator car for shipment.

The average loss in weight was 12% for the five varieties in the 28 hours after digging. The fact that most of the loss was from the roots was indicated by the average loss being about the same whether the bushes were pruned back short or not. The average decrease in weight was 13% where the plants were pruned short and 11% where they were pruned long.

To reduce the drying effect that digging and taking from the ground has on the bushes, some of the commercial growers wet the plants in the field right after they are taken from the ground. Then the bushes are placed in sheds or under cover as soon as possible; and the hauling is done in covered or enclosed trucks.

Foliage on the bushes at digging time is a source of trouble both from the heating effect when the bushes are bunched and tied, and also from the damage that decaying leaves do to the canes which they touch when in storage very long. Sheep have been used to pasture off the foliage as much as possible just before digging. This has been done

for a number of years in a few of the commercial fields on the west coast. In the East Texas area a machine recently has been developed which strips off most of the leaves just before the digger is run under the plants. Work is in progress to find a chemical which will give a satisfactory defoliation, but none has been found to date. Previously a good chemical

Table 1

Loss in Weight of Rose Bushes Immediately after Harvesting.

Variety	Cane Length* after Topping	Av. Wt. per Bush Lbs. When Dug & Topped	28 Hrs. Later	Loss in Wt. Lbs.	%
Red Radiance	30 inches	1.34	1.14	0.20	15
Red Radiance	15 "	0.85	0.69	0.16	19
Texas Centennial	30 "	1.40	1.23	0.17	12
Texas Centennial	15 "	0.95	0.84	0.11	12
Lady Hillingdon	27 "	0.68	0.63	0.05	7
Lady Hillingdon	14 "	0.50	0.48	0.02	4
Golden Dawn	24 "	0.98	0.86	0.12	12
Golden Dawn	12 "	0.73	0.61	0.12	16
Hinrich Gaede	22 "	0.81	0.72	0.09	11
Hinrich Gaede	13 "	0.61	0.53	0.08	13

*Length of cane was measuered from the base of the shank to the top of the cut-back canes. Calculations are from bundles of ten bushes each, a total of 400 bushes for the experiment.

treatment has been reported from Oregon in 1940, but it is not adaptable for use in the field (Science Vol. 91; No. 2352; p. 100). This utilized ethylene gas from apples placed in storage with the roses.

Another treatment which has been developed to help preserve rose bushes is the waxing of the canes. This is most usual in the case of bushes which are root-wrapped and to be merchandised over the counter to general store trade. A thin coating of paraffin or some similar material will do much to prevent drying out of the canes and the packing material also. In a trial to determine about how much moisture loss there was, three bushes were pruned and root-wrapped with moist packing material in waterproof paper. Three more were similarly prepared and in addition had the canes and top of the pack dipped in a melted paraffin type wax. Both lots were kept on a shelf at room temperature for three weeks. Weights takn before and after that time indicated the unwaxed packages lost about twice as much weight as the waxed ones (23% compard with 14%). A later trial with another variety was prepared with the top of the rack sealed with wax but the canes not waxed except where the top of the packing material was coated. This preparation allowed a 39% decrease in weight during 25 days as compared with 13% loss where the entire canes and the top of the pack were both waxed. Coating the entire cane showed considerable benefit.

The kind of wax to use has been the subject of experimentation for many years. In 1944 the Michigan Agricultural Experiment Station (Special Bulletin 222, p. 5) suggested dipping the canes in a hot preparation of paraffin, resin, and beeswax. The mixture was usable at 170° to 190° F. The bulletin states that "any device that retards drying out of the tops is beneficial". More recently paraffins of lower melting point have come into use; so now it is possible to do the treating with a compound at 150° F. or lower.

There also are cold wax treatments available with the materials a liquid at normal air temperature. These change upon drying to leave a waxy film over the bark. So far, these have not been satisfactory or at least have not come into general use on roses.

Since the apparent benefits of waxing rose canes have been mentioned, it might be well to point out one or two of the possible disadvantages. It has been observed that the branches which are waxed seldom are the canes which last through the first year after planting. They usually die back, and the bushes depend for growth upon new bottom breaks or shoots which originate from near the bud union. This may not be a definite harm, but it is not a normal reaction. Unwaxed bushes tend to keep the original branches active through the first year besides acquiring new shoots from near the bud union.

Another treatment involves the use of dye materials in the waxes. Some are an attractive transparent color. Others may be so intensely colored that bark characteristics are hidden, covering up dead canes and possible injuries. This could result in the misuse of the wax beyond the purpose of getting the rose bushes to the customer in as good condition as possible.

