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LOWER RIO GRANDE VALLEY PROCESSED PRODUCTS

COVER: *The diversity and importance of the processing industry in the Lower Rio Grande Valley is well illustrated by the large number of brand products shown in the cover photograph. These products rate high in quality and are marketed under many brand names throughout the U. S. and Texas. The products are processed either by canning or freezing; they include orange, grapefruit and tomato juices; green beans, beets, blackeye peas, broccoli, brussel sprouts, carrots, kale, lima beans, okra, turnip greens, sauerkraut, tomatoes and tomato catsup.*

The processors recognizing the importance of the industry to the economy of South Texas formed the South Texas Canners Association in 1937. In 1943, to better identify with the area served, the name was changed to the Texas Canners Association. As the industry grew and processing by freezing became more important, another change in organization was made in 1962, by forming the Texas Canners and Frezers Association.

Many new processes contributed by the USDA Southern Utilization Research, Fruit and Vegetable Products Laboratory, Weslaco, plus those by the industry, have created a highly specialized processing industry. Texas A&M University Agricultural Experiment Station, Research and Extension Center, Weslaco, has developed special strains of vegetables for processing which have proved invaluable to the area.

While no exact figures are available, processing, both fruits and vegetables, today contributes better than $50,000,000 annually to the agricultural economy of the Lower Rio Grande Valley.

(Photo by Thomas S. Stephens and R. L. Bowen)

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INTRODUCTION

Individuals closely associated with citrus production devote considerable effort to developing ways to produce more citrus more efficiently. There is certainly nothing wrong with improved efficiency. During these inflationary times, efficiency can be the difference between earning a little or losing a lot. However, it is also necessary to be concerned with how to market the product that is produced so efficiently and in such abundance. There are three major citrus producing areas in the United States, and all sell in the same market. Collectively the three areas are operating a production machine that is over one million acres in size. From the time that machine reaches four years of age, until it is 25 years, it continues to increase its productive capacity. When it reaches 25 years, it continues to produce at peak capacity until at least 50 years and many times longer. It is impractical to develop a marketing system for the output of that machine on a month-by-month or year-by-year basis. There must be prior planning. Consequently, it is worthwhile to project the marketing challenge which must be faced in the next few years. This discussion begins with a summary of past trends relating to planting rates, volume produced, products consumed and dollar returns. These trends provide background data which are used in projecting future conditions.

PLANTING RATES

The 1960's was a period in which the citrus acreage in the United States almost doubled, from three-quarter million acres in 1960, to 1.4 million by 1970. Texas acreage accounts for six percent of the U. S. total; California-Arizona, 25%; and Florida, 69%.

For the U. S. the relative position of varieties has remained essentially the same. Oranges began the 60's accounting for approximately three-fourths of the acreage and held that same position in 1969. The remaining one-fourth is divided almost equally between grapefruit and all other varieties.

VOLUME PRODUCED

Due to the delay between the planting of citrus and its reaching

[1] Talk given at the Rio Grande Valley Horticultural Institute, Weslaco, Texas, January 19, 1971. The opinions expressed are those of the author and do not necessarily represent the viewpoint of the Florida Department of Citrus.

[2] Economic Research Director, Florida Department of Citrus, University of Florida, Gainesville, Florida.

maximum production per tree, the production increase during the '60's was only one-third as great as the acreage increase. One hundred ninety million boxes were produced by all areas in 1960 compared to 249 million in 1969-70, an average gain of five million boxes per year. The production trend in Texas exhibits a severe dip in '63 and '64 as a result of the '62 freeze. However, Texas's production has made a rapid recovery. During the past five seasons, Texas accounted for three percent of the total United States citrus production which was also their ranking in the first five seasons of the '60's.

The California-Arizona area's total volume has generally increased over time although it lost a three percent share of the volume (29% to 26%) which was gained by Florida (68% to 71%).

There is very little change in the relative position of varieties over time. Grapefruit has maintained a relatively steady 22% of the volume; oranges have made a slight gain from 64% to 68% at the expense of other varieties which decreased from 14% to 10%.

There is a difference in the importance of varieties in each producing area. Florida is primarily an orange state as that variety accounts for three-fourths of the volume. California-Arizona's volume is approximately two-thirds oranges, whereas oranges account for only one-third of Texas' total citrus volume and grapefruit is the dominant variety.

All previous comments have related to the U. S. citrus industry. The U. S. has no monopoly on world production, nor is its production increasing at a faster rate than other citrus-producing countries. Since 1960 the U. S. share of total world production has remained at approximately 40% for all varieties. Oranges, which are the major variety in the United States, represent only 30% of the world's supply. U. S. grapefruit, on the other hand, is much more predominant, accounting for three-fourths of the world's total.

PRODUCTS CONSUMED

Oranges

The primary trends is the move from fresh to processed products which now utilize about ¾ of the U. S. crop. The trend to processing is particularly evident in Florida where almost 90% of the orange crop is utilized in this form. California-Arizona uses about one orange out of every three in processed form. Texas, since returning to the production level of four million boxes, has been utilizing its oranges on a fifty-fifty basis between processing and fresh.

Both the total and per capita consumption trend for fresh oranges is decreasing. With regard to processed orange products, FCOJ's sales trend is relatively flat except for the fluctuations accompanying the variation in prices. The trend for chilled oranges juice is generally upward whereas canned orange juice sales per capita are decreasing.

Grapefruit

At the start of the '60's, the majority (58%) of the U. S. grapefruit crop was sold in the fresh market. In 1965, the emphasis switched and processed products now account for over one-half of the total U. S. grapefruit crop. The total by states is as follows: Florida (two-thirds), California-Arizona (one-half) and Texas (one-third).

Fresh grapefruit's total consumption is relatively constant, but the per capita rate is decreasing. Canned single-strength grapefruit has been particularly strong since 1966. During the last couple of years there have been periods where sales have increased even as prices increased.

Synthetics and Substitutes

Since 1957, the citrus industry has been confronted with the introduction of a number of synthetic and substitute products. Primarily all of these products were introduced right after a freeze or when supplies of natural citrus products were relatively short and prices relatively high. Fo rexample, Tang was introduced following the freeze of 1957; Awake after the freeze of 1962 and Orange Plus, during 1968 when poor juice yields resulted in relatively high prices for natural orange juice. With one exception, these products have experienced a relatively poor sales history. The per capita consumption of frozen concentrated orange drinks and synthetics has generally sloped down except when prices for FCOJ were relatively high. The exception is the powdered products which have increased their per capita sales steadily since 1966.

DOLLAR RETURNS

Oranges

Total dollar returns at the on-tree level have generally decreased during the last ten years, and there has been considerable year-to-year variation accompanying the gyrating production levels. Production costs per box in Florida have also varied with the crop size, but have never, for the average grower, exceeded the on-tree returns.

Grapefruit

Total dollar returns for grapefruit have generally increased since 1960, but there has been considerable variation accompanying the changes in supply.

Grapefruit has not fared as well as oranges, however, on a per box basis. In Florida, for example, returns during five of the preceeding 10 seasons were less than costs.

SUMMARY OF PAST TRENDS

The following statements summarize trends in the U. S. citrus industry since 1960.

1. Citrus acreage has doubled since 1960, with a total of 1.4 million acre in 1969.
2. Oranges account for three-fourths of the acreage with the remaining one-fourth evenly divided between grapefruit and all other varieties.

3. Production has increased approximately five million boxes per year since 1960. The total estimated citrus crop for 1970-71 (as of January, 1971) is 286 million boxes.

4. The relative importance of each variety is as follows:

Oranges	68%
Grapefruit	22%
Other	10%

5. The U. S. produces only one-third of world's oranges but three-fourths of the world's grapefruit.

6. The consumption trend for oranges and grapefruit is to processed products.

7. Synthetics and substitutes have not made a substantial impact although the per capita consumption of powders continues to increase.

8. On-tree returns for oranges have fluctuated considerably, but have generally been good except during 1966-67.

9. Returns for fresh grapefruit have been generally good in all but two of the past ten years. However, due to the poor returns for processed products during this period, over-all grapefruit returns have been negative for the average grower in five of the last ten years.

PROJECTED TRENDS

Planting Rates

In Florida, no major change is expected in total citrus acreage in the next few years even though considerable new plantings are occurring in South Florida. However, there is an almost equal amount of acreage being converted to other uses resulting in a net increase in acreage during the last two years of only one percent per year. Because of the relatively low returns during 1969-70, and the prospects for the current season, essentially no net increase in acreage is assumed in making five to ten year projections.

The trend is similar in Texas as acreage has increased by only 5% in the last three years. Plantings in California-Arizona, however, have been just as extensive in the last three years as they were during the early part of the '60's. Hence, it appears there will be no major change in Florida's or Texas' total citrus acreage in the next few years, but a possibility of continued increases in the California-Arizona area.

VOLUME PRODUCED

Despite the relief expressed by many because plantings have slowed in Florida, the fact remains that three-fourths of Florida's orange acreage and one-half of the grapefruit acreage still has not reached maximum production. Hence, the potential productive capacity is substantial.

Florida's round orange production for the period 1971-79 is expected to increase from 150 to 191 million boxes, an average increase of 5 million boxes per season. Grapefruit production is estimated to increase an average of 1.4 million boxes per year or from 47 to 58 million boxes.

If the projected average increases in production were actually to occur, the impending market problems would not be severe because the average annual production increase is only 3% for both oranges and grapefruit. The potential problem, however, is that production may increase as much as 40 million boxes in one season as it did in 1966-67.

PRODUCTS CONSUMED

The previously cited supply projections have no particular significance when viewed alone. Of concern is the marketing challenge. That is, when the estimated supply is compared to the amount that can be sold at a reasonable price, how much remains?

Oranges

The outlook for the '70's would be quite favorable if a "normal" growth rate occurred. At a profitable FCOJ price of $1.65 per dozen 6-ounce cans, FOB, an estimated marketing challenge of 9 million boxes would occur in 1971-72, but essentially no challenge thereafter. A potential problem exists, however, because total orange production in Florida could vary from 200 million boxes in 1971-72 to 280 million boxes in 1978-79. This would cause an estimated marketing challenge, at break-even FOB prices of $1.35 per dozen 6-ounce cans of FCOJ, of from 50 to 65 million boxes, or in terms of FCOJ, 65 to 85 million gallons, depending on the season or seasons in which the above average crops occurred.

Grapefruit

For the remainder of the '70's, it is estimated that grapefruit sales can be made at an equivalent price of $4.00 per case of 12-46-ounce cans if current demand can be increased to handle only 2 to 5 million more boxes per season during the next four seasons. After 1975, demand will have reached such a level that favorable profits should be easily obtainable — providing current marketing efforts are continued. However, as with oranges, there is always the possibility of an extreme increase in production in a given season. Total production in Florida could vary from 56 million boxes in 1971-72 to 75 million boxes in 1978-79. This would cause a marketing challenge, at break-even prices, of from 5 to 7 million boxes, depending on the season or seasons in which the large crops occurred.

It is obvious from the above that major marketing challenges will likely occur during some of the next few seasons. Therefore, it is important that marketers continue to expand current markets and develop new markets.

DOLLAR RETURNS

On a per box basis, returns should continue to exceed production costs for oranges and grapefruit during most seasons providing current marketing efforts are continued. There will likely be seasons when exceptionally large increases in production will result in costs exceeding returns unless the three producing areas develop some type of coordinated production and marketing program.

SUMMARY

It is apparent that if average growth in citrus production occurred during the next few years, major marketing challenges would not be expected. However, it is likely that extreme fluctuations in production will occur during some seasons. As the number of producing acres continues to increase, the greater becomes the possibility of extreme upward fluctuations in supply, and disastrously low prices, but the lesser the possibility of freezes eliminating a sufficient amount of the crop to cause exceptionally high prices, and hence, windfall profits.

Growers and other interested parties can respond to these crop fluctuations in one of two ways. They can either choose to coordinate their production and marketing efforts or simply take their chances. If production and marketing efforts are to be coordinated, plans must be developed now for the kind of procedure desired two to three years hance. Programs cannot be developed and implement immediately upon confronting a major supply fluctuation. However, the further the movement toward coordinated management of production and marketing, the less control an individual grower or processor will have on his individual operation. Thus, to gain the advantages of coordinated management, it is necessary to relinquish certain decision-making privileges. The financial status of most parties in the industry may be such that they prefer to accept zero net returns, or returns that only pay half their production costs in years of surplus production, than resort to some of the restrictions of a coordinated marketing program.

It is suggested that each producing area give considerable thought and discussion to the alternatives they prefer in confronting the probable marketing challenges of future years. Specifically, two questions should be considered. First, how far do you want to go toward developing a coordinated marketing program? Second, how do you want to do it?

Trends in Australian Citrus: The Industry and Research

W. C. Cooper[1]

Abstract: The 12-million-box citrus crop in Australia is largely confined to the coastal, Murrumbidgee and Murray districts. The coastal region, near Sydney, has an average rainfall of 40 inches. The Murrumbidgee district, 40 miles west of Sydney, is hot and dry and is irrigated from the Murrumbidgee River. The Murray district includes the area in three states where the Murray River meanders through the westernmost portions of New South Wales and Victoria and the eastern part of South Australia. The climate of the Murray district is hot and dry, and citrus is irrigated from the Murray River. The principal problem of citrus in Australia is the high cost of production. The Australians are attempting to solve this problem by reduction in tree size, through use of virus-dwarfed trees on trifoliate orange rootstock, to allow high-density plantings of small trees with attendant economy in fertilization, irrigation, and weed control. To support these objectives, they are doing a very creditable job in research on "drip" irrigation, herbicide management and variety and rootstock improvement. They are extending the marketing season of the navel orange through the use of the new navel orange sport, Lane Late navel, which hangs on the tree — maintaining color, rind firmness and juiciness — well into the Valencia season.

INTRODUCTION

In December 1970, I attended the 7th International Plant Growth Regulator Substances Association meeting at Canberra, A.C.T., Australia, as a delegate from the Agricultural Research Service. I spent 2 weeks surveying the citrus industry of Australia as a guest of the Departments of Agriculture of the States of New South Wales (NSW), Victoria, and South Australia (SA). The object was to visit the citrus research stations and become acquainted with developments in Australia, as related to our citrus problems in the United States. I was there in December, which, of course, is the middle of summer in the southern hemisphere.

THE INDUSTRY

The annual production of citrus in Australia is approximately the same as that of the Rio Grande Valley of Texas, about 16 million boxes. However, the 16-million-box production is not limited to a single area as in Texas, but is confined largely to three districts — Coastal, Murrumbidgee, and Murray. The people involved in citrus growing live in small rural communities as in the Rio Grande Valley.

The Great Dividing Mountain Range, about 25 miles inland, parallels the east coast of Australia and is an important factor in the climate as it relates to citrus growing. When the warm, moist air from the northeast collides with these mountains, water is precipitated, providing 30 to 50

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inches of rainfall in the narrow coastal region on the east side of the mountains. The Hawkesbury River on the narrow backslopes of the mountains is wide and carries a large volume of water in its short eastern run to the ocean.

The principal town in this coastal district is Gosford. There is citrus planted on valley land and steep hillsides. Because of the extreme variability in soil types, citrus plantings are mostly in small isolated orchards. The climate is mild, but the area does have a few frost pockets. Although the average annual rainfall is about 40 inches (similar to that of Florida), supplementary sprinkler irrigation is used during dry periods in the spring. The average annual production in this district is about 2.5 million boxes.

On the western side of the mountains rainfall is scarce. There are two large rivers, the Murrumbidgee and Murray, which arise in the mountains, flow westward, and are dammed upstream to provide a reliable source of irrigation water. In the Murrumbidgee irrigation district, which is 400 miles west of Sydney, citrus is grown around Yanco, Leeton, and Griffith. The average annual rainfall is 16 inches; summers are hot, winters are cold, and frosts are frequent. The average annual citrus production is about 2.0 million boxes.

From its point of origin in the mountains, the Murray River flows westward for about 1200 miles and forms the boundary between NSW and Victoria, and then flows southward for about 800 miles through SA to the Sea of Adelaide. The Murray citrus district includes the area in three states where the Murray River snakes around through the westernmost portions of NSW and Victoria and the eastern portion of SA. Two large tributaries join the Murray — the Murrumbidgee upstream from Mildura, Victoria, and the Darling near Mildura — pouring large quantities of water into the Murray in the vicinity of the Murray citrus district. The climate is hot and dry, and the average rainfall is about 10 inches. Frost damage is rare. The soils vary from heavy, gray clay near the river to deep red sand farther away. The total annual production in this district is 6 million boxes (1.3 million on the Victoria side of the river, 2.1 million on the NSW side of the river, and 2.6 million in SA).

There is also some citrus production in Queensland (about 1.4 million boxes) and in West Australia (about 0.6 million boxes). The first citrus development in the country was in the NSW coastal district over a hundred years ago. Not until the turn of the century did citrus growing develop along the Murrumbidgee and Murray Rivers. Large expansions in acreage took place in these irrigated districts under government-sponsored schemes after the World Wars. Further expansion has occurred since 1959, with settlement schemes at Waikerie, near Renmark, SA. Of the states, NSW is the leader, producing 6.6 million boxes; SA is second, producing 2.6 million; and Victoria produces 1.3 million boxes.

The orange marketing season, starting with Washington navel and ending with Valencia, generally extends from May through December. Mandarins are marketed in May and grapefruit in December. Lemons are available all year. Growers generally sell their fruit to cooperatives or private packinghouses, who pack it and send it to the principal markets in Sydney, Melbourne and other Australian cities, and to New Zealand and Southeast Asia.

The industry is organized mainly on a state basis, and such organizations are generally concerned with marketing and other problems peculiar to the states. There is also a federal coordinating organization – The Australia Citrus Growers Federation, Berrie, SA – which handles matters of wide interest in the industry, including uniform grading and import duties.

RESEARCH ORGANIZATIONS

The agencies that conduct research on citrus problems are organized differently from those in the USA. There are no colleges of agriculture associated with state universities. Instead, the State Department of Agriculture has the responsibilty for agricultural teaching, research, and extension, as well as regulatory services. They operate several agricultural colleges and citrus research field stations and extension and regulatory offices throughout the state.

Whereas the State Departments of Agriculture are largely responsible for the applied agricultural research, the Commonwealth Scientific and Industrial Organization (CSIRO) and the University of Sydney, Melbourne, and Adelaide, and the National University of Canberra conduct basic research in the agricultural sciences. However, the CSIRO station at Griffith, NSW, is conducting both basic and applied research on irrigation, fruit set, mechanical harvesting, and herbicides.

NEW EXPERIMENTATION

Variety improvement.—The Valencia orange and Washington navel orange, originally introduced from California, are the main citrus varieties grown. Three strains of Valencia—St. Ives, Allen, and Newton—are now grown in Australia (10). The Newton strain has the least tendency toward alternate bearing and grows well on all rootstocks.

Two local selections of Washington navel orange—the Bellamy and Houghton—are apparently true Washington navel types. The Leng navel, a Washington navel orange sport, has fine rind texture and high juice yield, and is a popular variety (4).

Recently, a new navel orange sport, the Lang Lane navel, has been propagated extensively in NSW. While it has yet to be tested in various locations, at Curlwaa, NSW, on the Murray River, it is a sweet, low-acid fruit of typical navel orange flavor and hangs on the tree maintaining color, rind firmness and juiciness well into the Valencia orange season. The Washington navel orange in Australia is normally harvested in June and the Valencia orange in December. While visiting Mr. Lindsey Lane's place at Curlwaa in December, I saw a 15-year-old tree of the Lane Late navel orange that was heavily laden with handsome, firm, highly colored, good quality fruit.

The Joppa, Homasassa, Shamouti, and Red and White Silettas are grown in small numbers but are of very limited value commercially.

Mandarins, grapefruit, and lemons are grown to a limited extent. The mandarin varieties grown include the Emperor, Early Imperial, Unshu satsuma, and the Ellendale tangor, a late-maturing variety.

The principal grapefruit variety is the Marsh. However, the Thompson, Ruby Red, Wheeny, Foster, and Duncan are also grown. The Eureka is the only lemon of commercial significance in NSW. Two Eureka lemon nucellar selections—Lambert and Taylor—are recommended for planting. The Lisbon is popular in Victoria, and the Villafranca is favored in Queensland. The West Indian lime cannot be grown successfully in Australia because of sensitivity to tristeza disease (10).

A parent-tree planting of highly productive trees that are free of exocortis, xyloporosis, and psorosis viruses is maintained at the Dareton Citrus Station. The virus-screening work is done by the departmental virologists. Psorosis screening is done on sweet orange seedlings grown under glasshouse conditions. Xyloporosis screening is done in the nursery on seedlings of the Ellendale tangor, which is a more sensitive indicator of xyloporosis than the Orlando tangelo or Rangpur lime. Exocortis screening is conducted on trifoliate orange and Etrog citron.

Rootstock improvement.—Prior to 1940, the use of sour orange rootstock was limited, but this was replaced by the sweet orange or Rough lemon due to tristeza disease. The sweet orange has behaved erratically, especially in the coastal area of NSW, because of susceptibility to foot rot. There are now wide-scale plantings of citrus on trifoliate orange rootstock in the coastal and Murrumbidgee districts.

The trifoliate orange grows especially well on heavy soils where sweet orange and Rough lemon rootstocks have failed. However, there is a small incidence of "Sudden Death" to citrus trees on this rootstock. The disease, of unknown cause, is so named because of the rapid onset of visual symptoms of severe wilt and failure of the tree to "size-up" its current crop. Trees can collapse at any age, but are usually in the 10- to 15-year-age group. Frequently, the roots on affected trees have dead xylem tissue, while the phloem remains functional. However, when both xylem and phloem are affected, the tree wilts and dies. NSW pathologists have observed that the disease is a dry root rot similar to the dry root rot of the Troyer citrange in California and is distinct from the wet root rot condition associated with Phytophthora.

In addition to susceptibility to "Sudden Death," trees on trifoliate orange are also intolerant of salt. In rootstock trials at the Irymple (Victoria) Citrus Station in the Murray district, trees on trifoliate orange were the smallest in size, bore the least fruit, had chlorotic foliage, and showed chloride burn (1). Trees on Rough lemon and sweet orange in the same test produced large crops of fruit and showed no chloride burn.

General grower experience with the trifoliate rootstock in the light soils in the Murray River district has not been good. Currently, both the sweet orange and trifoliate orange are used commercially on the NSW side of the river, with the trifoliate orange used mainly in the heavy soils and the sweet orange in the lighter soils. On the Victoria side of the river, Rough lemon is generally used, while in SA both Rough lemon and sweet orange are widely used.

Tree spacing.—A double spacing (24' X 12' as compared to 24' X 24') trial at Dareton using Valencia orange on sweet orange rootstock has shown a 70% increase in production (23 tons per acre) in the first 5 years of production. The trees were planted in 1960, and the 5-year production record was for 1964-68. The increased production was achieved with very little additional cost, since fertilizer was applied at the same acreage rate as that for the trees planted at normal spacing (7). When the interplanted trees were on trifoliate orange rotstock, the yield increase over the same period was 66%.

Mechanical harvesting.—In the Murrumbidgee irrigation region, farmers have designed and constructed three shock-wave trunk shakers similar to those now used extensively in the southeast USA for the harvesting of walnuts and pecans. Prune crops have successfully been harvested with these machines (6). Semi-mechanical canvas catchers, which are unrolled and placed on the ground around the tree, have been used with the shaker. As soon as the tree is shaken, the catcher is rolled up mechanically and the fruit dumped onto a conveyor belt that carries it to a truck.

Fruit abscission chemicals.—Trials with ethephon to induce abscission of mature citrus fruit are being conducted by El-Zeftawi (1) at the Irymple Citrus Research Station. Ethephon at 300 ppm concentration applied to Washington navel and Valencia orange trees induced mature fruit abscission, but also caused severe leaf and flower bud drop. These results are similar to those obtained with this chemical in Florida. Research workers in NSW and SA are now interested in testing the effectiveness of cycloheximide for fruit scheduled for processing.

Virus-dwarfed orange trees.—Researchers (2, 5, 10) in NSW transmitted a dwarfing factor of the exocortis virus, not associated with bark scaling, onto either Marsh grapefruit or Valencia orange growing on trifoliate orange. In large scale experimental trials at the Somersby, Yanco, and Dareton Stations, they have used this technique of growing dwarfed orange and grapefruit trees without any deleterious side effects. The object of the tests was to reduce tree size to allow high density plantings of small trees with attendant economy in management. Studies have shown that the dwarfing is greater the earlier the tree is inoculated, and time of inoculation determines the ultimate tree size.

The use of dwarfing-strain budlines on rootstocks other than trifoliate orange is being investigated at Dareton, but the results are not yet available.