The Potential For Ornamental Horticulture In The Rio Grande Valley

A. F. DeWerth, *Head*
Department of Landscape Art
A & M College of Texas

Dr. WeWerth is a former Director of Phipps Conservatory, Pittsburg, Pa., one of the largest public Conservatories in the world He also served on the staff of the University of Pittsburg as Lecturer and Horticultural Consultant. He served as Horticulturist with the Pittsburg Bureau of Parks, and was Garden Editor of the Pittsburg Sun-Telegraph. Dr. DeWerth has spent three years in the Far East with the U. S. Army Corps of Engineers.

Our interest today lies in the extent to which we, as individuals or firms, will be affected by studies of the economic forces at work in the operations of floriculturists and ornamental horticulturists in the Rio Grande Valley as well as in Texas and the nation.

For several months past, and at present, we are facing radical economic changes. In any discussion of potential possibilities for ornamental horticulture we require a complete revaluation of the many factors of supply and demand, to successfully meet the changing economic and trade conditions in the competitive world of today.

Many industries accept this challenge with increased attention to production and distribution techniques, others seek new markets and new products to keep pace with expanded producing capacity. The ornamental plant industries must face the same picture. Whatever the approach, however, the untapped field in production and marketing of ornamental plant products in the Rio Grande Valley area provide a realm of opportunity which may well stagger the imagination.

In contemplating opportunities in the field of ornamental plants it is perhaps best to begin with the products of the industry. They are what the public sees, discusses and must like well enough to buy. We must also have in mind considerable work and a concerted effort to see that he does buy it. Production is lost without merchandising. We must be extremely interested in the present trends and future possibilities for the sale of ornamental plant products if we, as individuals, and the industry as a whole is to prosper. The prime reason anyone is interested in business and business potentials is to make a profit, and no profit is made until products are sold.

In most areas devoted to the production and sale of ornamental plant products much work has been done to improve and develop the production phases of this industry through research and practice and much of this work can be made applicable to conditions prevalent in the Rio Grande Valley, much more will be required as well.

Because of the service given and the commodity handled by ornamental horticulturists, they are aware that the users of their merchandise have been more highly selected than in other types of horticultural endeavor. The picture to strive for in the future, however, is a position in which we cannot tell the customer from the common people.

Our question is, what is the potential for ornamental plants in the Rio Grande Valley and what are the chances for success.

To begin answering this question, one line of thinking and planning is essential. Nothing is as constant as change. In ornamental horticulture, as in any other line of endeavor, yesterday's best is not good enough today. Things that were achievements years ago are no longer considered adequate today.

Thinking, standards and needs change. Success will not just happen. It is rarely a product of chance or circumstance, and never achieved by wishful thinking. Success in business must be planned. It is the result of a postive program of action.

How can we plan to make the best use of our opportunities in the field of ornamentals?

Certainly we cannot plan without basis. The various lines of endeavor comprising the ornamental plant field are made up of individuals and firms where few members are eager to divulge information relative to their own business, yet there are few who are not eager to accept information on the average costs of production; inventories of state production; extent of the sales volume of the industry; the population employed; potential selling or location of areas in relation to housing; and various other items that are essential in studying present trends and future potentials.

The ornamental plant field must also progress from a small industry producing a low volume of plants of indifferent quality which have, in most cases, been sold at a low margin of profit to an industry producing and selling a great volume of better quality plants and flowers.

A brief analysis of the past performances of floriculture and ornamental horticulture in Texas might serve as an example of what the potential in this area as well as Texas might be. Surveys of gross sales of ornamental plant products show that we are failing to produce by 75 per cent the products that we sell. This merely means we could increase production to four times its present value and then only supply little more than our own demand for ornamental crops.

From the florist's standpoint, we are buying many of the better grade flowers that grow well in our section or that can be replaced by others that would grow well. From the nursery stand point, too many plants sold here are produced elsewhere, and too many of those produced here could be replaced by others that are better suited to our conditions or that would sell better here and elsewhere.

Economic studies indicate that a very close relationship exists between the volume of retail florist sales and the volume of nursery sales. About two-thirds of gross sales of ornamental plant products are retail flower sales and about one-third are nursery stock and related outdoor items. Statistics show that on an average since 1909 consumers have consistently spent one-fourth of one cent of each dollar of disposable income with the retail florist. This indicates an average of 0.36 percent of all consumer expenditures goes for our products. The answer is very simple. We are not selling enough of our products or getting our share of the consumer's dollar. This proves without a doubt that our competition lies outside our industry.

The question then becomes—what can be done to improve this situation and to take advantage of the potential that exists for ornamental plants?

The following considerations might be offered for bettering the various phases with which we are concerned in the field of ornamental plants as they relate to the various opportunities existant in the Rio Grande Valley.

1. Increase our production to more nearly supply the ornamental plant products sold in this area and throughout the state.

2. Concentrate this production on crops and plants which are well adapted to these climatic conditions.

3. Develop the methods best suited to fully utilize the favorable climate in the production of better quality plants and flowers, outdoors, under expedient structures suited only to this climate, and increase yields—or, in other words, more plants of better quality with the same effort and space.

4. Study our own particular problems and train our own personnel.

5. Increase the knowledge of everyone—in and out of the industry in the field of ornamental plants.

We need more knowledge of our products and operations in the Rio Grande Valley area to carry out long term active planning. Any plans for short or long periods of time are dependent on the information at hand. We must become record concious in our operations to avoid costly mistakes.

The potentials in this area are great, and if proper planning is done and carried out the possibilities for increasing the size and scope of the activities in ornamental plant fields are unlimited.

The climate here is the important asset in the production of these crops. It has only been exploited on a small scale to date. Nature works no miracles, however, and can do nothing for those who lack determination and ambition. This advantageus climate opens no portals for those who seek quick and easy success.

In most sections of this particular area there are nearly frost free areas; however, in these sections there are not sufficiently low temperatures for chilling certain ornamental crops that require this in their environment. We must resort, therefore, to cold storage facilities in some of our operations.

Sunlight intensities and duration are favorable to many crops and unfavorable to others.

An added advantage, in some cases, where climate has been a boon to production when properly exploited, is that it permits the spreading of that production over longer periods to meet more advantageous markets. Not properly exploited, however, it imposes an additional factor to confuse the newcomer and uninformed grower. Hence we should train our own personnel and prevent encroachment on our opportunities.

Most regions might be classed as semi-arid where rainfall comes only at infrequent intervals. Irrigation, therefore, becomes a necessity and should be provided – this is true in other areas also – not to prevent droughts, but to be prepared should they arrive. Evaporation is great under these conditions and an adequate water supply must be provided. This condition also has advantages, however, as it essentially eliminates foliage diseases that are favored and spread by moisture and humidity.

Moderate winters are not entirely a blessing. They encourage more or less continuous development of insect pests, weeds, and many diseases. This imposes problems of rigid pest control.

The psychological effect of this environment on the florist and nurseryman himself cannot be entirely overlooked. There is evidence to indicate that in the past we have had a tendency to "let the climate do it" rather than to capitalize fully on this natural advantage by using the best possible cultural methods.

To progress and prosper, proper growing areas must be selected, successive plantings in variety must be made. We must breed our own ornamentals to develop varieties resistant to the various troubles we are faced with under our particular conditions.

Soil borne diseases have contributed to transient culture of some of our ornamental crops. In other areas where large investments in greenhouses and buildings have denied growers this privilege, they have used scientific knowledge to combat such problems. We must do the same in the future.

A planned program for the development of ornamental horticulture with the employment of scientific practices and well trained, efficient help is the insurance that is necessary to expand our potentialities.

New methods and increased efficiency in production will not be enough however. A sounder knowledge of the economic and marketing problems pecular to the area and to ornamental plants is also essential. A balanced growing program, by those best able to produce the highest quality plants at the lowest price and then market these at a fair profit, must be the goal.

To achieve the place in the ornamentals field that this area so richly deserves, general complacency over quality must give way to an appreciation of the substantially higher quality of ornamentals that are produced in other sections with more adverse environment and at higher costs than will prevail in this area.

Perhaps the potential for mass marketing is greatest, but quality must prevail and is never overlooked on a buyers' market.

Much of our opportunity is dependent on developing and supplying our own markets before going too far afield. Our problems of quality, production, and marketing are different and should be solved, developed,

and supplied by our own growers. This makes this area and the state as a whole a place of abundant opportunity for both grower and merchandiser. The emphasis in both research and practice should be in reduced variability in quality and yield, for this will do much to determine our markets and our future.

We must develop our methods and markets and keep ourselves informed on developments and be neither scornful or apprehensive of competition and try to adapt ourselves rapidly to any changes that may come in the industry as a whole. We must consider the other states with like climatic areas as well.

I maintain that it is logical and reasonable for the people of any newly developing area to demand that they be given access to the plant materials, wherever they exist in the world, out of which it may be possible to build the best plant surroundings, both economic and cultural, of which the area is capable.

It has been proven in many other areas, that this material must be obtained, preliminary tests made; and as soon as it is practicable delivered to the people in the area through nursery firms or by distribution to bona fide experimenters and experiment stations where it will be tested as to its adaptability to the soil and climatic conditions of the region and where its possible uses will be studied. By these means alone can we determine which crops are best suited to this area.

The facts that govern the sale of our products today are one of the greatest assurances of our opportunities. Today landscape plant materials are sold to comparatively few people if we consider everyone a potential customer. Ninety per cent of the sales in retail flower shops are for occasions demanding flowers—funerals, weddings, birthdays, sickness, and other like occasions. These occasions increase or decrease very little with the abundance or scarcity of our products.