Tristeza research.—Back in the early 1940's, tristeza, transmitted by black citrus aphids, spread rapidly through the citrus plantings of Australia. Ron Appleby at Merbein, Victoria, collected all the sour orange varieties he could find locally and tried them as rootstocks; all failed except Smooth Seville sour orange. Stubbs (9) became interested in these trees and reported that the Smooth Seville sour selection was tolerant of tristeza. I talked with Dr. Fraser at the Rydlemere Research Station about the experiments with the Smooth Seville sour and also visited Ron Appleby in Merbein. He now has some very healthy looking Marsh grapefruit and Valencia oranges of various ages up to about 20 years on this rootstock, but the oldest trees are only about two-thirds the size of trees of the same age on sweet orange rootstock. Appleby's habit was to plant rootstock in the field where the trees were to grow and bud them quite high when they were 2 to 10 years old. It is evident from these trees that the older the rootstock seedling at the time of budding, the more tristeza tolerance it possesses. Fraser's explanation of this (personal communication) is that the older seedlings probably carried a mild strain of tristeza and acquired resistance to the severe strain prior to budding.

Following the initial report by Stubbs (9) of the tristeza tolerance of the Smooth Seville sour orange, seed were sent to the USA. In experiments with these in Florida, Grimm and Garnsey (3) report that although trees budded to Smooth Seville sour orange showed more tristeza tolerance than the common sour orange, they are less tolerant than Rough lemon rootstock. Dr. Fraser (personal communication) and Grimm and Garnsey (3) report that the Smooth Seville has shown a high degree of tolerance to foot rot and root rot, and it may be valuable to plant breeders as a source of tolerance to Phytophthora and tristeza for further improvement of citrus rootstocks.

The workers in Australia report finding various strains of tristeza. Some cause decline of sweet orange and grapefruit on sour orange rootstock. The seedling yellows strain causes dwarfing of grapefruit on sour; a third strain causes stem pitting of grapefruit and when combined with the yellows strain causes further dwarfing and adverse symptoms. Another strain causes misshapen fruit and is apparently different from that causing stem pitting. They have a rootstock trial at Dareton (8) in which Marsh grapefruit is budded to Appleby Smooth Seville sour carrying the stem-pitting strain and Somersby Smooth Seville sour carrying the misshapen-fruit factor, but the results are not yet available.

Drip irrigation.—The 'drip' irrigation technique is now used successfully on a commercial scale in Australia. The method involves a system of plastic piping that trickles water slowly onto the soil and allows fertilizer to be added to the water. The wetted area is kept close to field capacity. A daily flow system of trickle irrigation using lengths of polyethylene microtube for outlets has been developed at the Scoresby Horticultural Research Station, Victoria. Also, a citrus grower at Gosford, NSW, over a period of 5 years, has developed his own daily application system with which he applies 5 gal per tree per day by microtubes (11). The water delivery is controlled by the length and size of the microtube. An innovation is a microtube of a larger bore, with a flow adjustment by a small screw. Various research workers in Australia claim drip irrigation saves water, and increases yield.

Herbicide management.—Herbicides have been adopted rapidly as an alternative to cultivation to control weeds in citrus orchards. During the past 8 years, Turpin et al. (12) have conducted herbicide trials at research stations at Narara, Yanco, and Dareton.

Herbicides were first screened at the Dareton Horticultural Research Station on a light sand about 3 ft deep (12). The average annual rainfall was 11 inches, and 36 inches of irrigation water was applied. The weeds were mostly annual species. The residual herbicides screened included diuron, simazine, and bromacil. Under these conditions, diuron at the rate of 2 lb per acre gave the longest residual life and effectively controlled weeds for 6 months. In field trials under orchard conditions, diuron applied in the spring and autumn at 2 lb per acre as a "blanket" treatment has been successful.

In field trials with herbicides in citrus orchards in loamy soils at Yanco, where there are heavy populations of both annual and perennial weeds, the residual herbicides bromacil, diuron, and terbacil applied in spring and autumn were compared with a treatment using repeated "knockdown" sprays of paraquat during the summer. Diuron was unsatisfactory at 4 lb per acre but was effective at 6 lb per acre, and, as the weeds were brought under control, the rate was decreased with time. Bromacil and terbacil treatments were both satisfactory at 4 lb per acre, and the rate was gradually reduced to 2 lb per acre. Paraquat sprays have proved very expensive and difficult to manage under test situations.

In a third test in light sandy loams at Somersby in the coastal region where the annual rainfall is about 48 inches, both annual and perennial weeds, including couch grass, are a problem. Either diuron or bromacil at 2 lb per acre in spring and autumn has given good control of most annuals but has not controlled couch grass. The citrus trees show no sign of damage from either diuron or bromacil, but paraquat applied as a spot "knockdown" spray damaged low-hanging leaves and fruit.

Research trials and grower experience have shown that the tolerance of citrus to either diuron or bromacil up to 8 and 10 lb per acre per annum is high enough to allow effective weed control. These herbicides may be used on under-tree strips or over the whole area as a blanket treatment (12).

Gibberellic acid sprays.—Gibberellic acid (GA) sprays decrease the cold hardiness of grapefruit. The effect of GA sprays on improving rind quality of Washington navel orange and Marsh grapefruit is being investigated at Yanco, NSW, by Jan Bellemy, but the results are not yet available. However, it was observed that the GA-treated grapefruit showed considerable superficial rind injury resulting from frost injury. There were no such rind blemishes on the unsprayed controls.

SUMMARY

The principal problem in citrus production in Australia, as in the

United States, is the high cost of production. The Australians are endeavoring to solve this problem by reduction in tree size, through use of virus-dwarfed trees, to allow high density plantings of small trees with attendant economy in fertilization, irrigation, and weed control. To support these objectives they are doing a very creditable job in research on "drip" irrigation and herbicide management, and variety and rootstock improvement.

Australian citrus is marketed locally and in New Zealand. They have adequate land and water for considerable expansion in the industry, but there is a shortage of manpower for any major new citrus developments.

There is much to be learned by USA citrus scientists from the Australian research on dwarfing trees, tristeza virus, and variety improvement. The possibility of extending the marketing season of the navel oranges in the United States through the use of the new Lane Late navel selection in Australia is sufficiently promising to justify the testing of this variety under quarantine in the United States.

ACKNOWLEDGMENT

I am indebted to Mr. J. W. Turpin, Principal Citrus Officer of NSW Department of Agriculture, for making arrangements for the trip, and spending 10 days of his time in accompanying me through the citrus regions of NSW. I am also indebted to Mr. Ron Webber, Principal Citrus Officer of the Victorian Department of Agriculture, and to Mr. M. B. Spurling, Principal Citrus Officer of the SA Department of Agriculture, for courtesies extended to me while in Victoria and SA.

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The Effect of Chloroform and Diethyl Ether on Cold Tolerance of Sour Orange Seedlings[1]

HEINZ K. WUTSCHER[2]

Abstract: Chloroform and diethyl ether vapors decreased the ability of sour orange trees to withstand freezing temperatures in the −2 to −8°C range. Chloroform was more damaging than diethyl ether.

INTRODUCTION

Little is known about the effect of anesthetics on plants. Paech et al. (5), in a comprehensive review, found the evidence for effects of anesthetics on membrane permeability contradictory. Later work (1) showed that the rate of Ca^{45} movement in plants is increased by vapors of diethyl ether. The present report shows effects of chloroform and diethyl ether on the cold tolerance of sour orange seedlings.

MATERIALS AND METHODS

Uniform two-year-old seedlings of sour orange, *C. aurantium* L., approximately 75 cm tall and growing in metal pots of 15 cm diameter in a lath house were used in the experiment. The prevailing ambient temperatures during the test period ranged from 4 to 27°C. The trees were exposed to −2.2, −3.3, −4.4, −5.6, −6.7, and −7.8°C in a freeze chamber programmed to lower the temperature at the rate of 1.1°C/hour to the desired minimums, hold the minimum temperature (±1°C) for four hours, and then increase the temperature at the rate of 1.1°C/hour to 1.7°C. The trees were allowed to recover for 24 hours in a growth chamber programmed at 15.6°C/4.4°C day/night temperature before being returned to ambient temperatures (4 to 27°C) in a lath house.

Eight trees, in individual polyethylene bags of 5000 cc volume, were frozen at one time; four trees had 125 ml Erlenmeyer flasks containing 20 ml of $CHCl_3$ or $C_2H_5OC_2H_5$ fastened to the trunks. Two groups of trees were frozen at each of the above temperatures to give a total of eight trees per treatment. Leaf and trunk temperatures monitored with copper-constantan thermocouples showed that the surfaces of these tissues were within 0.5°C of the programmed chamber temperatures.

Eight trees each were also treated with both anesthetics under ambient temperatures (4 to 27°C) for 24, 48, and 72 hours. Controls con-

[1] The work is part of a cooperative project of the U. S. Department of Agriculture and the Texas A&M University Agricultural Research and Extension Center at Weslaco.

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sisted of an equal number of plants enclosed in polyethylene bags, but without anesthetics.

The trees were inspected for leaf damage one week after treatment and for wood damage after 6 weeks. The t-test (7) was used to determine statistical significance of the difference in hardiness.

RESULTS

Neither chloroform nor diethyl ether vapors caused any apparent damage at ambient temperatures when the trees were exposed to them for 72 hours. At subfreezing temperatures, however, the leaves of trees treated with chloroform began to show damage after exposure to –3.3°C for 4 hours while the controls tolerated –5.6°C (Fig. 1).

Diethyl ether was less effective in decreasing cold tolerance of sour orange leaves. The control trees were partially defoliated after exposure to –6.7°C, the ether-treated trees showed damage after 4 hours at –5.6°C (Fig. 1).

Slight wood damage appeared on some chloroform-treated trees after exposure to –4.4°C, and on the control trees after –6.7°C. Diethyl ether raised the temperature at which wood damage occurred from –7.8 to –5.6°C.

DISCUSSION AND CONCLUSIONS

The results of the present experiment show that chloroform and diethyl ether vapors, harmless at normal growing temperatures, decrease the ability of sour orange seedlings to withstand freezing temperatures. If anesthetics would make the cell membranes more permeable to water an increase in cold tolerance should result, as excreting water into the intercellular spaces is thought to be one of the defense mechanisms of plant cells against freezing (3).

Changes in the relationships between proteins and the structured water around them may be one of the ways in which freezing temperatures damage living tissue (4). Pauling (6) proposed that the structure of this water is affected by anesthetics, that clathrate structures of hydrate microcrystals are formed which interfere with chemical reactions and mask the active sites of enzymes. Low temperatures favor this process (2). These microcrystals could also provide nuclei for the formation of intracellular ice crystals.

Further evidence for a mode of action of anesthetics in decreasing cold hardiness along the lines of Pauling's theory (6) is the greater effectiveness of chloroform in this respect. According to this theory, chloroform should be a more potent anesthetic than diethyl ether (2).

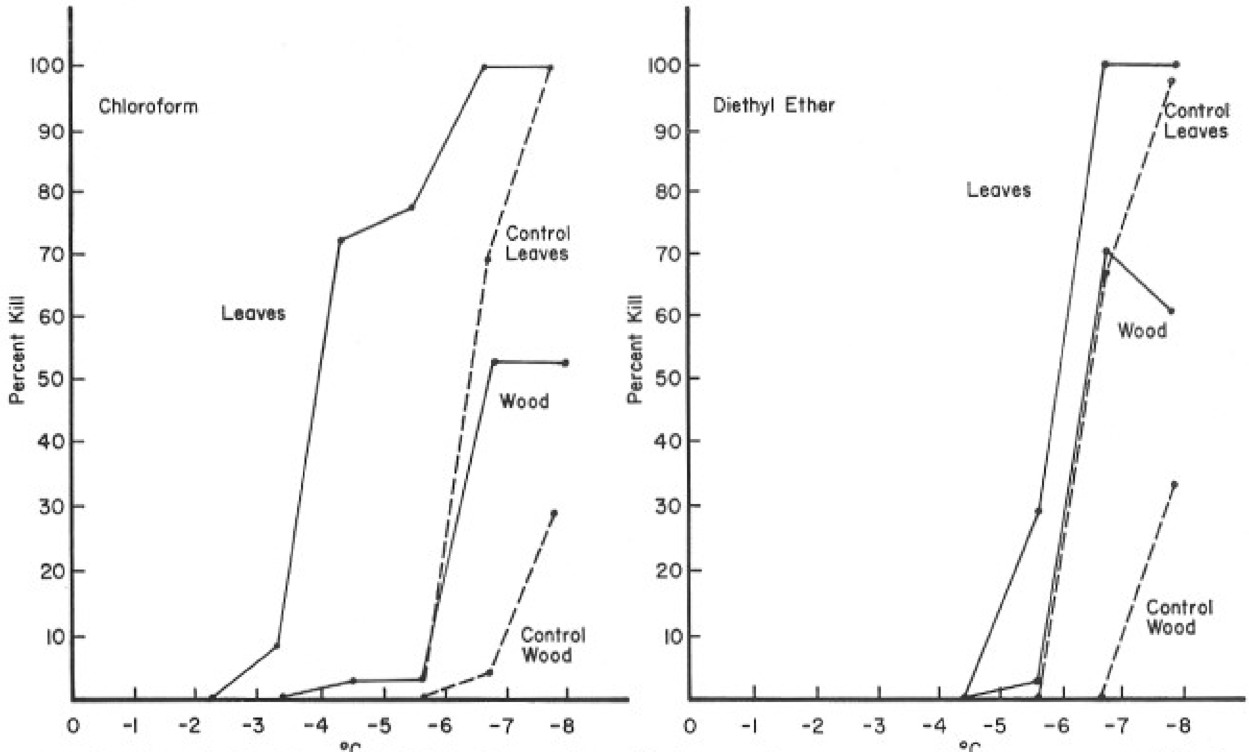

Figure 1. The effect of chloroform and diethyl ether on the cold tolerance of sour orange seedlings. Decrease in cold hardiness of leaves statistically significant with chloroform treatment (probability 95%) at −6.7, −5.6, and −4.4°C, with diethyl ether treatment (probability 90%) at −6.7 and −5.6°C. Increases in wood damage significant (probability 95%) at −7.8 and −6.7°C with both treatments. Chloroform treatment caused more leaf damage than diethyl ether treatment (probability 97%) at −5.6 and −4.4°C.

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Effectiveness of Preharvest and Postharvest Applications of Benomyl for Control of Postharvest Decay of Oranges

L. W. TIMMER[1]

Abstract: Benomyl, applied as a preharvest spray or a postharvest dip at 500 ppm, effectively controlled most postharvest decays of oranges. The postharvest dip treatment controlled green mold for at least 43 days on fruit stored under ambient conditions.

INTRODUCTION

Green mold, stem-end rot and other postharvest decays have consistently been problems on oranges and to a lesser extent on grapefruit in the Lower Rio Grande Valley. Research in California (7) and in Israel (4, 5, 6) has demonstrated that benomyl applied at 500 to 2000 ppm as a dip, spray, or in the wax effectively controlled most postharvest decay problems. In Florida, benomyl controlled postharvest green mold when applied as early as several weeks before harvest (1, 2) and stem-end rot when applied in the postbloom spray (2).

The following experiments were undertaken to compare the effectiveness of preharvest and postharvest applications of benomyl in the control of postharvest decay and to determine the duration of effective control.

MATERIALS AND METHODS

Navel oranges. The effect of treatment of Navel oranges (*Citrus sinensis* [L.] Osbeck) with basic copper sulfate, Captan (N-[(trichloromethyl)thio] -4- cyclohexene-1,2-dicarboximide) and benomyl [methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate] on postharvest decay was evaluated. Basic copper sufate sprays were applied at: (1) 45 g of metallic copper/100 liters of water 49 days before harvest; (2) 45 g 87 days before harvest; (3) 90 g 49 days before harvest; (4) 90 g 87 days before harvest; (5) 45 g 49 and 87 days before harvest. Captan 50 W (265 g/100 liters of water) was applied to the trees 87 days before harvest. Basic copper sulfate and Captan were applied primarily for brown rot control, but their effect on postharvest decay was also evaluated. Benomyl, at 50 g/100 liters of water, was applied to the trees 16 days before harvest or was applied to the fruit as a 3-min dip after harvest. Sprayed trees were thoroughly covered by applying about 100 liters per tree. Rainfall totaled 231 mm between the first application and

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harvest, 7 mm between the second application and harvest, and 1 mm between the third application and harvest.

Eight single-tree replicates were used for each treatment and a sample of about 100 fruit was taken from each tree. Varieties used in the experiment included young-line Washington Navels, young-line and old-line Summerfield Navels, and old-line Everhard Navels. Treatments were arranged in a completely randomized design.

The fruit was harvested on 10-11 December 1970. Some fruit from each replicate was packed in a cardboard carton and the remainder in cloth bags. Fruit was placed in the degreening room at about 30 C and 80-90% relative humidity for the first 72 hr after harvest and stored indoors under ambient conditions thereafter. Decayed fruit were counted and discarded 4, 12, and 24 days after harvest. The average temperature was 23 C (range 11 to 31 C) between 4 and 12 days after harvest and 21 C (range 11 to 27 C) between 12 and 24 days after harvest.

Midseason oranges. The effectiveness and longevity of the postharvest benomyl treatment was tested on Pineapple and Jaffa oranges from youngline trees. Samples of about 80 fruit were taken from 8 trees of each variety and packed in mesh bags. One half of each sample was dipped for 3 min in the 500 ppm of benomyl and the other half left untreated. To determine the effect of origin of the tree (young-line vs. old-line) on the postharvest decay, 100-fruit samples from 10 young-line and 10 old-line Hamlin oranges were stored in cardboard cartons and postharvest decay evaluated. All fruit was stored under ambient conditions for 29-43 days and the decayed fruit counted and discarded at approximately weekly intervals (see Fig. 1).

RESULTS

Benomyl, applied as a spray 16 days before harvest or as a postharvest dip, was effective in controlling postharvest decays of Navel and midseason oranges (Table 1 and Fig. 1). Preharvest applications of basic copper sulfate and Captan, seemed to increase decay (Table 1), but this was probably due to the varieties used rather than to the treatments. In the first experiment, treatments were not randomized among the different varieties of Navels used, and variety had a significant effect on the percent decay. Fruit from young-line trees had more decay than did fruit from old-line trees. For example, if the benomyl treatments were excluded, 56% of the fruit from young-line Summerfield Navels decayed in 24 days while only 23% of the fruit from old-line Summerfield Navels decayed. If the benomyl treatments were excluded, there was a negative correlation between the number of old-line trees per treatment and the percent decay ($r=-0.59$). The difference in decay between fruit from young-line and old-line trees probably explains the significant difference between decay in the controls and decay in the groups treated with basic copper sulfate and Captan (Table 1). Five of the 8 replicates in the control group were old-line trees, while all other groups had from 0 to 4 old-line trees.

The experiment with Navel oranges indicated that fruit from young-line trees had more decay than did fruit from old-line trees. Fruit from young-line trees may have had more injury from thorns and thus have been more susceptible to decay than those from old-line trees. Untreated fruit from young-line Hamlin oranges had more decay than did fruit from old-line Hamlins (Fig. 1), but the difference was not statistically significant.

In the Navel orange experiment, benomyl did not lose its effectiveness during the test period. However, with the midseason oranges, the percent decay of the benomyl-treated fruit began to increase rapidly after 3 to 4 weeks (Fig. 1).

Fruit decay in the different treatments was attributable to different organisms. In all controls and in the fruit treated with basic copper sulfate and Captan, losses were due almost entirely to green mold (*Penicillium digitatum* Sacc.), with some loss to stem-end rot (caused by *Diplodia natalensis* P. Evans and *Phomopsis citri* Fawc.), blue mold (*Penicillium italicum* Wehmer), sour rot (caused by *Geotrichum candidum* Link), and black rot (caused by *Alternaria citri* Ell. & Pierce). On the other hand, those losses that did occur among the benomyl-treated fruit were due primarily to black rot, with minor losses to green and blue molds, and stem-end and sour rots. Under these experimental conditions, benomyl is almost completely effective against green mold, but some losses from black rot occurred in the latter part of the storage period.

DISCUSSION

Benomyl, applied either before or after harvest, effectively controlled the most important postharvest decays for 43 days under ambient conditions. As of May, 1971, the material had not been cleared for use on citrus by the Environmental Protection Agency, although approval for postharvest use was expected before the 1971-72 season.

Table 1. Percent decay of fruit treated with different fungicides and stored for 3 days in the degreening room and 21 days under ambient conditions.

Treatment	*% Decay*	
Basic Copper Sulfate (preharvest)	33[1]	a[2]
Captan (preharvest)	32	a
Benomyl (preharvest)	6	b
Benomyl (postharvest)	8	b
Control	17	c

[1] Figures represent the mean percent decay of at least 8 replications of 100 fruit each.

[2] Means followed by the same letter do not differ significantly at the 0.01 level according to the Duncan Multiple Range Test.

Benomyl would be most economically applied after harvest. However, since it is a mite ovicide as well as a fungicide, preharvest application might be advantageous in certain cases. In experiments in Florida it controlled rust mite [*Phyllocoptruta oleivora* (Ashmead)] for up to 10 weeks

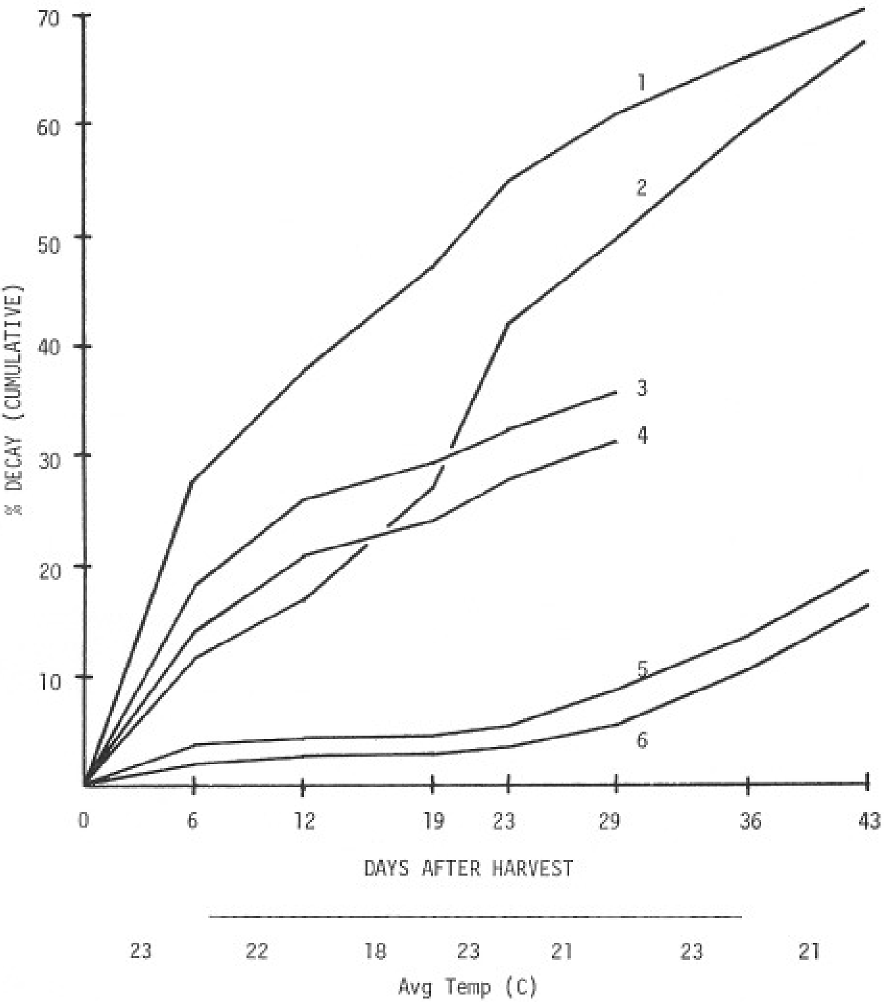

Figure 1. Rate of decay of midseason oranges with time of storage under ambient conditions: 1) untreated Pineapple 2) untreated Jaffa 3) untreated, young-line Hamlin 4) untreated, old-line Hamlin 5) Pineapple dipped for 3 min in 500 ppm of benomyl after harvest 6) Jaffa similarly treated with benomyl. With Pineapple and Jaffa oranges, each point represents the average decay of 8 replicates of approximately 40 fruit each and with Hamlins each represents the average of 10 replicates of 100 fruit each. Average temperatures for the periods between counts of decayed fruit are indicated.

(3). Preharvest decay and drop of oranges caused by *Penicillium spp.* is important in some local orchards and preharvest application should control this problem and increase yields. Benomyl applied before harvest could be included in the fall spray for fruit harvested early or in the postbloom spray for Valencia oranges and for grapefruit harvested late. More work is required to determine the earliest possible time of application and the lowest concentration that may be applied without loss of control of postharvest decays.

In these experiments, black rot was not controlled by the application of benomyl to the fruit, which confirmed earlier reports (3,4) that benomyl is ineffective against *Alternaria spp.* As long as black rot remains a minor problem, this is not a serious drawback to the use of benomyl to prevent postharvest decays.