The only part of our retail outlets that is materially affected by price is the purchase of take home plants and flowers. In general, this outlet is so small a part of the total business that it is negligible. The potential importance of this market alone is colossal and we could not do better than to set our sights to develop it to worthwhile proportions. This can and will be done when we are prepared to offer consistently dependable merchandise at stable prices.

Cooperation and organization of all those interested in ornamental plants in the Rio Grande Valley area can be of great value in developing the splendid potential that exists. Through such organization they can bring to the attention of the colleges, experiment stations, and other research agencies the need for study, research, education and extension on the production and marketing problems of the nurseryman and the florist. Organizations comprised of such interested parties must also assist in educating the public to understand and appreciate the role of landscape and flowers in the pursuit of living and the enjoyment of a home.

In my considered opinion the potential for ornamental horticulture in the Rio Grande Valley is as great or greater than in any other area with which I am familiar. I wish to assure you that we at A. and M. College stand ready to help you develop this potential to the limit of our facilities and time.

Ornamental Plants For The Rio Grande Valley

By MRS. DALE WASHBURN, *Donna, Texas*

Mrs. Washburn has spent 7 years as a florist doing nursery and landscape service. She is interested in all phases of floriculture and is a charter member of the Donna Garden Club. She has just completed a year as Beautification Committee Chairman of the Valley Chamber of Commerce. Mrs. Washburn is a member of the State Florists Association and is Secretary-Treasurer of the Retail Florists Association of the Valley.

January 12th, 1950, will go down in history as a Red letter day, not only for the Valley Horticultural Society, but for the further development of the Beautification program being carried out by the entire Lower Rio Grande Valley. While I am by no means an authority on condition, and haven't the answers for the many problems which confront the Valley horticulturist, it is with a great deal of pleasure that we bring you general information which might prove to be of assistance.

Today's discussion of the ornamental phases of horticultural work is probably the first of its kind on the annual Horticultural Society's program, and it is a division that can mean more at the present time than ever before, to Commercial and individual growers alike. Much research and experimenting is necessary, and by each of us working, individually and collectively, by pooling our knowledge and experience, we cannot only enlarge and expand the business of producing ornamentals, but encourage greater plantings and benefit by an even more beautiful Valley.

There is probably no locality which affords a longer listing of ornamental plants than the Lower Rio Grande Valley. While many of these ornamentals are natives to this section, a surprisingly large number have been imported from other localities and have grown well here. Despite our general soil condition, water and climate, such acid-loving plants as gardenias, camellias, azaleas, hydrangeas and magnolias ARE being grown; the success of such plants is of course dependant upon the effort, time and trouble expended by the grower.

It must be remembered that Wholesale and Retail growers have accomplished remarkable results in the Valley with the following plants; Potted plants of the foliage type, such as philodendrons, pothos, peperonia, diffenbachia, Chinese evergreen and etc., cacti and succulents, bougainvilleas, hibiscus, oleanders, palms, gladiolas, easter lillies, iris (Wedgewood) chrysanthemums, tube roses and roses. Not all of these can be be classed as strictly ornamental shrubs, of course, but we list them to show what has been accomplished on a wholesale scale.

Such failures as have resulted in the growing of ornamental stock in the Valley (both by professional and individual growers) may be attributed to the following factors: (1) Lack of knowledge of requisite growing factors; (2) insufficient study of location, soil content, and water drainage. (3) Changing trends of market demands (4) lack of proper marketing facilities, and (5) trying to grow numerous varieties, rather than specializing in one or two particular plant families.

These are some of the oranmental shrubs which are probably in

greatest demand at present: bougainvilla, hibiscus, oleander, strelitzia, bottle brush, plumbago, Chinese hat, thryallis, cassia, esperansa, acalapha, althea, banana, yucca, canna, ceniza, cigarette or firecracker plant, crottons, deadalacanthus, dombeya, golden dew drop, pyracantha, Indian carnation, jasmines, lantana, manzanita, ligustrum, papaya, poinsettias, pittisporum, pomegranate, rubber plant, shrimp plant, trumpet flower, tavershine, and ornamental grasses.

Popular demand trees are found in the following list: Australian pine; acacia; anaqua; Brazilian pepper; ebony; French salt cedar; hackberry; huisache; jacaranda; loquat; mesquite; orchid tree; palms; royal poinciana; Rio Grande ash; silver maple; tallow tree, tepehuaje; and tiger apple.

The demand for tropical or sub-tropical ornamentals has increased rapidly in the Valley of latter years, due to several facts. The fact that so many are typical of this area is one reason; another is that they are easily grown and cared for, and they lend themselves in a very decorative manner to both Spanish and modern types of architecture so popular in the Valley.

Last year's cold weather had a momentary tendency to influence many in asking for hardy ornamentals; however, the rapid recovery of damaged plants and the quick growth of new plantings has made this trend only a passing one. Marketing of a large volume of some tropical or sub-tropical plants by wholesale growers is perhaps not practical, due to the fact that many are acclimated strictly to this section, and are not in demand by Nurserymen farther north. Many of the most popular ornamentals grown north of us can, however, be grown here.

Propogation of ornamentals can certainly be increased, under correct conditions, by caretakers educated in the proper methods. Research and study are definitely needed to determine a profitable program.

A large percentage of all ornamentals sold as "finished plants" in the Valley are purchased as liners, from California and Florida, as well as other areas. Some success has been met with plants imported from Cuba, the Hawaiian Islands, Australia, Mexico and other climates similar to that enjoyed in the Valley. Many of these plantings are still in the experimental stage, and it would be well for the individual grower to consult his local nurserymen before attempting too ambitious a design.

May I emphasize again that the most urgent need for research, study, training and experiments with all new plants, as well as our better known varieties.

Let us begin, as soon as possible, on a definite program to expand ornamental horticulture. The field is wide, the opportunity is here, and the returns are well worth while, not only from a financial standpoint, but in making of us better growers and resulting in a more prosperous, more beautiful Rio Grande Valley.

Lawns

JAMES M. WALKER, *Manager, Landscape Architect of Baker-Potts Nursery Company of Harlingen, Texas*

There is little that is more beautiful than a well-planned and maintained lawn. It is normally the most dominant feature in any landscape, framing the buildings and enhancing the plantings. A beautiful, well-maintained lawn will increase the physical and sentimental value of any home. A beautiful lawn cannot be had without proper planning and lots of hard work on the part of someone whether it be the owner or the contractor. The soil and topography have to be studied to establish the final grade, quality, and quantity of soil to be used.

In order to have a beautiful lawn, care must be taken in every step in grading as it is the foundation upon which the lawn stands. Grading should be done in more or less the natural contours of the plot unless there is a definite reason for changing them in the mind of the landscaper. Severe grades without proper retainers should be avoided wherever possible for they are difficult to water and maintain without undue washing. If the slopes are exceedingly great, dry retaining walls and terracing is a must on slopes of greater than one foot to three feet horizontal.

If there is to be a great deal of grading work, the top soil should be scraped to one side until the sub-grade is established, then put back. Without good top soil grass does not have a chance to survive and become established. If there are any areas that will have to be filled excessively, they should be filled with a sandy, gritty soil for good packing and draining. Trash, brush and building debris should not be used for they will decay and cause settling. One of the greatest mistakes made by lawn builders is to cover their existing top soil with any old soil they can get which normally comes from street paving operations or from building excavations. The top soil is the important feature in building an lawn. Top soil should be a sandy loam soil, four to six inches deep, with the physical properties of good texture, structure and sufficient organic content.

The type of equipment for the soil preparation job depends upon the amount of dirt to be moved. Bull-dozers and graders can be hired to do the heavy ground moving, whereas a jeep or small tractor with a dozer blade can do the average job. Small garden tractors can do work in a short time that would require many man-hours of hand labor.

Well-rotted barnyard manure, goat manure, or organic compost is practically an essential to good lawns. The material should be worked into the top soil so that it will give the growing grass the necessary elements and organic matter that are so essential in establishing a lawn.

Most people forget that a lawn is composed of thousands of small, living plants crowded into a relatively small area. These cannot thrive in a heavy, compact, infertile soil any more than can flowering shrubs.

Before sodding, be sure to put in all water and drain pipes that are necessary, otherwise the lawn will be cut up and uneven if care is not taken in placing them later.

Here in the Valley our main lawn grass is St. Augustine grass, sometimes called carpet grass. There is a great deal of difference between carpet and St. Augustine grass, the latter being the best. There are also numerous lawns of Bermuda or Devil's Grass, but they are not as pretty as the St. Augustine. St. Augustine grass is a native of the Gulf Coast Area and is a very vigorous grower if properly cared for at planting and post-planting time. Bermuda is also a native and will take over without too much coaxing. The St. Augustine will choke out nearly every other grass and weeds that become established in the lawn.

The main methods of planting are roots and runners or sod-blocks and plugs. The roots and runner method of planting is a bare root method. It is a little cheaper, but the immediate effect is not as good as the sod-block method. Normally, one bushel of runners will plant one hundred square feet spacing the sets eighteen inches apart. Oftentimes enough materials can be gathered from friends or purchased from nurseries for a small sum.