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Texas Citrus Mite Control on Grapefruit with Various Post-Bloom and Summer Treatments[1]

H. A. DEAN[2]

Abstract: A larger number of Texas citrus mites was found in 2 of the 3 years in 412 oil plots than in 443 oil plots when these oils were applied at 1.0% at post-bloom or 1.6% during the summer. The oils were least effective during 1967 when mite populations were larger than in 1966 or 1968. The effectiveness of post-bloom treatments was generally ranked as follows: dicofol, tetradifon-chlorobenzilate, azinphosmethyl, 443 oil and 412 oil. The effectiveness of summer treatments varied considerably. Azinphosmethyl was ranked as one of the best treatments during 1966 and 1967 but provided the poorest control in 1968. Dicofol did not give as good control in 1966 as found in 1967 and 1968.

INTRODUCTION

Pesticide control of the Texas citrus mite, *Eutetranychus banksi* (McGregor), is usually considered during the post-bloom season each year in the Lower Rio Grande Valley of Texas. Subsequent applications of pesticides are dictated by the increase of these and other pests. Many growers adopted a practice of using 1.0% oil at post-bloom for control of Texas citrus mites and various scale insects since the cost of oil was less than other materials. Data reported herein concerns only the effect of various pesticides on Texas citrus mite populations during the periods from 1966-68.

MATERIALS AND METHODS

Materials were applied from hand-held single nozzle guns at ground level and above the tops of the grapefruit trees using a total coverage technique (1). Gallonage was at the approximate rate of 1 gallon per foot of tree height and 600 psi were used.

Rates of materials shown in the tables are expressed in quantities of the following formulations per 100 gallons of diluted mixtures: 710 ml 22.2% EC azinphosmethyl (Guthion); 178 ml 50% EC chlorobenzilate; 378 ml 42% EC dicofol (Kelthane); 1 lb 80% WP maneb (M-45); 1.0 gal and 1.6 gal 99.75% paraffinic oil (412 and 443°F-50% distillation temperatures at 10 mm Hg.); 946 ml 12.3% EC tetradifon (Tedion); and 1 lb 75% WP zineb. Zineb and maneb were included in certain treatments for the control of citrus rust mites and were not considered as controlling agents for Texas citrus mites.

Mite populations were determined from 40-leaf samples taken from

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8 of the 10 trees in each plot. Plots were randomized and replicated 4 times. Plots as indicated in the tables consisted of the same trees for post-bloom and summer applications during the 3-year period. Mature terminal flush leaves were randomly-sampled 4 to 7 feet above the ground in each quadrant. Mites were brushed from each 40-leaf sample onto a 5-inch plate coated with 12% detergent with a Henderson-McBurnie mite-brushing machine and were counted on ½ the area with a stereoscopic microscope.

RESULTS AND DISCUSSION

Following the post-bloom application in 1966, a few more mites and eggs were found 65 days after 1.0% 443 oil and azinphosmethyl than other treatments (Table 1). Following the June 16 count date, 10.93 inches of rain fell which apparently was associated with the reduced mite numbers found on June 28. However, mite numbers were very small during the entire period. Mite populations were much heavier on March 30, 1967 than on April 11, 1966 before post-bloom applications were made. Mites were more abundant in 1967 than 1966. The rate of increase in mite populations was greater in 1967 after 1.0% 412 oil than for 1.0% 443 oil, tetradifon-chlorobenzilate, azinphosmethyl or dicofol applications. After post-bloom treatments in 1968, the descending order of mite densities due to treatments were as follows: 1.0% 412 oil, azinphosmethyl, tetradifon-chlorobenzilate, 1.0% 443 oil and dicofol. Mite populations decreased after the count made 62 days after application. No rain was recorded during that period, but the maximum temperature on 12 of 14 days was 95°F or higher and appeared to have been associated with decreased mite numbers.

In 1966, the rate of increase of mite populations following various treatments 47 days after summer applications was greatest in plots treated with 1.6% 412 oil followed in descending order by dicofol, 1.6% 443 oil and azinphosmethyl (Table 2). After 68 and 96 days following these applications, this order changed as follows: dicofol, azinphosmethyl, 1.6% 412 oil and 1.6% 443 oil. The reduction in mite numbers after 47 days occurred during a period when only .41 inch of rain fell and the temperature rose to 95°F or higher on 17 of 21 days. The increased numbers of mites on October 17 probably would have been greater had not 5.24 inches of rain fell 2 days before that date.

In 1967, more mites were found in 1.6% 412 oil plots than in other treatment plots during the first 69 days after summer application. A sharp decrease in mite populations occurred after the September 4 count probably due to rain which fell on 8 different days and totaled 23.81 inches. Rain was evidently a major factor in reducing populations; however, mites increased rapidly after the count made 97 days after application. The smallest number of mites was found in azinphosmethyl plots before the rains, however, the double oil application plots had the smallest numbers after the rains.

During the first 62 days after summer applicaitons in 1968, more mites and eggs were found in azinphosmethyl plots than other treatment

Table 1. Numbers of Texas citrus mites and eggs per 80 leaves before and after indicated April treatments to grapefruit trees in experimental plots at Sharyland during 1966-68.

Sampling		*Treatment*	*Treatments*									
	After Treatment		*443 oil*		*Dicofol*		*412 oil*		*Chlorobenzilate-Tetradifon*		*Azinphosmethyl*	
Date	*Days*	*Date*	*Mites*	*Eggs*	*Mites*	*Eggs*	*Mites*	*Eggs*	*Mites*	*Eggs*	*Mites*	*Eggs*
4/11/66			7	1	0	5	8	1	1	1	14	3
		4/12	1.0% [1]		[1]		1.0% [1]					
5/11	29		0	0	0	0	0	0	0	0	0	0
6/16	65		37	35	15	13	10	15	14	9	32	76
6/28	77		10	16	1	17	10	13	5	1	6	17
3/30/67			98	306	107	288	218	428	118	403	199	533
		4/4	1.0% [1]		[2]		1.0% [1]		[2]			
5/2	28		2	0	1	1	18	14	3	2	0	0
5/22	48		61	142	8	23	292	858	26	50	25	52
6/11	68		421	956	69	166	950	2521	315	763	191	264
6/23	80		579	2334	279	820	935	1905	533	1112	267	264
3/18/68			3	3	0	0	5	3	2	10	3	0
		4/2	1.0% [1]		[2]		1.0% [1]		[2]			
4/22	20		0	1	0	0	2	3	1	16	0	0
5/13	41		1	3	2	8	10	16	5	5	4	4
6/3	62		46	80	21	57	230	445	56	99	174	278
6/17	76		8	25	2	7	11	42	9	25	17	57

[1] 1.0 lb zineb included
[2] 1.0 lb M-45 included

Table 2. Numbers of Texas citrus mites and eggs per 80 leaves before and after indicated summer treatments to grapefruit trees in experimental plots at Sharyland during 1966-68.

Sampling		*Treatment*	*Treatments*									
			443 oil		*443 oil*		*412 oil*		*Dicofol*		*Azinphosmethyl*	
Date	*After Treatment Days*	*Date*	*Mites*	*Eggs*	*Mites*	*Eggs*	*Mites*	*Eggs*	*Mites*	*Eggs*	*Mites*	*Eggs*
6/28/66			10	16	1	17	10	13	5	1	6	17
		7/13	1.6%[1]		1.6%[1]		1.6%[1]		[1]			
8/1	19		0	0	0	3	0	0	0	0	0	0
8/29	47		89	128	94	123	176	329	97	115	26	17
9/19	68		20	217	13	155	60	311	83	458	59	305
10/17	96		121	331	83	341	150	559	593	2034	363	1283
6/23/67			579	2334	279	820	935	1905	533	1112	267	617
		6/27	1.6%[1]		1.6%[2]		1.6%[1]		[2]			
7/24	27		31	27	19	20	41	52	1	17	0	6
8/14	48		87	114	65	112	141	179	31	51	2	6
9/4	69		268	700	391	1075	512	1202	84	276	34	38
10/2	97		16	16	18	43	18	26	25	19	18	40
10/23	118		282	1556	601	2890	161	700	381	1611	398	1856
6/17/68			8	25	2	7	11	42	9	25	17	57
		7/9	1.6%[1]		1.6%[2]		1.6%[1]		[2]			
7/29	20		0	0	1	0	0	0	0	0	10	2
8/20	42		0	0	0	0	0	0	0	0	6	24
9/9	62		17	13	4	10	0	0	8	32	321	548
9/30	83		208	286	46	90	55	34	166	163	654	1349
10/21	104		601	728	761	518	398	533	523	527	985	623

[1] 1.0 lb zineb included
[2] 1.0 lb M-45 included

plots. Greater mite numbers persisted in the azinphosmethyl plots in the 2 subsequent counts in September and October. Smallest mite populations were found in the 1.6% 412 oil plots.

In general, an increase in the number of motile mites occurred on subsequent sample dates when an increase in egg numbers was found. Weather conditions also appeared to have adverse effects on increases in mite populations. However, migration of motile mites can occur when overcrowded conditions prevail and affect total numbers in the counts.

Numbers of Texas citrus mites and their eggs were generally smaller following post-bloom dicofol than 1.0% 443 oil applications. Mite populations were smaller after 1.6% 443 summer oil in plots where dicofol was used at post-bloom instead of 1.0% 443 oil with one exception in 1967 69 days after treatment.

SUMMARY

During the 3 years of the test, the greatest rate of increase in mite populations following post-bloom application occurred in 1967 when the pre-treatment populations of mites were much greater than in 1966 or 1968. On the count dates 63 to 68 days after post-bloom applications, the smallest numbers of mites were found in 1966. Dicofol provided the most effective control in 2 of the 3 years. Better control was provided with 443 oil than with 412 oil in 2 of the 3 years. Control with azinphosmethyl was not as good during 1968 as found in the previous 2 years. Rainfall and/or high temperatures during the post-bloom period apparently are associating factors with mite reductions.

During the first 62-69 days after summer application, the greatest rate of increase in mite populations occurred in 1967. During that year, the ascending order of mite densities in the various plots were as follows: azinphosmethyl, dicofol, 1.6% 443 oil and 1.6% 4.2 oil. Total mite populations were greater during the first 60-70 days in 1967 and 1968 following post-bloom applications than following summer applications in 8 of 10 instances of treatment plot counts. A greater rate of increase in mite populations would have been expected after 1.0% oil than 1.6% oil; however, the potential increase may not necessarily have been the same during these periods. A larger mite populations was found following 1.6% 443 oil applied in 1966 and 1967 during the summer in comparison with dicofol applied in the same plots at post-bloom. In 1968, heavier mite populations were found in plots treated with azinphosmethyl. Citrus rust mites were found in the azinphosmethyl plots each year before they were found in other plots. Records showed citrus rust mites present in the azinphosmethyl samples in October 1966, December 1967 and September 1968 and were evidence of shorter residual control.

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Photographic Sensing of Boron and Chloride Toxicities of Citrus Trees[1]

R. Cardenas, A. Paynado, H. W. Gausman, A. H. Gerbermann, and R. L. Bowen[2]

Abstract: Film density measurements were used to discriminate between healthy Red Blush grapefruit trees and trees whose foliage exhibited boron (B) and chloride (Cl^-) toxicity symptoms (affected).

Citrus trees were photographed from an aircraft (3,000 ft altitude) and a Truco's aerial lift (9 ft above trees) with a Hasselblad camera, 50-mm focal length lens with 70-mm EIR film (Kodak Ektachrome Infrared Aero 8443) and a Kodak Wratten 15 filter with an approximate 100% absorption edge at 500 nm (nanometers). Light reflectance of foliage of B– and Cl^--affected trees produced pinkish (light red) images on EIR transparencies, compared with dark-red images for healthy trees.

Citrus leaves affected by B and Cl^- toxicities were primarily characterized by scattered yellow spots on upper (adaxial) surfaces, brownish, resinous gummy spots on lower (abaxial) surfaces, and edge or tip burn. Affected leaves also had less chlorophyll, higher water content, and were thicker and smaller in surface area than healthy citrus leaves.

Spectrophotometrically measured reflectance of top leaf surfaces revealed that B– and Cl^--affected leaves, compared with healthy leaves, had decreased reflectance (10%) over the 750- to 1350-nm near-infrared wavelength range, and increased reflectance (13%) at the visible green peak of the 550-nm wavelength.

Optical count densities were determined on transparencies using a Joyce, Loebl recording microdensitometer. For photographs at 3,000 ft altitude, best discrimination between healthy and affected trees using optical density measurements was obtained with a blue bandpass filter; a red bandpass filter gave best discrimination for photographs taken at a height of 8 ft above the trees.

INTRODUCTION

The objective of research reported here is to develop the use of aerial photography and corresponding film density measurements to discriminate between healthy trees and unhealthy citrus trees whose foliage exhibit boron (B) and chloride (Cl^-)[3] toxicity symptoms (affected). To interpret photographic images of healthy and affected trees, the relation of the tonal responses of Kodak Ektachrome Infrared Aero 8443 (EIR) film to reflectance of healthy and affected citrus foliage must be

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[3] The ion of chlorine (Cl^-) will be used since its usage is more common in the literature than the element (Cl).

understood, and the best method for measuring and comparing density readings must be determined.

Norman (9) and Norman and Fritz (10) obtained encouraging results with EIR film in connection with detecting stressed citrus trees. They obtained distinctive colors on EIR transparencies for foot-rot, advanced nematode infestation, very early *Tristeza* virus reaction, and manifestations of *Psorosis, Xyloporosis,* and *Exocortis* viruses. Gausman (4) showed that foot-rot affected trees appeared as white compared with red images for healthy trees on EIR film. The literature indicates, however, that many variables need to be evaluated before EIR film detection of citrus tree diseases can be accurate and dependable. For example, information is needed on EIR film images of citrus trees with B and Cl^- toxicities and iron (Fe) deficiency to see if these three images can be differentiated from each other and from the foot-rot image. Identification of B and Cl^- toxicities and Fe deficiency with aerial photography would be useful to the citrus industry for application of corrective measures before fruit production is curtailed. The detection of severely foot-rot-affected trees could be used to tell growers what trees needed to be replaced.

METHODS AND MATERIALS

Results were obtained in 1970 from a split-plot experimental design with two irrigation treatments (plots) within each of four blocks. Irrigation treatments have been applied every summer since 1963 and consist of irrigating with (a) canal water from the Rio Grande River (control treatment) and (b) canal water with the addition of 4,000 ppm of salts containing NaCl (sodium chloride), $CaCl_2$ (calcium chloride), and 6 ppm B (salt treatment). Each of the two irrigation plots within each block has eight Red Blush grapefruit trees (*Citrus paradisi,* Macf.), each on a different rootstock. Only the Red Blush grapefruit trees with the Troyer citrange rootstock were considered because they were more sensitive to B and Cl^-.

Thirty-five leaves (approximately 6 months old) of the late-summer flush were sampled from branch apices of Red Blush grapefruit trees with the Troyer citrange rootstock within each control and salt treatment plot of the four blocks. Leaves were wrapped immediately in Saran[4] and placed on ice to limit dehydration.

In the laboratory, leaf samples were randomly separated into three groups for (a) B and Cl^- assays, (b) total chlorophyll determination, and (c) spectral, leaf thickness, leaf area, and water content measurements. A Backman Model DK-2A spectrophotometer equipped with a reflectance attachment was used to obtain diffuse reflectance and transmittance measurements on upper (adaxial) surfaces of one leaf from each of the eight trees. The spectral measurements were recorded at discrete 50-nm

[4] Use of a company or product name by the Department does not imply approval or recommendation of the product to the exclusion of others that may also be suitable.

increments over the 500- to 2500-nm wavelength interval. Data were corrected for a decrease in reflectance of the MgO reference, caused by deterioration during aging to give absolute radiometric data (13). Thickness measurements were made at three locations on each leaf used for spectral measurements with a linear displacement transducer and digital voltmeter (7). Leaf area was measured with a planimeter. Percent water content was determined on an oven-dry weight basis (68°C for 72 hrs).

Leaves sampled for B and Cl^- assays were washed in water and detergent, rinsed with tap water, rinsed four times with distilled water, and then freeze-dried. Methods of Hatcher and Wilcox (6) and Cotlove et al. (2) were used for the B and Cl^- analyses, respectively.

Total chlorophyll (chlorophyll a + chlorophyll b) was determined using procedures of Hall and Hacskaylo (5) and Horwitz (8). Total chlorophyll was calculated as:

$$7.12 \log_{10} \frac{I_o}{I} \text{ (at 660 nm)} + 16.8 \log_{10} \frac{I_o}{I} \text{ (at 642.5 nm)},$$

where I_0 and I are transmittance values for the petroleum ether solvent and unknown solutions, respectively.

Photographs were taken from an aircraft and from the bucket of a Truco aerial lift ("cherry picker") with a Hasselblad camera, 50-mm focal length lens using 70-mm EIR film and a Kodak Wratten 15 filter with an approximate 100% absorption edge at 500 nm. Photographs were taken from the Truco at a height of 8 ft above each tree; overflight photographs were taken at an altitude of 3,000 ft. The scale of aerial photography was 1:18,000.

Optical count readings were made on EIR transparencies with a Joyce, Loebl recording microdensitometer using no filter (white light) and red (Wratten 92), green (Wratten 93), and blue (Wratten 94) bandpass filters in the densitometer's light beam. The microdensitometer output is in optical counts that are punched onto paper tape. The paper tape microdensitometer output consists of a base line count corresponding to the standard optical densities of the first step of the calibrated step wedge in use, plus added counts that depend on the particular step on the wedge that balances the light transmission by the film being analyzed in the second light beam. The distance the uniformly graduated step wedge travels to balance the transmission by the film determines the count registered by the encoder. The optical count is related to the optical density (O.D.) by the relation:

$$\text{O.D.} = [(\text{Optical counts} - \text{base reading})(\text{wedge factor})] + (\text{step wedge density}).$$

An area of 2 x 2 sq cm on each tree was selected for eight photographic transparencies taken from the Truco's bucket. Eight scan lines (2 mm distance between any pair of lines) were run for each tree of each transparency for each of the four filters. Twenty-five readings (data bits) were taken on each scan line representing a transparency area of 0.0798 sq mm.

One transparency was selected from the aerial photographs, and one scan line was run for each of eight trees and for each of the four filters. Scans were run in the central area of the tree canopies. Twenty-five readings were taken on each scan line representing a transparency area of 0.0062 sq mm.

Spectrophotometric data were analyzed for variance (14). Duncan's multiple range test was used to test differences among means when F ratios were statistically significant (3).

RESULTS AND DISCUSSION

Affected citrus leaves had leaf symptoms typical of B and Cl^- toxicities with scattered yellow spots on upper (adaxial) surfaces, brownish, resinous gummy spots on lower (abaxial) surfaces, and edge or tip burn compared with green healthy leaves (11). Chemical analyses showed that B and Cl^- contents were 285.5 ± 23.6 (standard error) ppm B and 0.24 ± 0.10% Cl^- for healthy leaves, and 832.5 ± 75.2 ppm B and 0.33 ± 0.12% Cl^- for affected leaves (Table 1). Affected leaves also had less chlorophyll than healthy—11.7 ± 0.6 mg/liter for affected leaves as compared with 15.2 ± 1.6 mg/liter for healthy leaves (Table 1).

Statistically significant differences ($p = 0.01$) existed among means of leaf surface area. Average areas per leaf were 40.4 ± 1.5 cm^2 and 29 ± 1.9 cm^2 for healthy and affected leaves, respectively. There were no statistically significant differences ($p = 0.05$) between affected and healthy leaves in leaf thickness. Average leaf thicknesses were 0.32 ± 0.02 mm and 0.31 ± 0.01 mm for affected and healthy leaves, respectively (Table 1). The percent leaf water content of affected leaves (57.1 ± 3.5) was not significantly different from healthy leaves (55.2 ± 4.1) (Table 1).

Relative to spectral measurements, statistically significant differences ($p = 0.01$) existed among means of all wavelengths for healthy and affected leaves for reflectance, transmittance, and absorptance (calculated as absorptance = 100 − percent reflectance + percent transmittance) measurements. Spectrophotometrically measured reflectance of top leaf surfaces showed that B– and Cl^--affected leaves had about 1 to 4% less reflectance than healthy leaves over the 750- to 2500-nm wavelength range (Fig. 1) except near the 1450- and 1950-nm water absorption bands where reflectance was approximately the same. In the visable range (500 to 750 nm), affected leaves had 13% more reflectance than healthy leaves at the 550-nm green wavelength peak (Fig. 1).

Table 1. Effects of control and salt irrigation treatments on chemical (total chlorophyll, B, Cl^-, percent water content) and physical (area, thickness) characteristics of Red Blush grapefruit leaves.

Irrigation treatment	*Chemical characteristics*[1]				*Physical characteristics*[2]	
	Total chlorophyll	*B*	*Cl^-*	*Water content*	*Leaf thickness*	*Area per leaf*
	mg/l	ppm	%	%	mm	cm^2
Control	15.2 ± 1.6[3]	285.5 ± 23.6	0.24 ± 0.10	55.2 ± 4.1	0.31 ± 0.01	40.4 ± 1.5
Salt	11.7 ± 0.6	832.5 ± 75.2	0.33 ± 0.12	57.1 ± 3.5	0.32 ± 0.02	28.9 ± 1.9

[1] Average of four determinations.
[2] Average of four measurements.
[3] Standard error.

Table 2. Means and ranges of optical density readings for white light and red-, blue-, and green-filtered light of EIR transparencies obtained at an altitude of 3,000 ft above healthy (control) and B- and Cl^--affected Red Blush grapefruit trees.[1]

Light	*Healthy trees*			*B– and Cl^--affected trees*		
	Lowest reading	*Highest reading*	*Mean of readings*	*Lowest reading*	*Highest reading*	*Mean of readings*
White	0.982[2]	1.148	1.049 ± 0.016[3]	0.834	1.129	0.943 ± 0.014
Red	0.054	0.848	0.628 ± 0.020	0.424	0.860	0.567 ± 0.016
Blue	1.090	1.273	1.177 ± 0.012	0.884	1.206	1.029 ± 0.014
Green	1.074	1.184	1.126 ± 0.010	0.940	1.176	1.048 ± 0.010

[1] For each of the white light and red-, blue-, and green-filtered light densitometer set-ups, one transparency with four healthy and four affected tree images was scanned with one scan line per tree and 25 readings per scan.

[2] Optical density = [(optical count − base reading)(wedge factor)] + (step wedge density)
= [(O.C. − 40)(.011)] + (.71)

[3] Standard error.

Affected leaves had 2.0 to 3.0% more absorptance than healthy leaves (Fig. 2) over the 750- to 1350-nm near-infrared wavelength range. The absorptance of healthy and affected leaves was essentially the same over the 1350- to 2500-nm wavelength interval. The greatest effect on absorptance was at the 550-nm wavelength where the absorptance of affected leaves was 18% lower than the absorptance of healthy leaves.

For EIR photographs taken from both the Truco's bucket and the aircraft, reflectance of light from B– and Cl^--affected trees produced light-red (pinkish) images, compared with dark-red images for healthy trees.