The sod-block method is by far the fastest method of sodding and gives immediate results. Using this method, one square yard of sod will plant approximately eighty-eight square feet of lawn area. Normally the sod is removed from the growing area in foot-square blocks with about one-half inch of soil on the roots. Then, at the time of planting these blocks are cut into plugs ranging from two to six inches square. The smaller the plug, the closer you should plant; whereas the larger the plug, the more undisturbed root area will result. This is an important factor for rapid growth.

The best time to sod a lawn is Fall through early Spring. There is little apparent growth during the winter months, but the plant is establishing a good root system so that it is ready to start growing rapidly in the Spring.

Often times Italian rye grass is planted after the sodding in winter. This will give immediate result of a green lawn but will not last through the summer. It will cover while the St. Augustine is growing and by the time it dies out in the summer the St. Augustine has started a very good growth. The Italian rye grass is a rapid growing grass that needs watering and mowing often. These features help in the development of the St. Augustine in that it needs frequent watering and mowing in the early stages. The weight of the mower has a tendency to keep the runners firm against the soil so that they can be held down by their feeder roots. The newly sodded plot should be watered at least every other day and preferably every day. The soil should be kept loose and moist until the sod has covered. The coverage time is directly proportionate to the amount of water and care that is given it.

The main reason for mowing lawns is to improve their appearance, but if not properly done the lawn can be ruined. The mower should be run perpendicular to the crest of terraces or changes in elevation. If they are mowed so that the mower rides the ridge lengthwise there is the possibility that the grass will be cut so short that the back-side of the mower will scalp the crown to such an extent that the life and health of the grass is endangered.

Like all other plants, grass is a living plant which depends upon its leaves for the manufacturing of foods. Continued removal of the foliage will eventually starve any plant. Close mowing has the same strangling effect upon grass; whereas, grass that is not mowed becomes excessively tall and spindly in the competetive effort to reach the light, thus forming a thin, weak covering instead of a thick sod.

Somewhere between these two extremes lies the happy medium where the grass will thrive and yet have the desired appearance. This medium is obtained between one and one-half to three inches, the shorter being used during the winter months when rainfall is more plentiful and the sun is not so scorching hot and drying. The longer grass protects the roots during the hot summer by shading and reducing moisture evaportation from the soil.

A more uniform color is maintained by high cutting in that the tips of the leaves are cut rather than cutting the leaves down to the bare yellowish stems. Thus, the grass has a good green color rather than an artificial and scalped appearance.

Aside from the appearance, proper cutting has a lasting influence on the health of the grass. There is a direct relationship between the tops and roots of all plants, grass not excluded. A longer top growth results in a more extensive root growth. Naturally, the more vigorous and extensive root system can go out and compete for soil, food and moisture. These factors are often the salvation of a lawn during a drought period.

Also, in shady areas of the lawn, the longer grass leaves play a very important part in that the longer and more exposed leaf area can compete for the very essential light that is so necessary in the manufacturing of plant food. Thus, we can say that the lawn under shade should be cut two and a half to three inches, if possible, and not too often during the hot summer months. This is one of the most important factors in having a green lawn in shady areas.

Another important factor in having good well-groomed lawns under shady conditions is water and plant food. Trees should be fed and watered so that they do not compete with the grass for the necessary water and plant food.

At least once every two years the average lawn should be top-dressed. This procedure is to re-vitalize the soil and plant. The best top dressing material is a compost made up of organic matter, sandy soil and some commercial fertilizer. For the organic material that is used in compost barnyard manure, grass clippings, leaves, or weeds can be used. The materials are normally put in a pile, mixed and wet down so that they form an intimate mixture and left to decompose for a period to destroy some of the weed seeds.

At the time of application of top dressing the lawn should be cut close, practically scalped, so that the materials will sift through the lateral stems as much as possible and also to facilitate finding the uneven ground, which can be corrected with the top dressing.

After the top dressing has been broadcast or spread, it should be

gone over with the back of a grading rake or some light drag so as to level it and work it down. This procedure should be followed by a good watering. In a very short time the grass will be back, greener than ever.

Vigorous growing grass, like any other plant, has a much better chance of throwing off attacks by insects and diseases. There are several insects and diseases that bother our lawns here in the Valley, such as grubs, termites, scales, cut-worms, web-worms, chinch bugs and many others. For these there is no one material that will control them all, but chlordane and parathion will come close to controlling all.

Beetle grubs are one of the worst pests in our area. Their damage is characterized by brown spots that will roll up like a carpet. The grubs feed on the roots of the grass, cutting them off so that the grass dies. Termites are also a great threat to the lawns here. They feed on roots and stems. Control is effected by applications of chlordane or in cases of bad infestation an expert should be called in.

There are several precautions that you should remember in order to build and maintain a beautiful lawn. The first is to prepare the grade and soil before sodding. Then, of course, the proper planting, watering, feeding and mowing of the grass after it has been planted and established will produce a healthy, growing and beautiful lawn which is an asset to any property.