Optical density readings were made on the tree images of EIR transparencies with white light and red-, blue-, and green-filtered light. Means and ranges of optical density readings are shown in Table 2 for photographs taken at an altitude of 3,000 ft from the aircraft and in Table 3 for photographs taken 8 ft above the trees from the Truco's bucket. For photographs taken from the aircraft, best discrimination be-

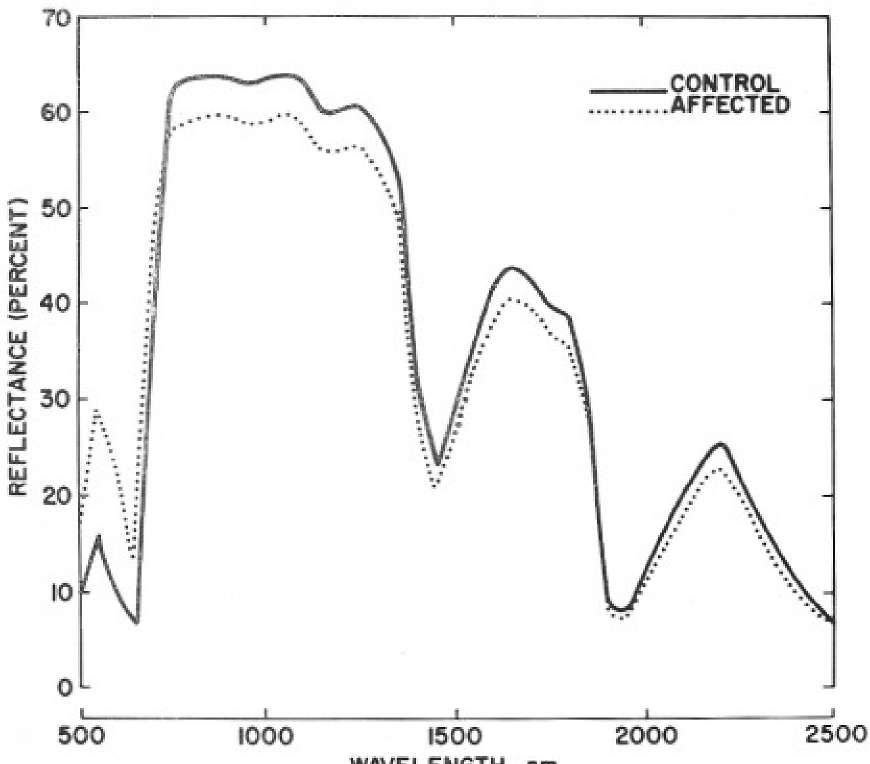

Figure 1. Total diffuse light reflectance of upper surfaces of control (healthy) and affected Red Blush grapefruit leaves. Each spectrum is an average of four leaves.

tween healthy and affected citrus trees was obtained with a blue bandpass filter. Density values (Table 2) were 1.177 ± 0.012 and 1.029 ± 0.014 for healthy and affected trees, respectively. For photographs taken at a height of 8 ft above the trees from the Truco's bucket, best discrimination was obtained with a red bandpass filter. Density values

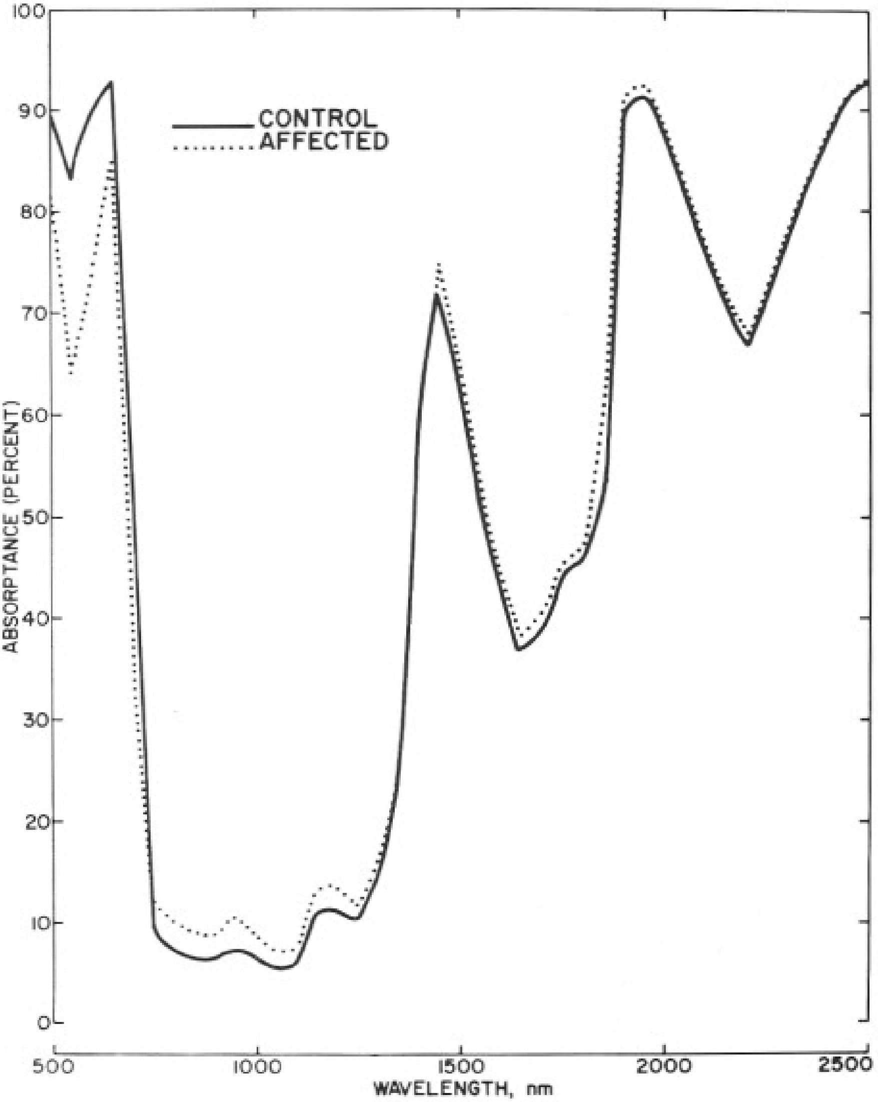

Figure 2. Total light absorptance of control (healthy) and affected Red Blush grapefruit leaves. Each spectrum is an average of four leaves.

Table 3. Means and ranges of optical density readings for white light and red-, blue-, and green-filtered light of EIR transparencies obtained at a height of 8 ft above healthy (control) and B- and Cl^--affected Red Blush grapefruit trees.[1]

Light	*Healthy trees*			*B– and Cl^--affected trees*		
	Lowest reading	*Highest reading*	*Mean of readings*	*Lowest reading*	*Highest reading*	*Mean of readings*
White	1.102[2]	1.352	1.239 ± 0.010[3]	0.942	1.205	1.077 ± 0.014
Red	0.980	1.302	1.158 ± 0.017	0.795	1.079	0.953 ± 0.027
Blue	1.129	1.314	1.189 ± 0.010	0.975	1.209	1.102 ± 0.013
Green	1.082	1.234	1.166 ± 0.006	0.952	1.139	1.057 ± 0.010

[1] For each of the white light and red-, blue-, and green-filtered light densitometer set-ups, eight transparencies were scanned with eight scan lines per tree and 25 readings per scan.

[2] Optical density = [(Optical counts − base reading)(wedge factor)] + (step wedge density)
= [(O.C. − 40)(.011)] + (1.01)

[3] Standard error.

(Table 3) were 1.158 ± 0.017 and 0.953 ± 0.027 for healthy and affected trees, respectively. Although more density readings were made on tree images of the photographic transparencies obtained from the Truco's bucket than from the aircraft, results indicate that a red bandpass filter is best for photographs taken at a low altitude, and a blue bandpass filter is best for photographs taken at a high altitude. These results agree with the findings of Albert (1) who reported that the camera by altitude interaction was often statistically significant. The different results obtained with the blue and red bandpass filters were apparently caused by the attenuation of light reflected from the citrus tree foliage at the 3,000 ft altitude.

Further work is planned for comparing film images of B– and Cl^--toxicities, iron (Fe) deficiency, and foot rot of citrus trees (4). The new Kodak Aerochrome Infrared 2443 (AIR) film will be used in future research.

If visual interpretation among images of foot rot and the nutritional maladies proves impractical, computer discrimination procedures will be applied to densitometer readings on AIR film transparencies (12).

ACKNOWLEDGEMENTS

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Citrus Mealybug, a Potential Problem on Texas Grapefruit[1]

H. A. Dean[2], W. G. Hart[3] and S. Ingle[3]

Abstract: The citrus mealybug, *Planococcus citri* (Risso), was an economic pest of Texas grapefruit on approximately 350 acres during 1970. Malathion-oil and azinphosmethyl-oil provided only 71 and 49% reduction in numbers during October. A parasite and a predator were introduced from California for possible control, but no recoveries have been made to date. A brown lacewing, *Sympherobius barberi* (Banks), was quite abundant during October and November and probably gave considerable reduction in mealybug numbers during this period. A parasite, *Pauridia peregrina* Timberlake, was very abundant during October, remained in large numbers with a declining mealybug population through March 1971 and was probably responsible for mealybugs being so difficult to find in April. Repeated usage of certain broad spectrum phosphate pesticides prior to the outbreak may have been responsible for the problem.

INTRODUCTION

The citrus mealybug, *Planococcus citri* (Risso), became a serious pest of grapefruit on approximately 350 acres in South Texas during 1970. Large infestations were found in a number of groves by late September in the Adams Gardens area west of Harlingen where several growers had used various broad spectrum insecticides in 3 to 4 spray applications during the year. Populations of mealybugs caused drop of fruit during 1969 and 1970 with much black sooty mold fungus covering the fruit and leaves. Investigations were begun to determine the best method to bring about control of this pest without causing problems with other potential pests.

A grower in the infested area had applied 4 sprays each year for various mite and insect pests of citrus during the 1968-70 period. In April 1968, the following rates of materials per acre were applied at 10X dilution (250 gal per acre) as follows: 15 lb 75% WP zineb, 15 gal oil and 11 lb actual copper. This application was followed in June, August, and September with 5 pints 46.5% EC ethion. In 1969, the same materials were applied except that in June, 15 gal oil and 1 gal 50% EC trithion® were applied. In 1970, 5 pints ethion and 10 gal oil were applied in April, June, August and September with 5 lb 80% WP carbaryl (Sevin®) being added with the September application. The outbreak of citrus mealybugs at this location may have been a result of continued usage of broad spectrum phosphate pesticides.

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It was interesting that grapefruit was the predominant citrus host plant in the various groves where citrus mealybug collections were made. Orange trees adjacent to grapefruit trees which were heavily-infested were seldom found to have more than just a few mealybugs (Figure 1).

CONTROL WITH CHEMICALS

The grower sought to control mealybugs with pesticides since he was interested in immediate results. He had considered using parathion for control but was advised he would increase his problem of soft scale, *Coccus hesperidum* Linnaeus, as experienced previously with parathion application to citrus and as reported with methyl parathion in the work of Hart et al. 1971. On October 15, 1970, 1 gal 22.2% EC azinphosmethyl (Guthion®)—10 gal oil and 2 gal 56% EC malathion – 10 gal oil per acre were applied in different parts of the grove for mealybug control. Mealybugs were counted on 6 12-inch terminals of each tagged tree on October 14 and twice 13 and 28 days after application of the sprays. None of the treatments provided more than 71% reduction in mealybug populations (Table 1). When severe infestations occurred, the mealybugs were covered with heavy incrustations of black sooty mold and were extremely difficult to contact with the insecticide. Beneficial insect activity had probably been restricted by the continued use of phosphate pesticides. Therefore in November, the grower was advised to withhold spraying and give the beneficial insects a chance to increase and possibly control the mealybugs.

BENEFICIAL INSECTS – INTRODUCED

Available records did not show prior identification of any parasite or predator of the citrus mealybug from this area. Texas Agricultural Experiment Station records showed that in 1952 and 1956 there were some noticeable infestations of mealybugs in a few groves and that a positive identification of citrus mealybug had been made from specimens collected in 1952. However, no parasites or predators had been collected to establish a beneficial insect-mealybug relationship. These infestations disappeared after short periods of time in those years.

On October 20, 1970, a shipment of *Leptomastix dactylopii* Howard (a parasite) and *Cryptolaemus montrouzieri* (Mulsant) (a predator) was provided by Dr. Paul DeBach of the Department of Biological Control at Riverside, California, as requested. Approximately 75 adult *L. dactylopii* and 60 *C. montrouzieri* were released at the grove 5 miles west of Harlingen. A laboratory culture was started with the remaining 8 beetles and 14 parasites. The culture was maintained until March 1971 when field-collected host material became impossible to collect; so, the laboratory material was released at the Harlingen location and in a grapefruit grove at the 1500 block east state highway at Donna. The only assurance that food was present at these locations was that a few mealybug crawlers were found. No recovery record had been taken of this parasite or predator by May 1971 at either location.

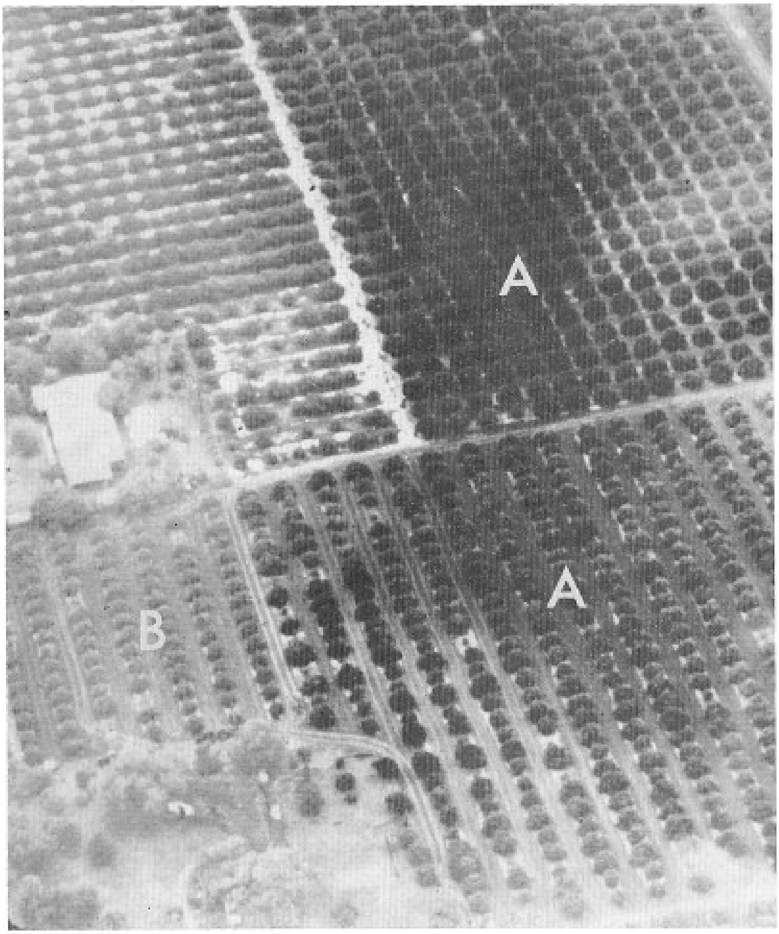

Figure 1. Black and white copy of aerial infra-red photograph of mealybug-infested citrus. *A* — Heavily-infested grapefruit. *B* — uninfested oranges.

Table 1. Comparative effectiveness of malathion and oil, and azinphosmethyl and oil on a heavy infestation of citrus mealybug.

	Mean No. of Mealybugs per Terminal				
	10/14/70[1]	*10/27/70*		*11/12/70*	
	No.	*No.*	*% Reduction*	*No.*	*% Reduction*
Malathion + oil	23.25	6.71	71.14	9.81	57.81
Azinphosmethyl + oil	23.35	11.80	49.46	13.21	43.82

[1] Spray applications made 10/15/70.

NATURALLY OCCURRING BENEFICIAL INSECTS

During the October-November period of 1970, a brown lacewing, *Sympherobius barberi* (Banks), was found in very large numbers during this period as shown by the number of larvae and pupae on the fruit brought to the laboratory for examination. Adults and pupae of *S. barberi* are shown in Figure 2. In December and January no larvae were found on the mealybug-infested fruit brought to the laboratory. The brown lacewings were among the most important enemies of mealybugs in California in 1931 (7). *Sympherobius californicus* Banks, *S. barberi* (Banks) and *S. angustus* (Banks) were the species which commonly fed on the various species of mealybugs. Eggs are deposited singly within the egg masses of the mealybugs or nearby and their abundance was found to be dependent upon temperature and availability of food (4). Brown lacewings were ranked next to *Cryptolaemus* in effectiveness as mealybug predators in California during 1953-55 (2).

An encrytid parasite, *Pauridia peregrina* Timberlake, was also very abundant during the October-November period and continued to parasitize large numbers of the mealybugs during December. Evidence of these predators and parasites was shown by the collections in laboratory cages where the introduced predator and parasite were being maintained on field-collected mealybugs. Adults of *S. barberi* were collected in the cages during December and January but none were collected during February. *P. peregrina* was collected in the cages in large numbers during the October-January period while small numbers were collected during February from the very low level infestations of field-collected material. Citrus mealybugs, adult *P. peregrina* and mummified mealybugs are shown in Figure 3.

Records were started in early January to determine the extent of parasitism by *P. peregrina* since it became apparent that this parasite was the predominant biological controlling agent during December in the smaller infestations of mealybugs (Table 2). The number of infested fruit for making the counts varied from 8 to 24. Originally, no more than 50 nymphs, adults or mummified mealybugs were examined at random on any one fruit. As mealybug populations declined, from zero to 2 mealybugs were found on many of the selected fruits, and by April 25, less than 200 could be found in a large sample of fruit. On January 5, mealybugs were much more numerous than on the later collection dates, however, a very close search was necessary to find enough infested fruit to provide sufficient mealybugs for 4 counts of 100 mealybugs each. The mummified mealybugs were a clear indication of parasitism and, in many cases, the parasite larva or pupa could be observed through the body wall of the mealybug. A larger percentage of mealybugs had immature forms of the parasite than those which were alive with no indication of parasitism on January 5. On January 17, the percentage of live mealybugs dropped to 20.5 while the percentage with live parasites also dropped to 21.5. It was necessary to crush each mummified mealybugs to determine whether or not the parasite larva or pupa was dry and dead. By February 17, very few mealybugs were found to examine, but the per-

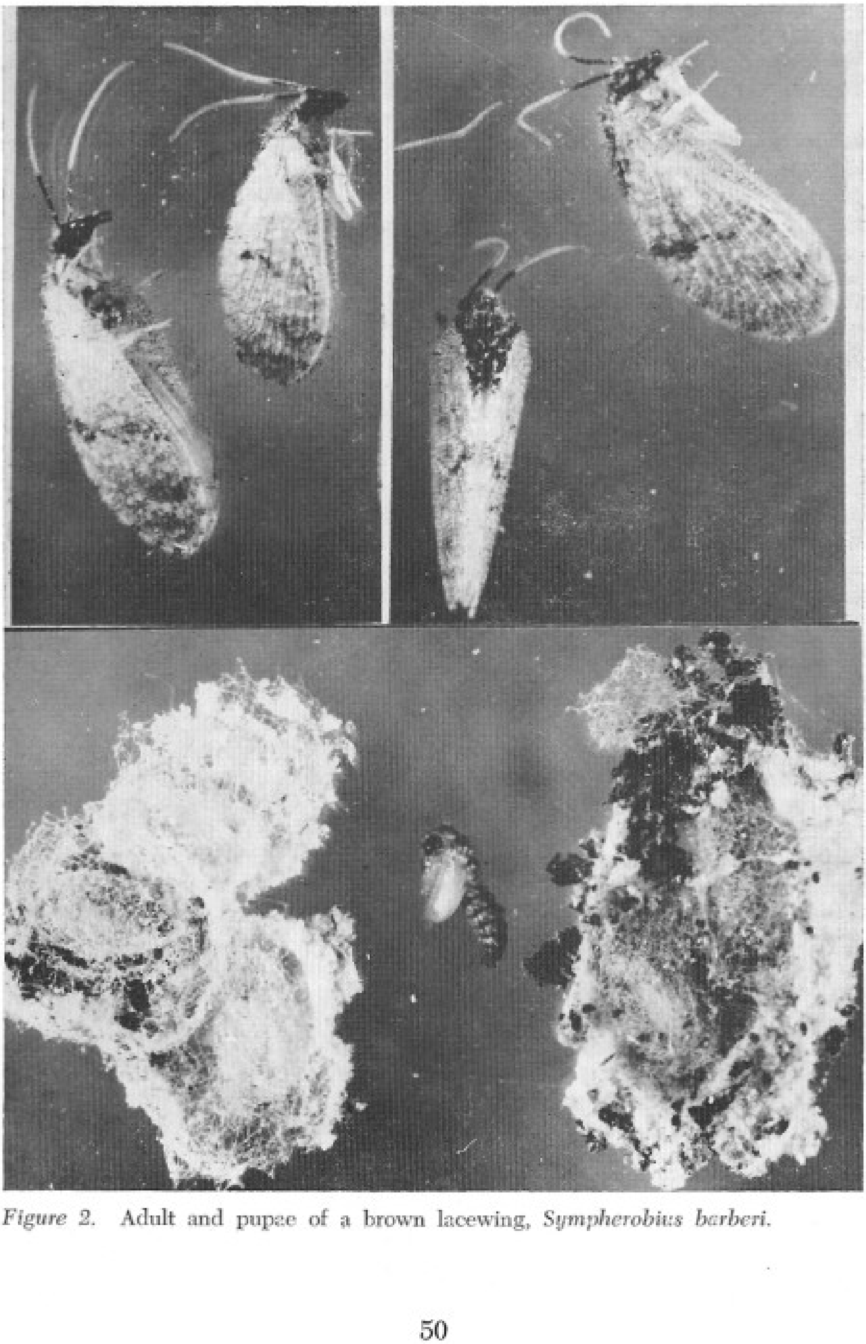

Figure 2. Adult and pupae of a brown lacewing, *Sympherobius barberi.*

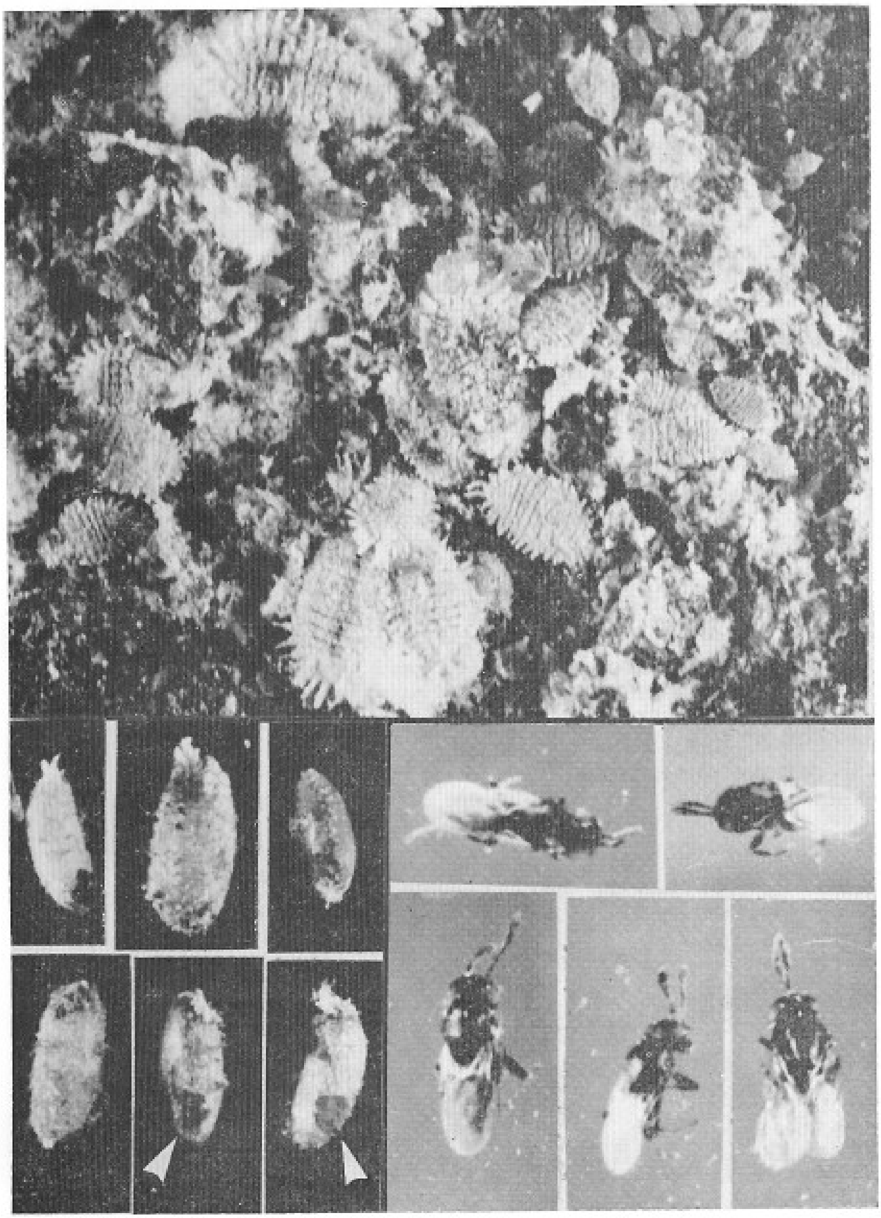

Figure 3. Citrus mealybugs and indigenous parasite, *Pauridia peregrina.* Lower left: mummified mealybugs with parasite emergence hole in lower-middle and lower-right. Lower right: adult of parasite.

centage parasitism was very high while the percentage of mealybugs with live immature parasites was quite large in comparison to the 2.4% of mealybugs found alive and unparasitized. On March 10, only 2 mealybugs were found that were larger than the crawler stage with most of the mealybugs parasitized but with only 1.6% having live immature parasites.

Many parasite larvae and pupae were found to have dried in the mummified mealybugs after the January 5 count. At this time for a period of 84 hours, the temperature varied between 33 and 48°F with 48 hours at or below 40°F. During the 84 hour interval, the relative humidity was below 50% for 28 hours and below 40% for 10 hours. Although the mealybug population had declined sharply, such evidence indicates that the lower temperatures might have been responsible for the failure of many immature parasites to develop through to the adult stage.

Mealybugs were not found during May and early June 1971 in trees of 3 groves where heavy infestations were found in late 1970. Samples taken with a vacuum sampler during this time contained no specimens of the brown lacewing or the mealybug parasites. Such evidence was an indication that if mealybugs were present, they were in extremely small numbers.

The first identification of *P. peregrina* from Texas was made from specimens collected from this area on October 8, 1970. The original description of the parasite was made by Timberlake in 1919 from specimens reared from *Planococcus krauniae* (Kuwana) on pigeon peas from Hawaii where it was very common (8). This parasite was called oriental mealybug parasite since it may have been introduced into Hawaii from China about 1908. It was known to occur in China, Fiji, Manila and Japan (3). This parasite was collected from China in 1950 and introduced into California but there was some question of establishment (5). Later work

Table 2. Parasitism of citrus mealybugs by an indigenous parasite during the January-March 1971 period at the Dan Smith grove west of Harlingen, Texas.

Date	*M*[1] *No.*	*AM*[2] %	*DM*[3] %	*PM*[4] %	*AP*[5] %
1/5/71	400	29.0	2.2	68.8	31.5
1/27	200	20.5	6.0	73.5	21.5
2/17	166	2.4	6.6	91.0	16.9
3/10	257	3.9	.8	95.3	1.6
4/25	184	8.1	16.9	75.0	7.1

[1] Number mealybugs examined.
[2] Motile mealybugs.
[3] Dead-cause undetermined.
[4] Parasitized mealybugs.
[5] Parasitized mealybug with parasite larva or pupa.

showed that this parasite did attack citrus mealybugs in Ventura County of California, however, *Leptomastidea abnormis* (Gir.) was the most important parasite of the citrus mealybug during 1955 and 1956, particularly in low density mealybug populations (1). *P. peregrina* was not introduced into our area intentionally, but it could have been introduced accidentally from Mexico.

ACKNOWLEDGEMENT

The authors wish to thank Dr. Paul DeBach, Professor of Biological Control, Citrus Research Center, Riverside, California, in providing an introductory shipment of the mealybug parasite and predator and identity of the mealybug parasite, and to Mr. Steve Nakahara for mealybug identification, Dr. B. D. Burks for making available parasite records and Dr. O. S. Flint for brown lacewing identification and making available brown lacewing records, all 3 of the Systemic Entomology Laboratory, ARS, USDA, Washington, D. C.

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Star Ruby, a New Deep-Red-Fleshed Grapefruit Variety with Distinct Tree Characteristics[1]

R. A. Hensz[2]

Abstract: A new grapefruit variety, Star Ruby, is described and compared with other commercial pigmented grapefruit varieties. The fruit has a red-tinged yellow peel with red blushes. Peel color begins showing in late summer. The flesh of the Star Ruby is redder than the Ruby Red variety and is suitable for sectioning. The juice of the Star Ruby is higher in soluble solids and acid than the Ruby Red variety. It is a bushy, compact tree. The cambium of the trunk and larger branches is red, the intensity of the color being greatest when cambial activity is lowest. The leaves appear lighter green than other varieties.

INTRODUCTION

Star Ruby, a new grapefruit variety for the Lower Rio Grande Valley of Texas, was developed at the Texas A&I University Citrus Center, Weslaco. It is a unique tree and the color, texture and quality of the fruit give it marketing advantages over the presently grown Ruby Red grapefruit for both fresh fruit and processing.

The Star Ruby originated as a seedling grown from Hudson grapefruit seed that had been irradiated with thermal neutrons at the Brookhaven National Laboratories, Long Island, New York (2,3). The seed were treated and planted in the spring of 1959. In the summer of 1960 buds were taken from the young seedlings and propagated on sour orange rootstock. The budded trees were planted in the field in the winter of 1961-62. The first fruit was set in 1966.

The major differences between the Star Ruby and the Hudson are that the parent variety is a seedy (40-60 seeds) old-line, and the Star Ruby is a seedless (0-9 seeds) variety developed from a seedling.

DESCRIPTION OF THE STAR RUBY

Fruit

Peel color, yellow with a red tinge and distinct red blushes; peel color develops in late summer and early fall; peel notably smoother and thinner than that of other grapefruit varieties; oil glands not raised; size, medium; shape, flattened to round; receptacle dome (button) and area on fruit where receptacle dome attaches, red; albedo, red tinged; flesh, deep red color (more than three times redder than Ruby Red throughout season); texture of flesh, smooth and firm; segments, 10-13; seeds, 0-9, average less than 4, polyembryonic; juice, higher soluble solids and acid than

[1] Cooperative citrus research of Texas A&I University Citrus Center and Texas Agricultural Experiment Station.

[2] Professor of Agriculture and Director, Texas A&I University Citrus Center, Weslaco.

Ruby Red, soluble solids 11.0% or more in October, solids to acid ratio meets Texas maturity standards in October-November.

Tree

Original tree grown from seed planted in 1959; thorniness slight on young trees propagated from original; shoot length short, internodes close, and branching profuse, giving the tree a bushy, compact appearance; cambium of trunk and larger branches red, but color intensity decreases with increased cambial activity; outer bark color is lighter than that of other grapefruit; small leaves at the tip of growing shoots may have a faint red tinge; the basal ¼-inch of the petiole of mature leaves on mature branches lacks green color; mature leaves on exposed outer canopy may appear slightly lighter green than those of other grapefruit varieties; leaves tend to be narrow.

DISCUSSION

The Fruit

Peel coloration of the Star Ruby begins in July on fruit that is shaded. Fruit exposed to the sun lose their green color more slowly. By October or November most fruit is fully colored. This may make it possible to ship the Star Ruby early in the season without the ethylene degreening required for other grapefruit varieties. This would reduce losses, cut packinghouse expense, and permit the shipping of fresher and more attractive fruit.

By March the color of the peel is Calvary Deep Chrome [Plate 1, F-12] (5). The peel of the Star Ruby is more colored than the Ruby Red.

The oil glands on the fruit are not raised and the peel is very smooth. This could make it easy for packinghouses to brush and clean the Star Ruby. Due to the thinness of the peel the fruit may require more care in handling.

A distinctive marking of the Star Ruby fruit is the red color on the receptacle dome, or button, and the area on the fruit where it attaches. This can also be seen on the parent Hudson grapefruit. By comparison there is only slight color in this area on the Ruby Red variety.

The color of the flesh of the Star Ruby is more than three times redder than the Ruby Red through the season (8). The color intensity decreases from its maximum in early fall. In March the flesh color corresponds to Poinsettia [Plate 2,L-9] (5).

The texture of the flesh of the Star Ruby is firm and similar to the parent Hudson variety. Tests on the Hudson (7) and subsequently on the Star Ruby indicate that the sections do not soften or weep as do Ruby Red fruit after treating to loosen the peel and sectioning. This offers the possibility for sectioning red grapefruit that we do not have with present commercial varieties.

The juice of the Star Ruby is higher in soluble solids and acid than the Ruby Red (Table 1). The differences, while not likely to be great enough to effect separate dates of maturity, may give the Star Ruby more taste appeal, especially late in the season. When groups of people have compared the taste of the Star Ruby and the Ruby Red they have generally rated the Star Ruby as being as good or better than Ruby Red.

The color of the Star Ruby juice is attributed to lycopene and associated carotenes located in the septa and juice vesicles. As with the Ruby Red the color is not soluble in the juice. Juice reamed from the Star Ruby fruit has the distinct red color of the flesh and should be an attractive processed red grapefruit juice. In laboratory tests pasteurized, canned single-strength Star Ruby juice retained its color and flavor after a year of storage.

The Tree

The original Star Ruby tree grew rapidly and was thorny but not as thorny as other seedling trees. Young Star Ruby trees vegetatively propagated from the original tree have fewer thorns than other young trees propagated from seedlings of other grapefruit varieties.

The trees have a bushy, compact appearance due to their profuse branching at the shoot tips, short internodes, and thus shorter shoot length. The branches are more brittle and break more easily than those of other grapefruit varieties. The trees bloom profusely and some of the fruit is borne in clusters.

An unusual characteristic of the Star Ruby tree and its Hudson parent is that the cambium of the trunk and large branches is red. No such coloration has been found in the many other citrus varieties and citrus relatives checked. By peeling back the bark and exposing the cambium the color can be seen on both the wood and the bark. The wood itself does not take on a red color however a cross section of a larger branch does show a tinge of red when compared to other citrus wood. The intensity of the color in the cambium decreases as cambial activity increases and is not usually seen on young rapidly growing trees. The color of the cambium of the mature Star Ruby tree in March, while dormant, was Emberglow [Plate 3,G-10] to Burmese Gold + [Plate 3,G-11] (5).

The color pigments in the cambium probably permeate the tree and may affect the color of the branches and leaves. The bark on the trunk of young trees and on branches one to two inches in diameter is usually lighter green than the bark on other grapefruit varieties. The small developing leaves of a new shoot are tinged slightly with red although it is not prominent as in lemons. It may not always be apparent and would be seen only by close inspection of the tree. Older leaves on mature branches usually have no green color on the basal ¼-inch of their petiole.

Chlorosis or a reduction in green color of the leaves of citrus trees caused by such things as poor drainage, excess herbicide, sunburning, winter chlorosis, etc., will be exaggerated in the Star Ruby. Occasionally the underside of young leaves exposed to the sun become silver colored. This seems to disappear as the leaf matures. At times some of the leaves may show areas or margins that have no green color. This can occur following application of some herbicides or insecticides, or it may occur for unexplained reasons. The condition is not chimeral. Caution should be followed when using herbicides and other chemicals around young Star Ruby trees.

The Star Ruby tree appears slightly lighter green than trees of other grapefruit varieties. This difference is more noticeable during the winter. Growers may be inclined to apply more fertilizer to these trees but, since it is possible that the color in the cambium may have a role in the observable color of the leaves, fertilizer applications should not be made on the basis of leaf color. The young Star Ruby trees grow as rapidly as Ruby Red trees under similar conditions even though at times they may have a lighter green color.

Leaves of the Star Ruby vary in shape but they tend to be narrower than those of other grapefruit varieties.

Other

The Star Ruby flowers are typical and produce abundant pollen. The seeds are large and polyembryonic.

The variety is distinct from the Burgandy (U.S. Plant Patent No. 1276) (6) in that the peel of the Burgandy is yellow without any reddish color or any red blushes (1,4,9). The albedo of the Burgandy is white whereas the albedo of this variety is white with a tinge of red. The Burgandy is derived from the Thompson and nucellar trees of either variety do not bear pigmented fruit, whereas the Star Ruby is derived from the Hudson whose nucellar seedlings do produce trees that bear pigmented fruit.

Yielding ability of the Star Ruby has not been determined in field trials. The original tree has produced substantial crops of good sized fruit.

The Star Ruby was developed from seed of a seedy variety either by induced mutation from the irradiation with thermal neutrons or as a

Table 1. A comparison of soluble solids and acid in the juice of the Star Ruby and Ruby Red grapefruit during 1970-71.

Sampling Date	*% Soluble Solids*		*% Acid*		*Solids/Acid Ratio*	
	Star Ruby	*Ruby Red*	*Star Ruby*	*Ruby Red*	*Star Ruby*	*Ruby Red*
Sept. 21	10.2	9.4	1.92	1.87	5.3	5.0
Nov. 18	11.3	10.6	1.61	1.41	7.0	7.5
Feb. 25	11.6	10.4	1.50	1.33	7.7	7.8
Apr. 7	11.6	9.5	1.45	1.19	8.0	8.0

chance mutation that occurred naturally in the developing embryo. A reversion to seediness in some future budded tree is a possibility, however, no seedy fruit have been found on the original Star Ruby tree through five fruiting seasons.

Budwood of the Star Ruby was made available to Texas citrus nurserymen in March, 1970. An application for a plant patent has been made for the Star Ruby.

CONCLUSIONS

The early season peel color development, the distinctively attractive peel color, the deep red color of the flesh, the firmness of the flesh offering a potential for sectioning, the higher sugar and acid and deep red color of the processed juice, altogether give the Star Ruby many advantages over the Ruby Red grapefruit that is now widely grown in Texas.

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VEGETABLE SECTION

Influence of Soil Salinity and Nitrogen Fertilizer on Spinach Growth[1]

G. W. Langdale, J. R. Thomas, and T. G. Littleton[2]

Abstract: The effect of soil salinity and N fertilizer on fresh yields and chlorophyll content of greenhouse grown spinach was studied. Nitrogen requirement for maximum spinach growth decreased as soil salinity (EC_E) increased from 1.2 to 7.2 mmhos/cm. Nitrogen fertilizer significantly increased fresh yields up to the 7.2-mmhos/cm soil salinity level. Fresh yields were not greater than 50% of the maximum (1.2 mmhos/cm with 150 mg N/kg soil) at all nitrogen fertilizer levels when soil salinity exceeded 7.2 mmhos/cm. Nitrogen fertilizer consistently improved chlorophyll content, which ranged from 6.0 to 16.4 mg/g of dry weight at all levels of soil salinity. Salinity appears to have no influence on chlorophyll content of spinach.

INTRODUCTION

Spinach (*Spinacia oleracea* L.) is a unique vegetable crop because of its moderate salinity tolerance and rapid growth immediately preceding harvest (2, 9). Nitrogen stress during this period of rapid growth affects yield and quality (6), whereas soil salinity ($EC_E > 5$ mmhos/cm) appears to restrict growth throughout the growth period (2). The roles of nitrogen in the chlorophyll molecule (3) and of soil salinity in leaf size (2) are prime influences on spinach quality.

An estimated 7 to 8 thousand acres of spinach are grown on potentially saline soils in south Texas. Nutritionally, nitrogen supply in south Texas soils is the most limiting factor for vegetable production (7). Nitrogen fertilizer has enhanced plant tolerance to salinity (4, 5). The interacting effects of nitrogen and salinity on the growth of spinach have not been investigated. The purpose of this experiment was to study these effects on fresh yields and chlorophyll content of spinach.

MATERIALS AND METHODS

This experiment was conducted in a greenhouse on Brennan fine sandy loam soil at Weslaco, Texas. Chemical characteristics of this soil are given in Table 1. Total N and $NaHCO_3$-extractable P were considered medium and high, respectively. Analytical procedures used to measure soil properties were those outlined by the U. S. Salinity Laboratory (8).

Eleven pounds of soil was placed in each 8-inch diameter pot lined with a polyethylene bag. The four soil salinity treatments were developed

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

[2] Research Soil Scientists, and Biological Technician, respectively, USDA, Weslaco, Texas.

by leaching with waters having electrical conductivities (EC) of 1.2, 3.6, 7.2, and 10.8 mmhos/cm. To maintain constant soil salinity, a small perforated plastic funnel was inserted through the bottom of each bag to allow free drainage.

Average electrical conductivity (EC) of available Lower Rio Grande Valley irrigation water is 1.2 mmhos/cm or a salt concentration of 12.6 meq/liter. This water was used for the 1.2-mmhos/cm salinity treatment. Synthetic solutions were developed with a mixture of NaCl, $CaSO_4 \cdot 2H_2O$, $MgCl \cdot 5H_2O$ and KCl salts to simulate the same ionic ratios as the available irrigation water for the other salinity treatments. Soil equilibration was considered complete when the EC of leachates equalled that of the applied waters. Soils were then incubated at field capacity (15% moisture) for two weeks without further evaporation or drainage.

Spinach seeds (var. Hybrid 424) were planted on January 11, 1971 in the salinized soils and thinned to 12 plants in each pot after emergence. The same treatment waters and drainage criteria were used after plant emergence.

Regent grade $Ca(NO_3)_2$ was applied in aqueous solution to develop nitrogen rates of 0, 50, 100, 150 mg N/kg of soil (0- to 300-lb N/acre). Nitrogen was applied in three applications at 2-week intervals after emergence. Salinity and nitrogen treatments were factorially arranged in a 4 x 4 design with 8 replicates, giving a total of 128 pots.

Plant tissue was harvested two months after emergence (January 15 to March 15, 1971). Chlorophyll content of a single representative leaf from each pot was measured just prior to harvest (1).

RESULTS AND DISCUSSION

Relative fresh yields for the various soil salinity and nitrogen fertilizer treatments are shown in Figure 1. All values are based on a maximum yield of 146 g/pot produced on the 1.2-mmhos/cm salinity treatment with 150 mg N/kg soil. Figure 2 depicts effects of salinity and nitrogen stresses on plant growth. Nitrogen stress restricts yield more than the 10.8-mmhos/cm salinity level. Plant emergence was also delayed at the

Table 1. Chemical characteristics of Brennan fine sandy loam soil used in this study.

pH	*CEC*[a]	EC_E[b]	*SAR*[c]	*N*	NO_3–*N*	*Extractable* $NaHCO_3$–*P*
	meq/100 g	mmhos/cm		%	ppm	ppm
7.7	11.4	1.2	0.60	0.09	21	24

[a] Cation exchange capacity

[b] Electrical conductivity of saturated extract

[c] Sodium absorption ratio

two higher levels of salinity, and damping-off problems were experienced in the absence of nitrogen fertilizer.

When soil salinity equalled or exceeded 7.2 mmhos/cm, relative yields were less than 50% of the maximum at all levels of nitrogen fertilizer. Nitrogen additions consistently increased relative yields at the two lower salinity levels. However, yield curves for nitrogen fertilizer rates become more curvilinear as soil salinity increases. Each increase in salinity significantly depressed yields at the two highest nitrogen levels. To maintain a given economical yield as soil salinity increases from 1.2 to 7.2 mmhos/cm, increasing nitrogen fertilizer rates are required.

When chlorophyll content of spinach leaves is used as an expression of quality, nitrogen fertilizer becomes extremely important. A deficient

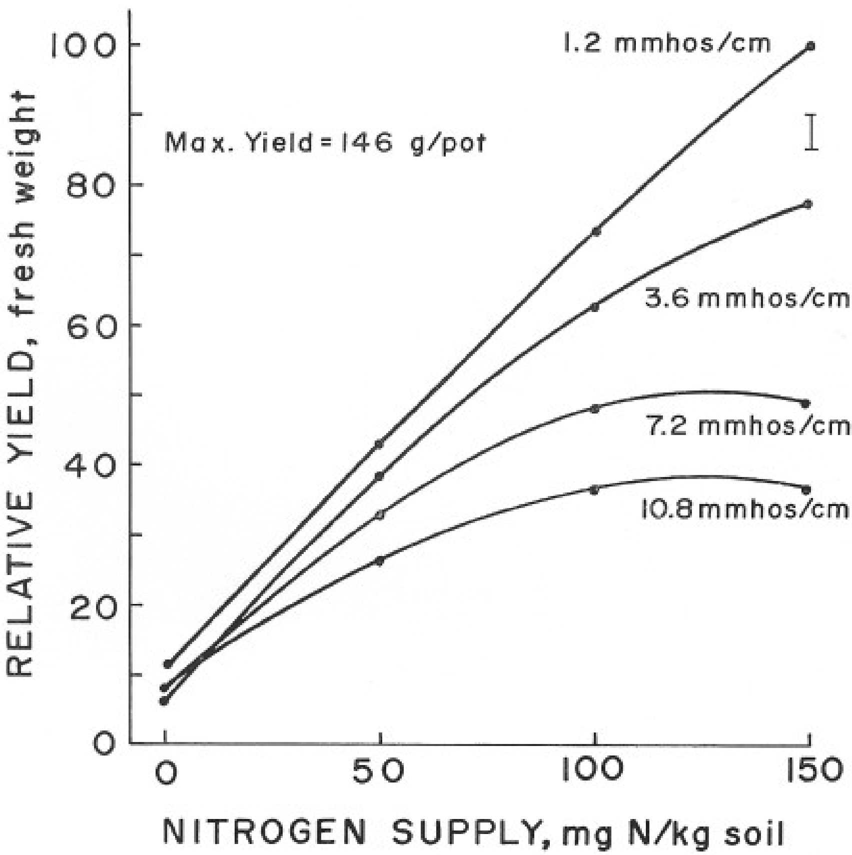

Figure 1. Effect of soil salinity and nitrogen fertilizer on growth of spinach. Soil salinity values are electrical conductivities of saturated extracts (EC_E). The vertical bar represents the l.s.d. at the 5% probability level.

Figure 2. The effect of nitrogen fertilization within a soil salinity level (A), and the salinity within a nitrogen fertilizer level (B). Soil salinity: $S_0 = 1.2$, $S_1 = 3.6$, and $S_2 = 7.2$, and $S_3 = 10.8$ mmhos/cm. Nitrogen fertilizer: $N_0 = 0.0$, $N_1 = 50$, $N_2 = 100$, $N_3 = 150$ mg N/kg soil.

nitrogen supply significantly reduces chlorophyll content (Table 2) as well as leaf size. Salinity does not appear to influence chlorophyll concentration when expressed on a weight basis. However, salinity did reduce leaf size and presumably chlorophyll yield.

Leaf succulence (90% water) was not influenced by either salinity or nitrogen fertilizer. However, total water use is related to leaf size, which was affected by both salinity and nitrogen treatments.

Results of this experiment suggest that nitrogen fertilizer improves both quantity and quality of spinach grown on saline soils. Optimum nitrogen requirements appear to decrease with increasing soil salinity. However, nitrogen fertilization may offset the effects of soil salinity on spinach growth.

Table 2. Effect of soil salinity and nitrogen fertilizer on chlorophyll content of spinach leaves.

Experimental nitrogen level	*Chlorophyll*[a]	*Experimental salinity (EC) level*	*Chlorophyll*[a]
mg N/kg soil	mg/g	mmhos/cm	mg/g
0	6.00 a	1.2	11.18 a
50	10.65 b	3.6	12.52 a
100	14.98 c	7.2	11.86 a
150	16.41 c	10.8	12.51 a

[a] Values followed by the same letter do not differ significantly at the 5% level by Duncan's Multiple Range Test.

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Ridge-Depressional Planting Technique for Tomatoes[1]

C. L. Gonzalez and M. D. Heilman[2]

Abstract: Yield of marketable tomatoes produced in shallow, narrow trenches was 14.0 tons/acre vs 9.0 tons/acre for conventional bed configuration. Advantages of the trenches were higher nighttime soil temperature, reduced wind damage of the young seedling, increased soil moisture in the seedbed, and lower accumulation of salt in seedbed.

INTRODUCTION

The Lower Rio Grande Valley used to grow between 30 and 40 thousand acres of early spring tomatoes, making it one of the major tomato producing areas in the United States. Current annual acreage is approximately 10 thousand (3). The prices received for fresh tomatoes are generally highest in April and lowest during June (1). However, Texas tomato growers must compete with California, Florida and Mexico for early markets. Environmental extremes of either heat or cold adversely affect the growth and production of the tomato plant.

Among the most common problems encountered with winter-seeded vegetables in the Lower Rio Grande Valley are freezes, wind damage, irregular soil temperature, lack of seedbed moisture, and poor seed germination. Previous work with foam for frost protection showed that planting in trenches reduced the cost of the foaming material (2). In 1970, another experiment was conducted to investigate the effects of narrow, shallow trench planting of early tomatoes as compared with conventional ridge planting. The results of this experiment are given in this report.

METHODS AND MATERIALS

The treatments consisted of single rows of tomatoes (Variety Homestead 24) planted in the bottom of a trench, 6 inches deep and 4-7 inches wide, placed in the center of a conventional 38-inch lister bed and single rows of tomatoes planted conventionally on the top of 38-inch planed beds. Each treatment consisted of 6 rows, 50 feet long.

The trenches were excavated with a three-row Rotary Corrugator.[3] The ridges were prepared using conventional equipment. All the treat-

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[3] Use of a company or product name by the U. S. Department of Agriculture does not imply approval or recommendation of the product to the exclusion of others which may also be suitable.

ments were hand planted on January 24, 1970 and thinned to 14-inch spacing on February 24. The plants were fertilized with 60 pounds N/acre at bloom. Plant indices for evaluating the trench planting technique include yield and plant height measurements. Yield measurements are by individual rows.

Soil temperatures were recorded using thermocouple sensors placed 1 inch below the soil surface at the bottom of the trench and 1 inch below the soil surface in the top of the conventional elevated ridge. Continuous temperature records were obtained by utilizing a multipoint strip chart recorder with an internal reference junction.

Soil moisture was determined gravimetrically. Wind speed was measured with a hot wire anemometer. The data were statistically analyzed as a paired block experiment. Electrical conductivity of saturation extract (EC_E) was measured for both the conventional bed and the trench bed configuration to determine the salt distribution.

RESULTS AND DISCUSSION

Tomato plant and fruit weight and plant height for different dates during the growing season are presented in Tables 1 and 2. The data indicate that the plants grew faster in the trenches than in the conventional bed planting. Plant weights (fresh) from the trench treatment were twice those grown on the conventional ridge planting configuration.

The tomatoes in trenches matured 3 weeks earlier and produced a significantly higher yield (101.9 vs 65.1 pounds/50 foot row) than did those growing on the conventional beds. The difference in yield of first harvest (7.2 vs 0.5 pound/50 foot row) indicated that the environmental factors associated with the trench bed configuration quickened growth and maturity.

The faster plant growth on the trench treatment was probably associated with a number of factors including soil temperature, wind protection, and soil moisture. Soil temperature on the conventional treatment

Table 1. Weight and height of tomato plants at different dates.

	Weight			*Height*	
	Treatments			*Treatments*	
Date	*Trench*	*Conventional*	*Date*	*Trench*	*Conventional*
	— — Grams[1] — —			— — Inches — —	
3/3/70	9.6	3.3	2/24/70	2.7	1.5
3/13/70	41.2	14.9			
3/19/70	60.1	24.8	3/3/70	2.9	2.0
3/24/70	75.3	40.1			
4/7/70	553.4	237.8	4/20/70	21.7	14.5

[1] Average fresh weight of 10 plants.

was about 11°C warmer than in the trenches at midafternoon, but quickly dropped at night (Figure 1). The soil remained at low temperature for approximately 12 hours. The soil temperature of the trench treatment did not exceed 20°C during the daytime but it did not drop as low during the night. Data from a previous experiment indicated a 2°C differential between an elevated conventional ridge temperature at night compared with the temperature in the trench (2).