Native Ornamental Trees For The Valley[1]

RAY D. GOODWIN, *Mission, Texas*

Mr. Goodwin came to the Valley in 1929 and became interested in native plants. This interest grew into an absorbing hobby and many residents in Mission and throughout the Valley have benefitted from his acquired knowledge. Mr. Goodwin is also associated with E. M. Goodwin, Inc., which has extensive holdings in citrus.

There are few places in this country where trees, both ornamental and utilitarian, are so much worthwhile as in the Lower Rio Grande Valley of Texas. Shade here is always welcome, and especially so during the summer months. They reduce the glare of the sun, their green color is always restful, the moisture which they secure from the soil and transpire into the air makes it more pleasant and healthful.

By reason of their permanence, the planting of trees about a home should be of primary importance. A vine, a shrub, a yucca, or a more lowly plant may live as long, but those of smaller size lose their identity.

The uses of trees are many; their beauty is so universally admired, and their benefits are so various that they should be given first consideration. They may be chosen to mark property lines; for street and sidewalk planting, to act as a wind-break or shade, to form lovely groups; or as accent and specimens; for fruit, and flower, or foliage; for quick growth or for enduring permanence; for beauty of tint in early spring and late fall, or to keep parts of the garden evergreen throughout the winter.

Many of our best shade trees are native. They are suited to the climate, having become accustomed to it through many years of adaption. Soil, moisture, and drainage conditions are also to their liking, and native trees may be selected to fit into all, or nearly all situations. They harmonize with the landscape, for they are part of it, and no jarring note is introduced when native trees are planted, as is sometimes the case when introduced kinds are used.

Many picturesque and beautiful trees, such as our mesquite and ebony, were planted by nature long ago. They stand close together in clumps or groups, or far apart, with other native growth in between. Their trunks are old and knarled and crooked, they lean over to one side, their branches spread out at strange angles. They have rough tissured bark and a strong weathered look that comes to trees that have withstood winds and storms of many years. They have character, a picturesque beauty, and an individuality all their own. They blend into the landscape. They are part of their surroundings.

Often the plot of ground on which the home is to be built has such trees growing on it. Too often the first step is to clear the entire space completely, and so destroy trees that it took nature many years to produce, and which it will take many more years to replace.

The ground plan of the house and its location on the property should

1 Paper read by Ray D. Goodwin before the Rio Grande Horticulture Club April 27, 1949.

be studied carefully with reference to existing worthwhile trees. It may be possible to save fine specimens by changing the house plan or location slightly. Space for buildings and approach must be cleared away, but this should be undertaken only after careful study. Roads and walks can be located so as to pass to one side or another of fine trees.

If existing trees are to be saved, grading should receive careful attention. It is difficult to lower grades without injury to root systems. Roots of large size may be cut away on one side, but not all the way around the tree, and when this is done it is always best to prune back the top to restore the balance between roots and branches. In some cases mounds may be left about the tree sufficiently broad and high to save them, while some distance away from their trunks the grade can be reduced to the desired level.

When filling is necessary, the conditions created for the trees are more difficult. Root growth is dependent on air, and when roots are covered with an additional amount of soil, air is excluded, root growth ceases and the tree dies.

If possible, filling should be done gradually, that the roots may become accustomed to the new conditions. When this is not possible, trees may be walled in with brick or concrete. From the well four or five lines of porous tiling may be laid out as far as the tips of the branches. The fill is then made to desired level.

In the Valley, even large trees can be transplanted successfully by experts any month of the year, but for the amateurs, December, January and February are considered the safest months. The trees are then more nearly dormant and suffer the least shock from being moved.

There are two methods of digging trees, one known as "bare root", the other as "balled." The "bare root" method can be employed for all deciduous trees and shrubs during the three previously mentioned winter months, when they are most nearly dormant. When possible, it is better to dig trees "balled", as the loss of balled trees is negligible compared with that of those dug bare rooted.

At least one-third of the root system should be preserved. In cutting through the roots, shape the ball carefully and wrap tightly with burlap, so that the soil will remain solid and intact.

Trees should be cut back or pruned when transplanted. This is because the roots are pruned in the process of digging, and the top should be reduced in proportion, otherwise, too rapid transpiration takes place through the leaves. The root system remains almost dormant during its recovery from the shock of having been transplanted. Generally speaking, it is a safe plan to cut back ends of all branches from one-third to one-half their length, removing all broken, injured and weak branches.

Trees that are to be used on streets, parkways or where much traffic of any kind is to pass should be headed up at least six feet or more.