The soil at the 0- to 3-inch depth generally had 2% more moisture in the seedbed trench treatment than in the conventional ridge treatment. This reflects the reduced evaporation associated with the lowered relief of the trench.

Visual observations indicated that wind speed within the trench was lower than on the conventional treatment. Reduced wind speed is one of the most favorable results of trench planting.

The open furrow between rows was used to irrigate both treatments. Following irrigation all treatments were sampled for salt distribution (Figure 2). The EC_E from the trench furrow averaged 2.9 mmhos/cm compared with conventional bed EC_E of 4.1 mmhos/cm. The trench, therefore, was more favorable for seed germination and plant establishment than the conventional bed. The open furrow ($EC_E = 2.1$ mmhos/cm) was the least saline, due to leaching effect of the irrigation water, and was only slightly lower in salts than the trench furrow.

SUMMARY

Tomatoes planted in shallow trenches yielded 14.0 tons/acre compared with 9.0 tons/acre for conventionally-planted tomatoes. Marketable tomatoes were produced 3 weeks earlier in the trench treatment. The soil temperature remained higher at night and wind speeds were lower on

Table 2. Tomato fruit harvests at different dates and total yield for trench and conventional planting.

Date	*Planting configuration*	
	Trench	*Conventional*
	– – – – Pounds[1] – – – –	
5/8/70	7.2	0.5
5/18/70	19.6	5.1
5/26/70	10.1	5.0
6/3/70	24.1	12.2
6/9/70	25.4	28.5
6/12/70	15.4	13.9
Total pounds	101.9	65.1
Total tons/acre	14.0	9.0

[1] Sampled row length was 50 feet.

$t = 4.79$ **

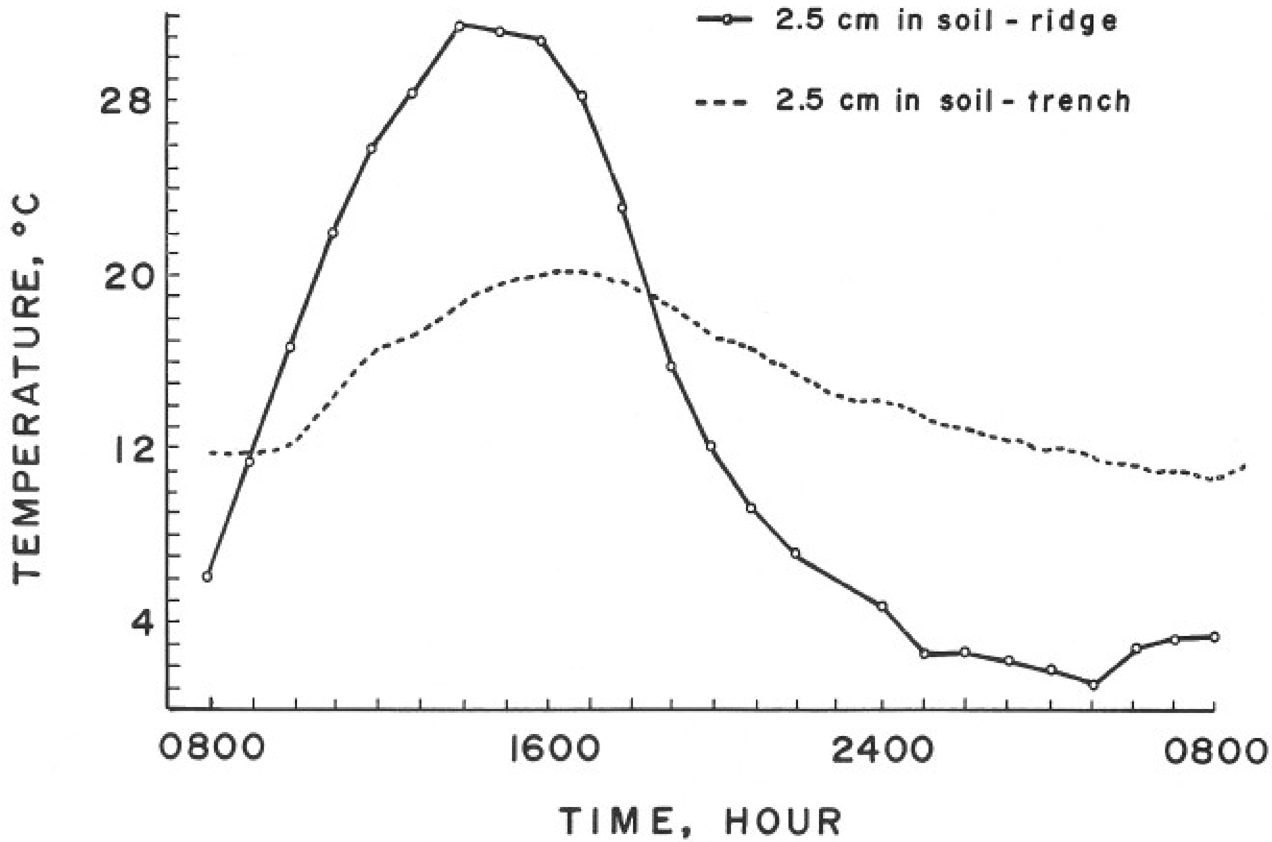

Figure 1. Comparison of diurnal soil temperatures for conventional bed and trench planted tomatoes.

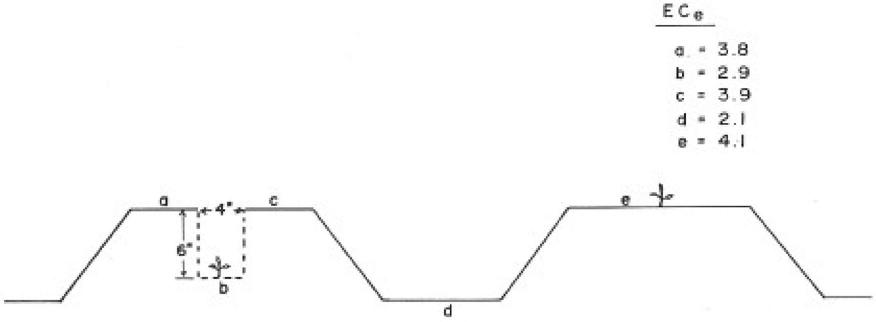

Figure 2. Comparison of salt distribution for trench planting vs conventional ridge planting.

the trench treatment. Soil moisture percentages were higher in the trench furrow for longer periods of time following rainfall or irrigation than in the conventional bed (0-3 inch depth).

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A Comparison of Peeling Methods to Improve Firmness in Canned Seasoned Salad Pack Tomatoes

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HAROLD E. BROWN and FRANCIS P. GRIFFITHS[1]

Abstract: Chico variety, M-110 and M-121 strains of tomatoes were peeled with hot calcium chloride, liquid nitrogen, and hot water, and canned as seasoned salad (specialty) pack tomatoes with and without calcium chloride added to the product.

The salad pack prepared from tomatoes peeled with a hot calcium chloride solution were firmer than tomatoes peeled with either hot water or liquid nitrogen and were slightly firmer than tomatoes peeled with hot water or liquid nitrogen with added calcium. The addition of calcium chloride to the salad pack tomatoes which had been peeled in hot water or liquid nitrogen increased the shear press values of Chico variety from a reading of .16 to .50; of M-110 strain from .17 to .35; and of M-121 strain from .31 to .75. Tomatoes in the salad pack which were peeled with liquid nitrogen contained the same amount of natural calcium and were as firm as tomatoes peeled with hot water. There were only slight differences in pH, titratable acidity, and °Brix which could be attributed to the peeling method or the addition of calcium chloride to the tomatoes. The outside surfaces of the tomatoes peeled in liquid nitrogen were smoother and had a redder visual color than tomatoes peeled in hot water.

INTRODUCTION

The cryogenic peeling of tomatoes described by Brown, et al. (1) offers a new method of peeling tomatoes in order to prepare and improve a seasoned salad (specialty) pack tomato product from southern grown tomatoes. Tomatoes grown during the spring in the southern states ripen during high temperature conditions and have a tendency during some growing seasons to be a little soft. It is more difficult to prepare a firm, crisp, highly colored seasoned salad pack tomato product from these tomatoes than from tomatoes grown under more ideal conditions. A method of peeling tomatoes which will result in a high degree of wholeness, increased firmness and crispness, and retain the red color of the tomatoes in the finished product, would be very desirable. Canned seasoned tomato slices and wedges are prepared for commercial distribution from tomatoes grown in the western part of the United States. These pre-seasoned tomato slices and wedges are used as substitutes or to supplement fresh tomatoes in the preparation of vegetable salads.

The purpose of this investigation is to compare the quality of seasoned salad pack tomatoes which have been peeled by three different

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methods: hot water, hot calcium chloride, and liquid nitrogen; and canned with and without calcium chloride added to the product.

MATERIALS AND METHODS

Chico variety and M-110 and M-121 strains of tomatoes were grown at the Texas A&M University Agricultural Research and Extension Center,[2] Weslaco, Texas. Chico variety and M-110 strain are pear shaped tomatoes, and M-121 strain is cherry shaped. Approximately 100 pounds of fully red-ripe fruit of Chico variety and M-121 strain and 75 pounds of M-110 strain were harvested, washed, and all cracked, insect-damaged, and sunburned tomatoes removed. There were five samples of tomatoes prepared from Chico variety and M-121 strain, and four from M-110 strain. The first sample of tomatoes, the control, was dipped 1 minute into boiling water, hand peeled, and canned with sodium chloride added. Tomatoes for the second sample were peeled with hot water and canned with a 30-grain salt tablet containing 80% sodium chloride and 20% calcium chloride. Sample No. 3 was peeled according to Childs, et al. (2) method of submerging the tomatoes 29 seconds in a boiling 42% calcium chloride solution (bp 250°F) and canned without additional calcium added but with the sodium chloride level adjusted to that of the control pack. The third sample of M-110 strain was omitted. The fourth and fifth samples were peeled by submerging the fruit in liquid nitrogen for 20 seconds and thawed in tap water for 30 seconds, according to the method of Brown, et al.(1). Tomatoes of sample No. 4 were canned without calcium salt and sample No. 5 had a 30-grain salt tablet containing calcium chloride added to each can.

Twelve No. 303 cans for each of the five treatments for the three cultivars were prepared by adding the following flavoring ingredients to each can: 10 ml 45-grain vinegar, 35 ml of vegetable oil (Wesson[3]), .2 g of garlic powder, 2.5 g salt, 4.5 g of tomato seasoning (Stange No. 97588), and 2.36 g citric acid. After the tomatoes were peeled, Chico variety and M-110 strain were cut into ⅜-inch slices. M-121 strain (cherry type) was packed as whole tomatoes. Approximately 300 g of tomatoes were weighed into each can and hot tomato juice added. The cans of tomatoes were placed in a steam exhaust box until the center-can-temperature reached 160°F, closed, cooked 15 minutes in boiling water, cooled in tap water, then stored at 70°F to allow the flavoring material and tomatoes to equilibrate.

Drained weight of the tomatoes was determined according to the procedure outlined in the United States Standards for Grades of Canned Tomatoes (9). Degree of firmness was determined on 200 g of drained

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[2] The authors wish to express their appreciation to Mr. Paul W. Leeper, Texas A&M University Agricultural Research and Extension Center, Weslaco, Texas, for supplying the tomatoes for this study.

[3] Use of a company and/or product name by the Department does not imply approval or recommendation of the product to the exclusion of others which may also be suitable.

tomatoes with an Allo-Kramer Shear Press (4). The instrument was operated using a 1000-lb. proving ring, a 50% range setting on the recorder, and 1-minute time setting for the full stroke of the instrument. The area under the time-force curve on the recorder was measured with a Gelman Planimeter Model No. 39231.

The drained tomatoes from the firmness determintaions were blended without the cover juice for 2 minutes in a Waring Blendor, deaerated and used in the determinations of color, pH, titratable acidity, °Brix, and percent calcium.

Color notations were made on the blended samples with a Gardner Color Difference Meter which had been standardized with a tomato red color plate: RD = 5.36, a = 30.4, and b = 14.6. The a/b ratio was used in color comparisons according to Robinson, et al. (6).

Titratable acidity was determined by titrating 10 g of the blended tomato sample diluted with 100 ml of distilled water to a pH of 8.2 using 0.1567N sodium hydroxide and a Corning Model 10 pH meter. The pH was measured with the same pH instrument. A Bausch and Lomb refractometer was used to determine the °Brix.

Calcium content of the blended tomato samples was determined with a Perkin Elmer Model 303 Automic Absorption Spectrophotometer using the dry ashing technique. This procedure involves accurately weighing 10 g of blended sample, bringing the sample to dryness at 90°C in a drying oven, then ashing the sample overnight at 500°C. The ashed sample was taken up in 5% HCl containing 1% lanthanum and calcium determined according to the procedure described by the manufacturer of the instrument.

The data were subjected to an analysis variance as described by Steel and Torrie (7).

RESULTS AND DISCUSSION

The hot water, calcium chloride, or liquid nitrogen methods of peeling did not have a significant effect on the drained weights of Chico variety or M-121 strain of salad pack tomatoes, Table 1, 3. However, M-110 strain with calcium chloride added was significantly greater in drained weight than tomatoes without calcium chloride added, Table 2. Kertesz, et al. (3) reported an increase in the drained weight of whole canned tomatoes to which calcium chloride had been added, and Stephens, et al. (8) found that the drained weight was greater in canned whole tomatoes peeled in a hot calcium chloride solution compared to tomatoes peeled in hot water. The calcium chloride treated samples of Chico variety and M-121 strain did not have a significantly greater drained weight value than the untreated samples probably because of small differences in can-fill-in weights at the time of processing.

The nitrogen peeled tomatoes with calcium chloride added tended to be higher in drained weight in all three varieties than the other peeling methods and treatments; however, it was not statistically significant.

Tomatoes peeled in calcium chloride were as firm or firmer with approximately the same or a smaller amount of calcium in the finished product than tomatoes peeled with hot water or liquid nitrogen to which calcium chloride had been added. However, the small cherry type tomatoes, M-121, Table 3, absorbed about twice as much calcium from the peeling solution than did Chico variety, Table 1. The cherry type tomato absorbed more calcium due to the increased surface area exposed to the hot calcium chloride solution. Although tomatoes peeled in hot calcium chloride are firmer than tomatoes peeled in hot water or liquid nitrogen, calcium peeling has limitations. It is difficult to control the amount of calcium absorbed by the tomatoes from the hot peeling solution and according to Stephens, et al. (8), the dissolved solids from broken fruit in the boiling calcium chloride solution may impart a burned-sugar smell to the tomatoes.

Calcium chloride added to the cans of salad pack tomatoes whether they were peeled in hot water or liquid nitrogen caused an increase in the shear press values when compared with hot water peeled tomatoes with sodium chloride added, and increased the amount of calcium absorbed by the canned product. However, if the hot water peeling method is compared with the nitrogen peeling method, Tables 1, 2, 3, there are no significant differences between the amounts of calcium absorbed or the shear press values obtained. The three cultivars had about .010% calcium in the hot water or liquid nitrogen peeled fruit with shear press values of about .16 for Chico and M-110, and .31 for M-121, whether hot water peeled or liquid nitrogen peled. The increased shear press values for the M-121 tomatoes were probably due to the fact that these where whole tomatoes and could have contained a higher percentage of "core" than did the slices from the other cultivars. Adding calcium chloride to the cans increased the percentage calcium in the tomatoes to approximately .042% for the three cultivars and increased the shear press values to approximately .50 for Chico, .35 for M-110, and .75 for M-121. Brown, et al. (1) reported that Chico variety tomatoes which had been peeled with liquid nitrogen had a greater shear press value than comparable samples peeled with boiling water and that the addition of calcium chloride to the cans increased the firmness of the nitrogen peeled tomatoes more than the hot water peeled tomatoes, but the was working with canned tomatoes without seasoning. The oil and seasoning added to the salad pack tomatoes might have altered the ability of the tomatoes to absorb calcium from the cover solution.

The slightly lower pH of most of the samples with added calcium chloride and those peeled in calcium chloride may be attributed to an increase in methylesterase activity. McColloch and Kertesz (5) reported that an increase in concentration of di-valent salts cause a corresponding increase in the enzyme activity freeing more carboxyl groups to lower the pH. In most of the samples treated with calcium chloride, there was a corresponding increase in titratable acidity values as the pH values decreased. The changes in pH and titratable acidity were very small for all treatments.

Table 1. Quality of salad pack tomatoes prepared from Chico variety.

Treatment	*Drained Weight* g	*Calcium* %	*Shear Press Values*	*pH*	*Titratable Acidity* %	*Brix* °	*Gardner Color Notation* *a/b*
Hot water peeled	271a[1]	.010a	.15a	3.6ab	1.13bc	7.7b	1.76a
Hot water peeled, $CaCl_2$ added	279a	.042c	.45b	3.5a	1.21c	7.9b	1.70a
$CaCl_2$ peeled	277a	.026b	.60b	3.5a	1.15bc	7.9b	1.68a
N_2 peeled	279a	.010a	.16a	3.7b	1.02ab	7.9b	1.65a
N_2 peeled, $CaCl_2$ added	286a	.042c	.58b	3.6ab	1.00a	7.3a	1.78a

[1] Values followed by the same letter are not significantly different at the 5% level by Duncan's Multiple Range Test.

Table 2. Quality of salad pack tomatoes prepared from M-110 strain.

Treatment	*Drained Weight* g	*Calcium* %	*Shear Press Values*	*pH*	*Titratable Acidity* %	*Brix* °	*Gardner Color Notation* *a/b*
Hot water peeled	259ab[1]	.010a	.16a	3.7b	1.04a	7.6a	1.74a
Hot water peeled, $CaCl_2$ added	276bc	.041b	.37b	3.7b	1.02a	7.7a	1.70a
N_2 peeled	257a	.010a	.17a	3.7b	.98a	7.6a	1.69a
N_2 peeled, $CaCl_2$ added	284c	.043b	.34b	3.6a	1.01a	7.5a	1.75a

[1] Values followed by the same letter are not significantly different at the 5% level by Duncan's Multiple Range Test.

Table 3. Quality of salad pack tomatoes prepared from M-121 strain.

Treatment	*Drained Weight* g	*Calcium* %	*Shear Press Values*	*pH*	*Titratable Acidity* %	*Brix* °	*Gardner Color Notation* *a/b*
Hot water peeled	279a[1]	.011a	.31a	3.6a	1.16a	7.3ab	1.74a
Hot water peeled, $CaCl_2$ added	287a	.045bc	.75b	3.5b	1.31b	7.1a	1.77a
$CaCl_2$ peeled	287a	.047c	1.14c	3.5b	1.26b	7.5b	1.75a
N_2 peeled	289a	.011a	.31a	3.6a	1.18a	7.4b	1.85a
N_2 peeled, $CaCl_2$ added	304a	.041b	.76b	3.5b	1.22a	7.3ab	1.79a

[1] Values followed by the same letter are not significantly different at the 5% level by Duncan's Multiple Range Test.

There was a significant difference in °Brix, but the differences were small and could not be attributed to the peeling methods.

There was no statistical difference in color as measured by the Gardner Color Difference Meter between the blended tomato samples peeled by the three different methods, nor did the addition of calcium chloride affect color. However, the tomatoes peeled with liquid nitrogen had a much smoother surface and a redder visual color which the instrument did not detect, possibly because the color notation was made on the blended tomatoes. Brown, et al. (1) observed the same condition existed when canned tomatoes were peeled with liquid nitrogen.

The liquid nitrogen method of peeling tomatoes for a seasoned salad pack product is preferred to peeling the tomatoes with calcium chloride or hot water. Peeling in calcium chloride produces a firmer tomato; however, it is difficult to control the amount of calcium absorbed by the tomatoes and spent calcium chloride solution aggravates the cannery waste disposal problem. Tomatoes peeled in hot water appear rough and the exposed white vasular bundles detract from the visual appearance and color of the tomatoes.

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The Vegetable Industry in the Rio Grande Valley Past, Present and Future[1]

WAYNE A. SHOWERS[2]

Man has been on the earth about one million years, but has been farming only approximately one and a half percent of that time, or 17,000 years. Farming, as we know it, was introduced into the Rio Grande Valley by the early settlers. Historical accounts of the early settlements indicate that as early as 1770 cattle raising was the main farm enterprise. Gradually, the area planted to crops increased and consisted mainly of raising subsistence crops as corn, beans, peppers and other vegetables. Cultivated crops were produced on slightly more than 2,000 acres as late as 1880, but by 1900 the area had increased to 10,000 acres according to the Federal census.

The first major agricultural crop endeavor of any importance began about 1890, when a small sugar factory was ereceted, which was supplied with sugar cane grown with irrigation. In 1902 permanent irrigation systems began to be installed in the Valley. In the same year a rice mill was erected at Brownsville, and an extensive acreage of irrigated rice was planted in Cameron County. This project was short lived, as rice culture was abandoned in 1905.

With the advent of the railroad in 1904 and the arrival of new settlers, agriculture had its real beginning. Two sugar mills were constructed in 1908, – one at Brownsville and one at San Benito. High quality cane was grown extensively over much of the Valley for a number of years, but the last five major mills were closed in 1921 because of low sugar prices due to a relaxation of sugar imports.

Onions were an important item in the early development of the Valley's vegetable industry, accounting for 48% of the volume shipped in 1907; the first year that production is said to have assumed commercial importance. Onions were first grown as an irrigated crop, but gradually production moved to the dryland and by 1925 approximately 3,000 acres were raised in Willacy County.

Rapid progress of farming in the Valley is evidenced by the increase from 8,940 acres of cultivated land in 1910 to 74,168 acres in 1920 in Hidalgo County alone, which was increased to 127,220 acres by 1924.

Corn ranked second to cotton in acreage in the early 1920's followed by truck crops. Vegetable growing was on the increase, with cabbage

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2 Vice President, Trophy Frozen Foods, Inc. and General Manager, Griffin and Brand, Inc., McAllen.

being the main vegetable crop. Cantaloupes, tomatoes, peppers, green beans and other vegetable crops were increasing in importance and being shipped to the fresh market. Lettuce was grown with fair results, but quality was irregular and potatoes, as well as spinach and other green crops, were tried in the late 20's and early 30's.

There have been two major growth periods of the vegetable industry – just prior to the depression of the 1930's and just after World War II in the mid and late 1940's.

By 1947 an enormous increase in the irrigation facilities in the Valley had taken place with the formation of many new irrigation and improvement districts. The completion of Falcon Dam, which caught its first water in 1954 from Hurricane Alice, gave a big boost to the vegetable industry.

The agricultural economy of the Lower Rio Grande Valley is the most complex in the state and, possibly, in the nation. With a subtropical climate and year long production, it is the most intensively cultivated area in the state. The four South Texas counties, Cameron, Willacy, Hidalgo and Starr, comprise the Lower Rio Grande Valley, an area of some 4,226 square miles, a little more than 1% of the land area of Texas but right at the top in farm cash income in comparison with other areas.

After major freezes in 1949 and 1951, much of the citrus land was planted to vegetable crops, but a bigger percentage went into cotton. In 1949 there were 182,000 acres of vegetables, while in 1959 the acreage had dropped to 136,000 acres. In 1969 less than 100,000 acres of vegetables were planted.

The peak years of vegetable production in the Valley were during World War II and the years just following the War – the 40's and early 50's. With the large demand for food and fiber during this period, the greatest number of farmers and shippers were active in the Valley.

Some of the same factors that caused a decline in the vegetable industry during the 30's also caused the decline after World War II, namely a reduction in the number of farm units due to many complex factors. The same trends in the Valley are also to be found in all vegetable growing areas in the United States. In 1925 there were 6.5 million farms in the United States making up 25% of the population, while in 1970 only 2.8 million farms, or 5% of the population, and the year 2000 projects only 0.5 million farms in the U. S. However, the importance of Valley vegetable production to the horticultural economy of Texas is still indicated by the fact that Hidalgo and Cameron Counties grow the greatest variety of vegetables of any counties in the state.

Hidalgo County in 1959 had the highest acreage, or was in the top ten counties of highest acreage, with some 15 different vegetable crops. Area Farm Management Specialist, Ralph E. Peterson, ranked the 10 most important Valley vegetable crops in the following order:

1. Onions
2. Carrots
3. Cantaloupes
4. Cabbage
5. Tomatoes
6. Green peppers
7. Spinach
8. Sweet corn
9. Lettuce
10. Honey dew melons

Other vegetables of importance in the Valley are broccoli, beets, cucumbers, beans, squash and watermelons. Time will permit only discussion of a few of the crops from the above list.

Onions — With the development of vastly superior varieties, which burst dramatically upon the scene in the late 1940's and early 1950's, production shifted again almost exclusively to the irrigated sections. Sharing the Nation's spring onion deal with the Laredo, Coastal Bend and Winter Garden districts, the Valley grows from 9,500 to 12,000 acres each year.

Carrots became a commercial crop in the Valley about 1920 and was a well established item by 1930. Produced for both fresh market and processing, the Valley grows 25,000 to 30,000 acres of carrots each season. The 1951 freeze, which froze the tops, put the Valley in the "cello" business.

Cantaloupe production is of great interest because the Valley produces the first melons in the nation each spring. The acreage declined with the growing incidence of powdery and downy mildew diseases and the ravages of aphids. The development of superior disease resistant varieties, as Perlita, and better insect and disease control chemicals are primarily responsible for the current expansion of the enterprise. Acreage has increased significantly in recent years with a current season estimate of 8,000 acres; production is centered in the drier Western areas of the Valley.

Cabbage has been, perhaps, the most important vegetable in the establishment of the winter vegetable industry. With the development of competing production areas and the instability of market prices, acreage in the Valley has significantly declined. In recent years, acreage has varied from 15,000 to 20,000 acres.

Tomatoes, formerly a mainstay of the vegetable industry declined in recent years; from 35,000 acres spring tomatoes in 1953 to only 8,700 in 1965. During this same period, Florida increased their plantings from 24,400 acres in 1953 to 50,170 in 1965. Although there have been production improvements, such as improved varieties and more effective pest control practices, these have not been sufficient to offset the effects of competitive areas. The recent development and release of the Chico tomato has provided the processing industry with a variety competitive in yield and raw stock quality. New strains of promise are nearing perfection and release as vineripe market types.

GENERAL CONSIDERATIONS

Many changes have taken place in the past few years. For instance, before the 1951 freeze there were 44 canners in the Valley, now there are only 5 in operation.

The trend from small farms to larger farms and to corporate farming operations or grower-shipper complex, has gained momentum the last ten years, and there seems to be no end in sight. The only exception is in a small specialized, highly technical operation.

The Valley is below average on most vegetable crops as far as production and value per acre are concerned. This is not necessarily as bad as it sounds, since land prices and production costs are also below U. S. averages. What is important is that difference between the unit cost and unit price received, which will give the highest net return.

Another major factor involved in our vegetable situation is the foreign trade situation. Imports from Mexico, for instance, have increased 5 fold during the past 10 years and most of this is due to vegetable crops requiring high labor inputs. Our only hope in reversing this tend lies in our ability to produce a better quality product, at a lower or equal price and to transport and market it at a profit. This means mechanization of many of our crops and substitution of capital for labor.

Trends of food consumption in the U. S. dictate what path we should take in the vegetable industry.

Processed vegetable consumption in the U. S. has increased 37% in the last 15 years, with the largest increase in frozen processed vegetables. Fresh vegetable consumption in the U. S. increased approximately 15% during the same period.

Expansion of the vegetable processing industry in the Valley should be encouraged in order to keep up with consumer trends. For with improved technology, improved machinery, new hybrids, herbicides the Valley can keep pace with the vegetable demands. There are now three large freezing plants in the Valley and 5 canning plants, and it is my belief that more will be forthcoming.

As our population increases the demand for vegetables will increase, but per capita consumption has been decreasing somewhat. For years, 1,500 pounds of food consumed per person per year has been a "rule of thumb"; now researchers use 1,450 to 1,475 pounds.

In the United States we have the capacity to overproduce our consumptive needs by 18% while 90% of our production is consumed in the U. S. In the future we will be faced with increased surplus production if careful planning is not carried out. Technology has been able to increase food production faster than population has increased.

The tend toward both enterprise and geographic specialization is quite pronounced. Along with specialization and increased mechanization, many vegetable crops are shifting from the fresh market to the process market. The approximately 30,000 acres of vegetables now being grown for processing in the Valley at a pre-determined price take the risk out of marketing and do not compete with the fresh market.

Imports of vegetables are becoming more important than exports, with the imported crops primarily those which are too difficult to mechanize domestically and require large amounts of labor, that is becoming more expensive with each passing year.

In the Valley at present we now have approximately 96,000 acres in vegetables and 80,000 acres in citrus out of 705,000 acres under irrigation. It appears that in the future highly skilled, highly mechanized operators, coupled with hybrid seeds, herbicides and the like will be able to survive in the society ahead.

The vegetable industry of the Valley has problems that require attention, research and long term consideration; the more important are:

(1) Drainage — salt build up.

(2) Water supply — water suit, etc.

(3) Capital supply — Unit banking requirement in Texas.

(4) Advertising and promotion restraints — enabling legislation needed.

(5) Railroad Commission permits for additional trucks as railroads become less efficient and profitable.

(6) Legislation aimed at curtailing pesticides and fertilizers and herbicides through the new E.P.A.

SUMMARY

Since World War II, the direction of production trends for fruits and vegetable products has been very similar. Both groups have had a reduction in number of farms and an increase in size of farms; for both, total output and output per farm has increased. Acreage declined steadily until recent years. Since 1964, however, acreage has increased slightly.

The trend toward geographic specialization and larger producing units is fostered by advances in the technology of producing, harvesting, handling, and transporting fresh fruit and vegetable products. Faster and cheaper product movement reduces the advantages of small scale producers near major population centers and promotes growth of larger scale commercial producing units in areas where soil, climate, and costs are more favorable. Economics of size favor the larger producer.

The utilization of fruits and vegetables has changed markedly in the direction of processing. Mechanization has been a major influence in this change. The increase in utilization through processing appears to be a contributing factor to the trend toward concentration and specialization in production. Specialization and increase in size of enterprise is necessary to justify the adoption of mechanization. Processing firms tend to locate in areas of relatively dense production, and the establishment of a processing industry stimulates further production increases.

As processing increases, the fruit and vegetable producing areas which surround and supply large metropolitan centers with fresh products will find their markets diminishing. Production and farm numbers in such areas will tend to decline or be shifted to production of processed fruits and vegetables.

Imports of vegetables exceeded exports in 1969, and imports of fruits are rising more rapidly than exports. As we examine the trends in foreign trade, the rapid increase in imports is most relevant to our interest in mechanization. It suggests a comparative advantage in the production of selected commodities primarily because of lower labor costs in foreign countries and the inability to mechanize the domestic production. Farm labor, land, and other input costs have been rising rapidly, and they are likely to continue this trend. In the future, we are more likely to import the fruits and vegetables with a high labor requirement and export those that we can mechanize. A good example is onions and carrots. Last year 3 shiploads of onions and 2 of carrots from the Valley were shipped to Europe. Those crops that cannot be mechanized will likely decline in total production, although not necessarily in total value.

Increased demand for fruits and vegetables in the future will come primarily from increases in population. Per capita consumption is likely to remain relatively steady with only small increases in the near future.

Effects of Foliar Applications of Iron, Manganese, Zinc and Boron on Crop Yield and Mineral Composition of Sweet Potato Leaf Tissue

D. R. Paterson and D. E. Speights[1]

Abstract: Foliar sprays containing iron, manganese, zinc and boron were applied to Centennial sweet potato plants. Use of a spray containing zinc resulted in a highly significant increase in the zinc concentration of the leaf tissue. Foliar applied iron significantly reduced leaf calcium and boron content. There was a highly significant increase in the boron and a significant reduction in the zinc concentration of the leaf tissue when boron was applied as a foliar spray. None of the 16 spray combinations had any significant effect on the grade or yield of sweet potato roots at harvest. The phosphorus, potassium, molybdenum, manganese, copper, strontium and barium content of the sweet potato leaf tissue was not significantly affected by the foliar sprays noted above.

INTRODUCTION

Secondary and trace elements are of major importance in the production of a commercial crop of sweet potatoes (5, 6, 9, 11, 12). Lambeth (8) found no significant response to Mg above the base (2.3%) level of cation exchange capacity. There was no beneficial effect from the addition of Es-Min-El trace element mixture in this same study (8). Speights, et al (11) reported no response to sources of K that included S and Mg. Jackson and Thomas (4) reported that the addition of dolomitic limestone enhances yield of sweet potatoes at high K levels. Severe Mg deficiencies developed in plots which did not receive Mg in the form of dolomitic limestone. Yield of roots was not decreased as greatly as th eappearance of the Mg deficient tops indicated (4).

In solution cultures, Leonard, et al noted that vine growth of the sweet potato was reduced more than was the growth of the storage roots by low levels of N and P (9). This same study showed that levels of Ca and Mg sufficient to support vigorous vine growth did not produce storage roots. Maximum storage root production did not coincide with maximum vine growth (9). In the above study, Na in the nutrient solution appeared to depress the percent of K and Ca to a greater extent than percent Mg of plant parts (9). Solution of Mg sharply depressed percent Ca while percent K was only slightly depressed. Applied K depressed both percent Ca and Mg (9). In the series of these experiments, chloride and sulphate depressed the percent of N and P in all plant parts (9).

Lutz, et al (10) indicated that neither rate of borax application nor rate of fertilizer had any significant effect on cracking or keeping quality

[1] Respectively, Associate Professor and former Assistant Professor, Soil and Crop Science Department, Texas A&M University.

of sweet potatoes in storage. Greig and Smith (3) have shown that excess cations may stunt or kill sweet potato plants either by causing toxicities or by producing nutrient deficiencies. These same workers have demonstrated that Na decreases and K increases the carotene content of sweet potato roots (3).

The purpose of this experiment was to evaluate the effects of foliar applications of minor elements with crop yield and mineral composition of sweet potatoes.

MATERIALS AND METHODS

A commercial field near Gilmer, Texas with a uniform stand of Centennial sweet potato plants was selected for study. The soil had previously been fertilized with 500 pounds per acre of a 5-20-20 fertilizer. Plants were set 1.5 feet apart in 4 foot rows.

All possible combinations of 2x2x2x2 BxFexMnxZn factorial were used and replicated once (2). Boron was supplied by Solubor at 22 gms per gallon, iron as 330 Fe at 4 gms per gallon, manganese as Seq. Na_2Mn at 2 gms per gallon and zinc as Zn 45 at 10 gms per gallon. The first foliar spray was applied 2 weeks after planting. Approximately 0.5 liter of spray was used on each 32 foot plot. A similar application was applied one month later. Twenty leaf samples were taken from each plot 2 weeks after the second spray application. The roots were harvested on October 27, 1967 and the weight and number of marketable roots recorded. All cultural practices in the plots were the same as in the commercial field in which the plots were located. The dried leaves were ground in a Wiley mill to pass a 40-mesh screen. A representative sample of this material was used for analysis either by official methods (1) or by photoelectric spectrometer analysis (7). At the end of the experiment, yield and mineral composition values were subjected to the analysis of various procedures (2).

RESULTS AND DISCUSSION

Foliar applications of iron significantly reduced both the calcium and boron content of leaf tissue while similar zinc sprays gave a highly significant increase in the zinc content of the leaf, Table 1.

Table 1. Effects of foliar applications of iron and zinc on the nitrogen, calcium, zinc and boron content of Centennial sweet potato leaves.

grams/gal. 330 Fe	Zn 45	*percent* N	Ca	*ppm* Zn	Bo	Fe
0	0	4.650	1.472	25	55	187
0	10	4.569	1.391	31	60	206
4	0	4.606	1.290	27	54	211
4	10	4.725	1.249	28	50	194

There was a highly significant iron times zinc interaction with respect to zinc content and a significant iron times zinc interaction with respect to nitrogen and iron content of the leaf tissue. The addition of iron or zinc as a foliar spray caused an increase in the iron and zinc content and a reduction in the perecent nitrogen of the leaf tissue, Table 1. Iron and zinc applied together increased the nitrogen iron and zinc content of the sweet potato leaves, Table 1.

There was a highly significant iron times manganese interaction in respect to the aluminum content and a significant iron times manganese interaction in respect to magnesium, iron and molybdenum content of leaf tissue. The addition of iron or manganese caused a reduction in the aluminum, iron and magnesium content of the leaf tissue, Table 2. Iron and manganese applied together increased the iron content of the sweet potato leaves, Table 2.

There was a highly significant manganese times zinc interaction with respect to zinc and a significant manganese times zinc interaction with respect to boron. The use of manganese or zinc as a foliar spray increased the zinc and boron content of the leaf tissue, Table 4.

There was a significant iron times boron interaction in regard to the zinc content of sweet potato leaves. The use of iron or boron alone or in combination as a foliar spray caused a decrease in the zinc content of the sweet potato leaf tissue, Table 3.

Table 2. Effects of foliar applications of iron and manganese on the magnesium, iron and aluminum content of Centennial sweet potato leaves.

grams/gal. 330 *Fe*	*Seq.* Na_2Mn	% *Mg*	*ppm* *Fe*	*Al*
0	0	0.485	209	379
0	2	0.420	184	290
4	0	0.395	193	289
4	2	0.429	212	353

Table 3. Effects of foliar applications of iron and boron on the zinc and boron content of Centennial sweet potato leaves.

grams/gal. 330 *Fe*	*Solu-bor*	*ppm* *Zn*	*Bo*
0	0	29	39
0	22	27	76
4	0	28	35
4	22	28	68

The use of iron, manganese, zinc or boron alone or in combination as foliar sprays did not significantly affect the grade or yield of sweet potato roots at harvest. The phosphorus, potassium, molybdenum, manganese, copper, strontium and barium content of the sweet potato leaf tissue was not significantly affected by the foliar sprays noted above. A summary of the yield as well as the mineral composition values of this experiment are presented in Table 5.

Table 4. Effects of foliar applications of manganese and zinc on the boron and zinc content of Centennial sweet potato leaves.

grams/gal.		*ppm*	
Zn 45	*Seq. Na_2Mn*	*Bo*	*Zn*
0	0	53	25
0	2	59	30
10	0	56	27
10	2	51	29

Table 5. Means of the yield and mineral composition values of Centennial sweet potato leaf tissue.

Yield 55 lb.bu./A	387 Total
Yield 55 lb.bu./A	151 No. 1
N %	4.637
P %	0.264
K %	3.018
Ca %	1.351
Mg %	0.432
Fe ppm	200
Mn ppm	210
Zn ppm	28
B ppm	55
Cu ppm	12
Al ppm	328
Sr ppm	111
Ba ppm	160
Mo ppm	2

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OTHER AREAS

Weather Modification and Prediction[1]

J. A. Riley[2]

Horticulture and meteorology are sister sciences in the large and growing family of studies involving our large but relatively shrinking planet. And with the increasing importance and wide spread interest in ecology, the relationship between our two sciences is becoming even closer.

On this occasion of your Institute's silver anniversary, it is interesting to do a little stock taking. Predictions of the development of the science of horticulture made 25 years ago are at some variance with current conditions. This is true in meteorology, too. Some extravagant claims were made for progress in long range weather forecasting 25 years ago; many of these have not occurred, but the National Weather Service takes pride in the advances that have occurred in more specific forecasts that are now routine in the 12- to 24-hour period. There has been progress in weather modification, in agricultural meteorology and in the study of atmospheric pollution. This paper will discuss the status of these studies.

Big advances have been made in weather observing equipment during the last 25 years. Radar has become one of the most important tools for the short range forecaster. The Weather Service Office in Brownsville has a fine set, a crew of very experienced men, and they make detailed analyses of current rain throughout south Texas, northwest Mexico and adjacent waters of the western Gulf of Mexico. We are installing the same large sets in Hondo and Midland now; and with the cooperation of the Federal Aviation Administration, we utilize reports from their sets to give complete radar coverage over the Rio Grande.

Computers now play a big role in weather forecasting and the output from these mechanical brains forms the basic weather analysis from which the final weather forecast is shaped.

With the computers has come an advance in the knowledge of dynamic meteorology, and this is the factor that makes it possible to use the computers. Perhaps, the fundamental feature of weather forecasting now is the use of the concept of vorticity. This means the spin of the air. The rotation of the earth imparts a spin to all masses of air. Circulation around Low and High pressure systems gives some spin and the decrease or increase of wind speed up-stream and down-stream, and to the right and to the left of the air flow also affect the vorticity.

Upper air soundings such as those made in Brownsville and some 60

1 Presented at the Twenty-fifth Annual Horticultural Institute, Weslaco, Texas, January 19, 1971.

2 Chief, Weather Analysis and Prediction Division, National Weather Service.

places in this country and Mexico, and many other locations are analyzed by the computer to calculate vorticity . . . this is sent out on weather maps by facsimile lines to forecast offices which in turn use these calculations to determine vertical air currents, building of pressure systems and the future of our weather . . . the weather forecast you hear on radio and television. Two of the largest and fastest computers are used by the National Meteorological Center to make weather analyses, and plans are already in effect for the next generation of computers as soon as they become available. But present indications are that the final forecast that you receive from the news media will always be made, or at least screened by man. No substitute is in view for the human brain in the final link in the chain of events leading to preparation of a weather forecast.

Satellites now play a big role in weather forecasting, in fact three roles: Local area cloud surveillance, global cloud surveillance, and wide area temperature surveillance by infrared sensors.

Local cloud surveillance is very important in the Lower Rio Grande Valley, but we still have a large time lag of 6 to 12 hours between observation and delivery. We hope to shorten this in the next few years. With the data-sparce areas from the east to south and to the west over parts of Mexico, this information is used in forecasting rain as well as protective cloud cover in this area.

All weather systems seem to affect each other, and the lack of information over oceans limited the accuracy of weather forecasting significantly prior to the age of satellites. Now with the new temperature sensing read-out, computers are able to make a much better analysis of the total weather picture, a necessity for forecasts beyond the 24-hour period.

It is not quite realistic to compare the affects of computers with satellites . . . like a horticulturist comparing citrus with ornamentals . . . but in some ways, in the Lower Valley, the satellite is of more help. Knowing where the clouds are is necessary before a good forecast can be made.

Studies have shown that two of the most difficult events to forecast are the initial formation of a Low and the southward limit to the push of a cold High. Both affect this area.

Most Lows affecting this country come off the Pacific, but of those that don't — most form just east of the Rockies. Predominant air flow, one to four miles above the ground, is from the west. As westerly flow reaches a critical speed over the mountains to the west and north, a trough of low pressure forms and sometimes develops into an active Low pressure storm system. This is much like water flowing over a shallow rock ledge in a fast flowing stream — a layer of turbulence forms, the same as in the air, and we have precipitation.

The Rockies, including the mountains to the west of us here, are real problems for forecasters. Cold air coming down from Canada usually stops or turns east before it gets this far south . . . but not always. This type of rare event is hard to forecast.

Statistics are good forecasters in some endeavors but not in this problem. Severe freezes occurred in 1951 and 1962, so a cycle would suggest 1973 as the next. But cycles don't work in these problems. At times, having an on-the-spot analysis of clouds and temperatures aids the short range forecaster and the trip of Mr. Oldmixon to near Edinburg on the cold night of January 4 worked well. But, this is not a sure thing either for all cold spells.

Weather Modification — Much confusion accompanies the efforts in this study, and some of it stems from the name itself. Many interpret this as rain making; it is not. It is the increase or decrease of precipitation or the redistribution of it.

About the time of your first Institute, it was discovered that an increase in condensation nuclei would modify precipitation under some conditions. As you probably know, water vapor is an invisible gas, and it must condense in droplets to form clouds before rain forms. Each droplet forms on a nucleus, and introduction of silver iodide is often used to supply the nuclei.

Up until about 15 years ago there was little faith in the weather modification process in the scientific community. The National Academy of Sciences committee on weather modification classed the view as somewhat pessimistic concerning commercial possibilities 10 years ago; they raised this to guarded optimism five years ago and now class the scientific attitude as one of rising expectation.

The first authoritative statement by the National Academy of Sciences released in 1966 was a guarded report that stated modest increases in precipitation are possible under certain conditions. They plan to release an updated report this year indicating that an increase of 10 to 30 percent is possible under specific conditions, a decrease in precipitation is possible under other conditions, while with still other conditions it is not possible to modify precipitation.

Experiments in modifying Hurricane Debbie in August 1969 were encouraging. Maximum winds near the center were reduced by 30 percent following cloud seeding; two days later a reduction by 15 percent was noted after another cloud seeding session.

The National Academy of Sciences considers the greatest need in this effort to be more basic information in regard to the fundamental problem of nucleation.

Along with the progress noted in the study of weather modification has come the awareness of certain vital questions. Rainfall in an area may not be equally desirable by all, and who is to decide whether to modify or not? Some sociological surveys of experimental areas have suggested that the population, even those with little at stake in the increase of precipitation, will demand a say in this decision. Also, weather modification is essentially a process of redistribution and those downstream who are denied rain will, no doubt, have an opinion. As the succes in modification increases, so will the legal and political problems.

Ecology is becoming a very popular word nowadays, and increased rainfall could be a useful ecological management tool in wetlands whose normal flow patterns have been altered by man. The Florida Everglades pose an interesting example, as the NOAA Experimental Meteorology Laboratory has shown that massive seeding of selected cumulus clouds can substantially increase rainfall. But it would be dangerous to assume that this would solve the ecological problems of the Everglades. It could even introduce a new problem. Present evidence suggests that levels of copper and mercury too low to produce any detectable physiological effects in adult organisms may inhibit reproduction of fishes and invertebrates. Although silver's reaction may not be identical, it is possible that massive seedings of this heavy metal could have an effect on ecology.

Air Pollution — One of the principal effects of increased pollution on the air is a sharp rise in the carbon dioxide content of the atmosphere; and burning of fossilized fuels and oxidized soil organic matter are the main sources. Carbon dioxide acts like a greenhouse, letting in short wave radiation from the sun but trapping long wave outgoing radiation from the earth. This causes a rise in temperature.

But there are many unknowns affecting this process. It is well known by horticulturists that artificial addition of carbon dioxide concentrations of about 600 ppm are regularly used to fertilize commercial greenhouses. Recent estimates suggest that the carbon dioxide level of the atmosphere may increase by 15 to 20 percent by 2000 A.D., and this will yield about a 10 percent increase in photosynthesis, principally in the forests. This estimation suggests that no serious changes will occur by 2000 A.D., but the scientific community needs to give more serious attention to this process.

Agricultural Meteorology. Mr. Haddock, the Advisory Agricultural Meteorologist for the National Weather Service located here in Weslaco, has a number of joint experiments with horticulturists and other agricultural scientists. Most of these relate to micro climate within the plant environment to development and growth of the plant. There are more than a dozen of these agricultural weather offices now and some are working on important horticultural problems. In Griffin, Georgia we have done some rather basic work relating cold tolerance with peach trees. Measurements with the cambium layer show some strong fluctuations as life processes accelerate in the spring. Covering the sensitive trunk areas of peach trees at the time the sap starts to move appears to offer a practical method of micro weather modification that is of real benefit to the horticulturist . . . Work going on in Florida jointly between the National Weather Service and agricultural research workers is similar to that here in the Valley; and all of this adds up to the remarkable progress that has been shown in horticulture since you had the first Institute 25 years ago.

SUMMARY

Weather forecasting has improved in selected areas in the past 25 years and is likely to continue to do so; but we are likely to continue to have some real busts too. Greatest improvement has been in the very short term 6-12 hour forecasts, and if you can gear your operational decisions to this, you can increase operational efficiency. Radar and satellite information spot rain and clouds which affect the available moisture and affect the minimum temperature.

Weather modification is approaching the practical in moist areas and will undoubtedly improve in years to come.

Atmospheric pollution has become so bad that even our youth are worried about it. Evidence suggests that the scientific community can and will handle it but much more information is required and time will be needed to acquire the technology.

Agricultural meteorology has brought out many relationships of value to the horticulturist, and continued joint research by the two disciplines can yield great benefits to commercial horticultural production.

Drip Irrigation[1]

C. D. GUSTAFSON[2]

Drip irrigation is not new. It is an old concept of watering crops, but the present-day application of the system is new. Shortly after the end of World War II in the United Kingdom the basic development of this concept was started, and it was for use in glasshouse watering and fertilization. One of the two men responsible for the development of this system was Dr. Symcha Blass, who later moved to Israel, and in 1959 began the work on a drip irrigation system. Even though most of the development work was done in Israel under Dr. Dan Goldberg, other countries such as Mexico, England, Italy, Denmark, Japan, Australia, and the United States have been working on drip irrigation to be applied to various crops, both in the field and in greenhouses.

The original work was carried out in the arid regions of the Negev Desert in Israel. In the early trials, using very saline water, one grower reported harvesting 16 tons per acre of winter tomatoes using sprinklers, and almost 26 tons per acre using the drip irrigation. With melons there was an increase in excess of 70% in production when the drip system was used. Grapes showed a 30% increase. Orchard yields increased between 20% and 50% and many vegetable crops increase 50% to 100%.

For a number of years the ornamental nursery growers, who produce most of their plants in containers, have used a type of drip irrigation system. Nurserymen growing commercial fruit and ornamental trees have, likewise, used a modified drip system to irrigate thousands of trees growing in containers, either in greenhouses or outside on raised benches.

WHAT IS DRIP IRRIGATION?

Drip Irrigation can be defined as the daily maintenance of an adequate section of the root zone of a plant with moisture somewhere between saturation and field capacity during the growing season. This system provides a soil-water-plant relationship that is conducive to better growth and better yields. Plants not subject to extremes in wetting and drying of the soil are healthier and more productive.