Pruning young trees is done to shape and train them. If carefully pruned every year, they will mature faster and remain in better health than if left untrimmed. Mature trees are pruned to improve their health and to repair damage. They should be given frequent inspections for ants and diseased branches.

All cuts should be made flush with trunk so there is no projecting stub. This enables the bark to roll smoothly over the cut in healing and leaves no pocket in which water may lodge and start decay.

The cuts should be treated with some form of asphaltum paint. Cavities or diseased places in trees should be cut out, that is, all dead and diseased wood removed. Large cavities in trunks of large permanent trees may be filled with concrete, after being properly cleaned out and disinfected. The smaller branches or small areas may be filled with a mixture of asphaltum paint and ground cork or sawdust. This is mixed one part asphaltum paint to five parts cork or sawdust by volume. With cavities closed and dead wood removed, the ants, which do so much damage to trees, are practically excluded.

In their natural habitat, trees are provided with food by nature. Fallen leaves and vegetation, as they slowly decay, release the chemical elements necessary for growth. On domestic property, however, the grass and weeds are gathered as they fall, thus depriving the trees of their natural source of food.

Grass growing beneath them further depletes the soil. Thus robbed of food, a dying back and a slowness of grow appear. The trees lacking resistance become an easy prey to insect enemies and disease. It is, therefore, of importance that trees on domestic property be fertilized to give the best results.

I am sure that if public utilities, such as light companies and telephone companies, also highway maintenance crews, were better trained regarding the pruning of trees along their rights-of-way, the community would be much benefited, and I am also sure that those companies concerned would have much more community goodwill. Almost daily we see our beautiful trees maimed and destroyed by thoughtless people.

A partial list of deciduous and evergreen trees that are used in the Lower Rio Grande Valley for ornamental purposes.

ABBREVIATIONS

T—*Trees that attain a height of 30' to 50' at maturity*
M—*Trees that attain a height of 20' to 30' at maturity*
D—*Dwarf or small growing trees*
R—*Rapid Growth*
"M"—*Medium Growth*
S—*Slow Growth*
VS—*Very Slow Growth*

(1) *Deciduous Trees*—

Under this head are included trees which are devoid of foliage during a short period at the winter, usually Decemebr, January and February.

ASH—*Fraxinus Velutina*—T-M. A well known native variety, with straight, clean trunk; soft, mellow, green foliage; good shade tree or street tree; subject to insect attacks—especially tree borer, fairly long lived.

HACKBERRY—*Celtis Occidentalis*—T-R. One of the best native shade trees. Has numerous slender drooping branches; leaves are light green and shiny; bark thick and rough; fairly long lived.

MESQUITE—*Prosopis Juliflora*—M-"M". The predominant native tree in the Valley; usually armed with thorns and bearing green, feathery foliage with narrow leaflets about one inch long. In the spring the soft green shade of the new leaflets is very pleasing. Long lived.

WILLOW—*Salix Fragilis*—T-R. These trees often seen growing along canals and water courses. Used for wind-breaks and background plantings. Very brittle. Short lived.

(2) *Evergreen Trees*—

Trees that retain all or a portion of their foliage the year round.

ANACUA—*Ehretia Elliptica*—M-"M". Leaves dark green, underside covered with fine, velvety hairs. Early in spring bears white flowers borne in terminal panicles, followed by small, round shaped fruits. Rather dirty tree. Fairly long lived.

ANACHUITA—*Cordia Boissieri*—Wild Olive—D-S. A small, round-headed tree. Has large, dark green, oval shaped leaves. At intervals during the spring, summer and fall is covered with showy clusters of white, tunnel shaped flowers, with yellow centers. Flowers followed by reddish-brown fruits about one inch long, and resembling olives. This tree is very difficult to transplant. Fairly long lived.

EBONY—*Sideocarpus Flexicaulis*—M-S. Our most attractive native tree. Leaves very small, dark green, glossy, forming a very dense, spreading top. Branches short and gnarled in appearance. After each rain or heavy watering is covered with a mass of small, yellowish white flowers. Long lived.

HUISACHE—*Acacia Farnesiana*—M-R. A much branched, thorny tree with feathery foliage, deep yellow, fragrant flowers borne early in the spring. Likes a wet situation, and is usually seen growing along canals and low lands. Fairly short lived.

RETANA—*Parkinsonia Aculeata*—M-R. A graceful tree with smooth green bark and many feathery reed-like branchlets which take the place of leaves. During spring and early summer is a mass of small bright yellow flowers, with orange centers. Favors a wet situation. Fairly long lived.

TEPEGUAJE—*Lysiloma Acapulcensis*—T-R. A very rapid growing tree. Round-headed leaves, fern like. In early spring covered with small, delicate, yellow flowers. The tree is very brittle and is difficult to keep in shape, due to wind and girdling beetle—Rather dirty tree and short lived.