HOW DOES IT WORK?

The drip irrigation system consists of several components: (1) A

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[1] Presented at Drip-Irrigation Seminar, Escondido, California, July 16, 1970, Agricultural Extension Service, University of California, and at the Twenty-fifth Annual Horticultural Institute, Rio Grande Valley Horticultural Society, Weslaco, Texas, January 19, 1971.

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"head," connected to the water supply includes filters, control valves, couplings, water meter, pressure gauge, and connections for a fertilizer applicator. (2) Conducting pipes of proper diameter, according to distance and discharge. (3) Distribution tubes (laterals) of small diameter, generally ½" to ¾" connected to submains. (4) Nozzles, emitters, or drippers. (5) A fertilizer applicator which connects to the main water line to carry dissolved fertilizer material into the pipes at each irrigation.

Key to the proper operation of this system is the filter. Because of the small orifices of the droppers, the water has to be clean. The amount of water passing through the system should be measured by the use of a volume control unit. All system components other than the "head" and the fertilizer apparatus are generally of plastic material. The laterals, with the drippers in them, are placed on top of the soil. One or more drippers are placed at the base of the plant, depending on whether it is a small tomato plant or an avocado tree. For a sizeable tree, three drippers are used, one at the trunk of the tree, and one on either side of the trunk, about two feet away. The drippers are engineered to discharge one-half, one or two gallons per hour. In Australia this system is called a "daily flow" system, which is designed to replace the water used by a plant the previous day. Drip irrigation, therefore, places the moisture in an area where the root system can obtain it and water loss is minimized. This system also saves labor through application of fertilizer together with irrigation water.

POTENTIAL ADVANTAGES

Preliminary reports from researchers using drip irrigation indicate the system has the following potential advantages: (1) Increased yields, (2) accelerated growth in young trees or plants, (3) root zone remains moist all the time, (4) plant is not subject to continual cycles of soil saturation to wilting point and the consequent setbacks to growth. (5) water and fertilizers can be applied at the same time, (6) significant water conservation, (7) area between rows remains firm and dry, assisting in spraying and harvesting operations, (8) weed growth between the rows is reduced greatly, (9) particularly useful on hillsides and rolling ground, (10) improved quality of crops, (11) use of poor quality water — high saline waters have been used with far less damage than comparable waters used with sprinklers, (12) irrigation can be carried out 24 hours a day.

POSSIBLE PROBLEMS

People working with this system are optimistic that there will not be as many disadvantages as there are advantages. However, there are some areas which need further study and investigation: (1) Salinity and the buildup of salts in the drip pattern must be determined; (2) the effects of saving water should be investigated; (3) the development of a good filtration system; (4) the basic need at the present time is for obtaining information on the wetting zone of different soil types with different discharge rates; (5) knowing the discharge rates and wetting zones for different soil types, a set of recommendations could be given for how much water to apply, how often, how long to run the system, how much interval required between the drippers in the line; (6) because this system incorporates a continuous fertilizer program, there should be a study to determine how much benefit is being derived from the frequent irrigations with usual fertilizer methods as compared to the frequent irrigations with frequent fertilizer application.

SALINITY

The important question often asked in regard to drip irrigation is "What about salinity?" In Israel the water used ranges from 400 to 500 ppm to over 3000 ppm total salts. The chloride content varies from about 150 ppm to 80 ppm. The outstanding yields they have been able to obtain in areas using the high saline water is explained by the high soil moisture content (salt is diluted), and the leaching of the salts from the relatively small root zone. The dilution of any salt in the soil by the constant application of moisture permits plants to grow satisfactorily in that soil even though the water contains high salts.

Salt accumulates in the upper few inches of the soil, at the outer edges of the boundaries of the wetted area and in the lower soil due to leaching. In areas of normal or heavy rainfall, the salts that have accumulated during the irrigation season will be leached sufficiently during the periods of rainfall. In areas with insufficient rainfall, a portable irrigation system will be required to wet the entire soil area in order to leach out the salts prior to the next season's operation.

SUMMARY

The great interest in drip irrigation for use on crops grown in California warrants further investigation of this concept. What has been reported and what has been observed in countries experimenting with this type of irrigation system indicates a breakthrough to improve irrigation practices at a reduced cost. With all the plus factors reviewed, there still are many questions yet to be answered. Some of these questions can be listed as follows:

What effect does salt accumulation in the wetted area have on plants?

How is the salt distributed in the soil?

Where are the highest concentrations of salts?

How high can the salt content in water be without detrimental results?

What is the recommended discharge rate from drippers for different soil types and different agricultural crops?

What is the wetting pattern with different discharge rates?

How much water is acutally saved when using the drip system, compared to the standard sprinkler system or furrow method?

Are increased yields and improved fruit quality possible?

Can the growing period be shortened, resulting in early maturing?

What effect does frequent fertilizing have on plants, as compared to less frequent applications of fertilizer material?

It's obvious that there are many questions that must be answered about drip-irrigation performances under California climates, in California soils and California crops.

Soil Granules and Drenches for the Control of the Spruce Spider Mite Infesting Italian Cypress[1]

George P. Wene[2]

Abstract: The spruce spider mite, *Oligonychus ununguis,* is a destructive pest infesting Italian cypress in southern Arizona during the winter and spring months. Good control was obtained with systemic insecticides applied during November, January and March. Aldicarb granules, 10%, were effective when applied at 0.3 pounds pid (per inch diameter of trunk). Dimethoate 2E and Meta-Systox-R 2E were effective as drenches applied at 25 ml pid in 2.5 gallons of water. Meta-Systox-R drench failed to give control when reduced to 12 ml pid. Disulfoton granules, 10%, failed to control during cool weather but were effective when the weather warmed up.

INTRODUCTION

The spruce spider mite, *Oligonychus ununguis,* is a destructive pest infesting Italian cypress in southern Arizona. Feeding of this spider mite causes the foliage to turn brown and prolonged feeding by heavy populations can kill a tree. Large populations enclose the foliage in an unattractive webbing (Figure 1). Roney and Wene (1969) recommended spraying with dimethoate. This is impractical because trees are usually too tall to be sprayed effectively with equipment available to the average homeowner. To adequately spray tall trees would require expensive commercial spray applications. Because of the drift problem such commercial applications would not be possible in many situations. Experiments were therefore conducted to determine if systemic insecticides applied either as drenches or granules could be used to control the spruce spider mite in a simple and effective manner. Preliminary experiments showed that aldicarb and Di-Syston (disulfoton) granules gave effective control of this spider mite (Wene, 1969). In the same paper soil drenches of dimethoate (Cygon) and Meta-Systox-R (oxydemetonmethyl) were shown to give control of the pyracantha mite. Drenches of dimethoate and Meta Systox-R also gave control of elm leaf beetles (Wene, 1970).

PROCEDURE

This experiment was conducted in Holy Hope Cemetery. Practically all the trees planted in the cemetery were Italian cypress trees. The Italian cypress trees were approximately 15 feet tall and varied from 4.5 to 5 inches in trunk diameter. A plot consisted of a single tree and each of the treatments shown in Table 2 was replicated four times. Surrounding each tree was a basin approximately four feet in diameter.

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[1] University of Arizona Agricultural Experiment Station Journal Series No. 1788.

[2] The late Urban Entomologist, University of Arizona.

The aid of Edward Motzkin, grounds superintendent of Holy Hope Cemetery, is gratefully acknowledged for making this research work possible.

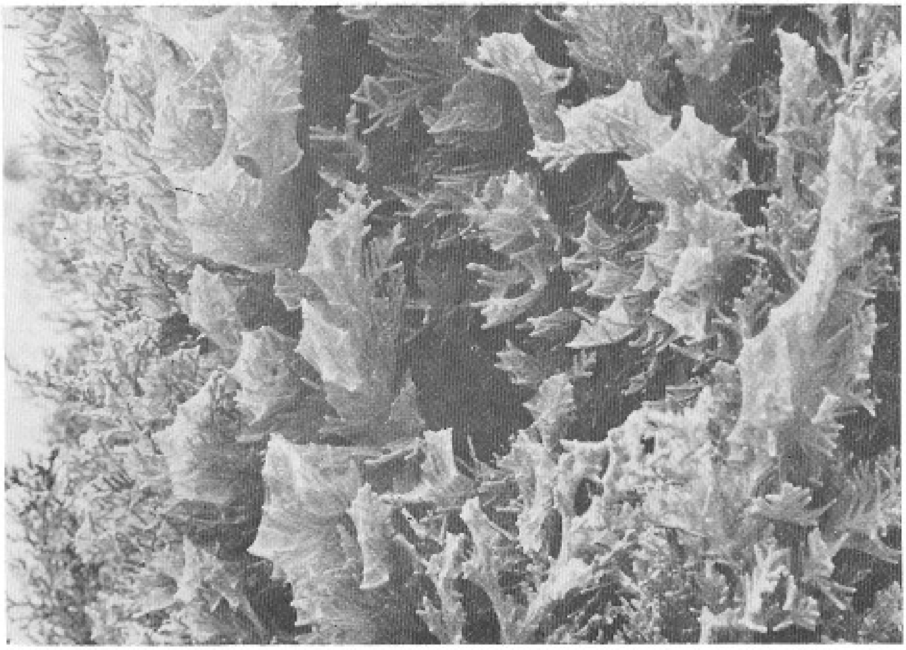

Figure 1. Untreated tree, showing spruce spider mite webbing, an indication of heavy populations.

The granules were spread over the surface of the basin at 0.3 pound pid (per inch trunk diameter). Shortly afterward the basin was filled with water. After that the trees received their regular irrigations.

Emulsifiable concentrates were used in formulating the drenches. The amount of concentrate pid was mixed in 2.5 gallons of water and then poured into the basins. Since these trees were about 5 inches in diameter a total of 12.5 gallons of drench was used for each tree.

Population records were taken at weekly intervals. This consisted of shaking a branch over a white paper tablet and then counting the spider mites on a square inch area. Best results were obtained by waiting a minute or two after the spider mites had dropped on the paper, because they then started crawling and were easily distinguished from dead spider mites or debris.

Injury was determined by estimating the percentage of foliage that had a color change which varied from a brownish-green to brown.

The experiment was started on November 22, 1968. The treatments were applied again on January 24 and March 12, 1969, when most of the treatments had lost their effectiveness. The experiment was terminated on April 12 because of the severely mite-injured untreated trees which the cooperator wanted to treat.

Daily temperature records were obtained from the Soil Conservation Service, which was approximately one mile away.

RESULTS

The data in Table 1 show that the temperatures were cool during the period of the first two treatment applications. During most of the time there was hardly any increase in spider mite populations on the untreated trees. Even though the populations were low spider mite damage increased on these trees. This was evident just before the third application (February 28) when spider webbing was observed on the inner foliage. Webbing was also found on the inner foliage of trees treated with disulfoton granules and the 12-ml oxydemetonmethyl pid drench. These data show that low spider mite populations are injurious in cool weather, a time when Italian cypress trees are doing little or no growing.

The weather warmed up after the third application, which was made on March 12, 1969. In the month following, spider mite populations and injury increased greatly.

The best control was obtained with aldicarb granules. Spider mite populations did not increase between treatment applications indicating that the intervals between applications were probably too short. The amount of injury which was low at the beginning was practically nonexistent at the termination of the experiment.

Dimethoate 2E, applied at 25 ml pid also gave effective control of spider mites. The data indicate that after five weeks it started losing its effectiveness. These trees had an average of 23 percent of their foliage injured at the start of the experiment. After three applications of this drench the spider mite injury was reduced to three percent.

Meta-Systox-R 2E was as effective as dimethoate when applied at the rate of 25 ml pid. When the dosage was reduced to 12 ml pid, the effectiveness of Meta-Systox-R in controlling spider mites was reduced. Spider mite webbing at the end of the experiment was also evident, in-

Table 1. Temperatures prevailing at Tucson, Arizona during the experimentation, 1968-69.

Treatment Periods	*Temperatures F*		
	Mean	*Max Range*	*Low Range*
11-22-68 to 1-22-69	53	52-85	22-52
1-22-69 to 2-26-69	54	54-81	28-54
2-28-69 to 4-12-69	60	57-94	32-60

Table 2. Effectiveness of soil applications of systemic insecticides in controlling spider mites on Italian cypress. Tucson, 1968-69.

Weeks after Applications	*Aldicarb 10% G 0.3 lb. pid*[a]		*Di-Syston 10% G 0.3 lb. pid*		*Meta-Systox-R 25% E 25 ml pid*		*Meta-Systox-R 25% E 12 ml pid*		*Dimethoate 23.4% E 25 ml pid*		*Untreated*	
	Mites per sq. in.	*% Injury*	*Mites per sq. in.*	*% Injury*	*Mites per sq. in.*	*% Injury*	*Mites per sq. in.*	*% Injury*	*Mites per sq. in.*	*% Injury*	*Mites per sq. in.*	*% Injury*
	1st Application: 11-22-68											
0		8		10		10		9		23		5
3	0.1	4	0.3	14	0.5	9	0.9	15	0.5	23	1.9	16
4	0.2	5	1.6	20	0.5	6	1.3	9	0.9	20	1.9	16
5	0.2	5	3.0	19	0.7	8	1.3	18	0.8	19	2.0	12
6	0.1	5	2.2	16	0.3	8	0.8	9	0.6	8	2.4	10
7	0.3	5	4.1	30	1.2	9	0.9	15	0.8	23	2.1	18
	2nd Application: 1-24-69											
1	0	4	1.0	34	0.5	11	1.5	16	0.6	20	1.4	19
2	0.1	3	7.4	40	1.0	14	1.3	13	0.1	20	2.2	26
3	0	4	6.6	26	0.9	9	3.0	20	0.4	14	3.7	21
4	0.1	3	1.0	36	0.3	10	1.6	11	0.1	21	0.5	24
5	0	5	5.8	44[b]	2.8	11	2.5	18[b]	0.9	18	6.1	24[b]
	3rd Application: 3-12-69											
1	0	5	3.3	58	2.0	10	3.9	18	0.1	10	6.8	30
2	0	4	3.1	34	3.3	11	1.7	18	1.3	18	8.2	33
3	0.1	1	0.9	25	1.8	11	5.8	6	0.2	9	20.0	58
4	0	3	2.0	21	2.3	0	5.7	28[c]	1.3	3	25.0	63[c]

[a] per inch diameter
[b] spider mite webbing of inner foliage
[c] spider mite webbing enveloped 25% or more of the branches

Figure 2. Treated tree showing absence of spruce spider mite webbing, an indication of good control.

dicating that a dosage of 12 ml pid is of no value in controlling the spruce spider mite.

Disulfoton (Di-Syston) granules, when used at the rate of 0.3 pounds of the 10-percent concentration, did not control this spider mite during cool weather. The data in Table 2 showed no control when the minimum daily temperature hit below 30°F during the periods of the first two applications. However, as the daily temperatures increased during the period after the third application (Table 1) disulfoton controlled this spider mite effectively. Five weeks after the second application, which was during the cool period, a considerable amount of webbing occurred in the inner foliage. After the third application of disulfoton, which was applied during a period of warm weather, the spider mite population decreased, the webbing disappeared, and the foliage started to green up again.

The control of spruce spider mites was reflected in the condition of the foliage. On the untreated trees most of the leaves were brown in color and more than 25 percent of the branches were covered with webbing (Figure 1). The control obtained with the effective insecticides is illustrated in Figure 2. The leaves on these trees were dark green.

LITERATURE CITED

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ADDENDUM

Aims and Objectives of the Society

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

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

The Society has sponsored 25 annual Institutes, where outstanding speakers from all parts of the country present new developments in the field of horticulture. Panel discussions, social get-togethers and a barbeque round up the all-day program.

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

Anyone interested in horticulture can become a member of the Society. The annual fee is $5.00, which includes the Journal. Applications for membership, and annual dues should be sent to the Secretary-Treasurer, Rio Grande Valley Horticultural Society, Box 107, Weslaco, Texas.

Officers of the Rio Grande Valley Horticultural Society

1971

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Program of the Twenty-fifth Annual Institute
Rio Grande Valley Horticultural Society
January 19, 1971

MORNING SESSION: Eugene Goodwin – Chairman

Invocation .... Robert LeBard
Valley Grande Academy, Weslaco

Address of Welcome .... Glenn White, President
Rio Grande Valley Horticultural Society

History of the Rio Grande Valley
Horticultural Society .... Harry Foehner, Harlingen

Weather Modification and Predictions .... Mr. John A. Riley, Chief
Weather Analysis & Prediction Division
National Weather Service

Rio Grande Valley Vegetable Industry –
Its past, present and future .... Wayne Showers, McAllen

Drip Irrigation in California,
Israel and Mexico .... Mr. Don Gustafson, Farm Advisor
San Diego, Co., California
Agricultural Extension Service

AFTERNOON SESSION: Dr. Bailey Sleeth – Chairman

Presentation of the Arthur T. Potts Award .... Dr. R. H. Cintron

Citrus Outlooks and Trends .... Dr. Bernie Lester
Director of Economics Research
Florida Department of Citrus

Herbicide Residues in Vegetable Soils .... Dr. Robert Menges
Research Horticulturist
Crop Science Research Division
USDA, Weslaco

EVENING SESSION: Dr. Richard Hensz – Chairman

Valley Beautiful .... Richard White, Hewlitt-White, McAllen

Flower Arranging .... Henry Link, Link Floral Co., Weslaco

ADDRESS OF WELCOME

25th Annual Horticultural Institute

MR. GLENN WHITE
President
Rio Grande Valley Horticultural Society

Good Morning Ladies and Gentlemen!

It is my distinct pleasure on behalf of the Members of the Lower Rio Grande Valley Horticulture Society and, particularly, the Institute Committeemen, to welcome each of you to our Annual Institute.

This is an important milestone in that it is the 25th consecutive Institute held by our Society. As an anniversary gesture we are going to recognize the Past Presidents and the Arthur Potts Award recipients, that are present today, for their personal contributions to the Society and to the horticultural development of our Rio Grande area through the years.

Also, this year at a regular meeting in 1970, Dr. Richard Hentz, Director of Texas A&I University Citrus Center, as a part of one of our Citrus Section Programs, took advantage of the opportunity to announce and explain the development of the new "Star Ruby" red seedless grapefruit. This is an important development and one that promises to become an important contribution to the citrus industry in Texas.

This meeting marks the close of my year as President of our Society. It has been a pleasureable year for me because I had the feeling that we were having a good year. A good many new people have joined the organization and the members have shown a very fine degree of interest. The proof of interest was in the very fine attendance at our meetings throughout the year.

I wish at this time to publicly express my sincere thanks to the officers and directors for their generous assistance and, particularly, the Vice-Presidents for their arranging excellent and timely programs for all the regular meetings.

While I'm in the "thanking" business, I want this meeting to know who did the work of producing this "show" today. The General Chairman is Dr. R. H. Cintron. Serving with him were Gary Sandberg, Dr. Calvin Lyons and Dr. Craig Weigand; —thanks a million for the outstanding job you have done.

Also, the Journal Committee with Tom Longbrake as Chairman and assisted by Norman Maxwell, Dr. Heinz Wutscher and Dr. Harold Brown, have turned out an outstanding Journal. Again, thanks to you, the editors, for a job well done. This is one of the most important projects of our Society. I have a copy of the new Journal here. Members of the Society will receive their copy in the mail. Your Journal is paid for in part by your dues. We are indeed grateful to the contributions of our Patron and Sustaining members, whose generous support makes the publication of the Journal possible. By the way, individual annual dues were raised to $5.00 by vote of the members to start with this new year.

I want to thank Harry Foehner for the generous help in handling publicity through the year in his usual efficient manner. Last, but not least, I wish to thank Dr. Bailey Sleeth for his work on editing the News Letter. You have done an outstanding job, Bailey. It was a great help to me, as you were on many occasions with advice on such matters as "Society Tradition", again, thanks.

I hope this recitation is not too boring to our visitors. It is a part of winding up a year's program. So, again, Welcome to all of you; we are glad you came.

HISTORY

Rio Grande Valley Horticultural Society

Harry Foehner[1]

The Rio Grande Valley Horticultural Society, which observed its twenty-fifth anniversary in 1970, actually is a fusion of several organizations with similar aims in this field.

The first of these was the Rio Grande Valley Horticultural Club. Then, there was the Texas Avocado Society and finally the Texas Grape Society. These merged June 1, 1955, to form the Rio Grande Valley Horticultural Society.

The Rio Grande Valley Horticultural Club had been formed 10 years previously, in 1945, at a meeting held at Rio Farms. The membership was limited to 45 persons who were actively engaged in some branch of horticultural work and were qualified to participate in programs of the club.

The group included citriculturists, olericulturists, ornamental horticulturists, entomologists, plant pathologists, soil scientists and irrigation engineers, all of whom were active in Valley horticulture. About half of the members were personnel of state and federal agricultural agencies in the Valley.

One of the early projects of the Club was one destined to have a lasting effect on the area's citrus industry. Its citrus psorosis committee brought Dr. H. S. Fawcett, world authority on citrus diseases, to the Valley from California and worked with him in making a psorosis survey. Dr. Fawcett and the committee recommended a citrus budwood certification program as a solution to the problem. A Valley Nurserymen's Association was formed as an action group to carry out this recommendation. It is still active. Similarly, a Horticultural Club committee was responsible for formation of the Texas Avocado Society in 1948. The Club also conducted freeze-damage surveys following the 1949 and 1951 freezes and made recommendations to citrus growers on pruning of frozen trees.

The annual Rio Grande Valley Horticultural Institute was the Club's greatest endeavor. These institutes arranged for a discussion of the area's horticultural problems with the growers. The first one was held in 1946 and was limited to a discussion of citrus problems. In 1947 and 1948, scope of the Institute was expanded to include vegetables as well as citrus and in 1949, ornamental horticultural programs were added.

The 1946 Institute was a joint endeavor of Texas A&M University

[1] Talk given at the 25th Annual Horticultural Institute.

and the Rio Grande Valley Horticultural Club. Dr. Guy W. Adriance, head of A&M's Horticultural Department, asked the club to assist in conducting a short course, or institute, on citrus culture in the Valley and the Club did so. Since then the Club and the Society which succeeded it have directed these institutes with the cooperation of various state and federal agencies.

The first president of the Club was the late W. H. Friend of Weslaco, then superintendent of the Valley Experiment Station. Other club presidents included Lloyd Ryall, W. H. Hughes, Don McAlexander, William C. Cooper, E. D. Kornegay, E. B. Dubuisson, Norman Maxwell, R. H. Cintron, E. O. Olson and George P. Wene, who presided over the last meeting of the Club when it combined with the Grape and Avocado Societies to form the Horticultural Society.

Stanley B. Crockett was the first president of the Horticultural Society, which succeeded the Horticultural Club. Others who have served include Dr. George Schultz, Harry Foehner, Dr. Joe B. Corns, Orval Stites, Howard Wright, Brad Crockett, Bruce Lime, Dr. Bailey Sleeth, C. E. Davidson, Noel L. Ryall, Clay Everhard II, Dr. Richard Hensz, Tom Longbrake and Glenn White. Arthur Hentz will serve as president until the 1972 institute.

The Texas Avocado Society, which later became a part of the Rio Grande Valley Horticultural Society, was organized in April, 1948, in order to encourage the study of subtropical fruits, including the avocado. During the first year, test plots were established to study the adaptability of many named varieties from California and Florida and seedling selections found in the Valley.

In 1947, the Society began to explore Mexico for superior selections of avocados and these selections were brought to this area for testing.

Those who served as presidents of the Avocado Society were E. B. Ballard, R. H. Cintron, J. B. Chambers, Jr., William C. Cooper, Norman Maxwell and Henry Link.

The Texas Grape Society was formed in 1958 to study the feasibility of growing vinifera grapes commercially in this area and the president was Dr. Paul W. Rohrbaugh.

The Society's Institutes have been held at Texas A&I University Citrus Center since 1949. Until that time they were held in the Weslaco High School Auditorium.

The Society set up the Arthur T. Potts Award in 1955 to recognize leaders in the field and Dr. Potts was its first recipient. Others were Dr. Wilson Popenoe, E. M. Goodwin, Dr. J. B. Webb, Dr. G. H. Godfrey, Dr. W. C. Cooper, Lon C. Hill, W. H. Friend, Paul W. Leeper, Stanley B. Crockett, Harry Foehner, Sam Tayloe, O. F. Marrs, Dr. P. W. Rohrbaugh, Arthur V. Shull, Frank Schuster and Dr. Guy W. Adriance.

DR. GUY W. ADRIANCE

Recipient of the Arthur T. Potts Award 1971

The First Annual Horticultural Institute held in 1946 was highlighted by a paper on "Influence of Soil Conditions on Root Distribution of Citrus Trees" by Dr. Guy W. Adriance, the recipient of the 1971 Arthur T. Potts Award. This award is presented each year to one person by the Rio Grande Valley Horticultural Society in recognition of his outstanding work in horticulture and contributions to the Valley. The award was named for its first recipient, Arthur T. Potts.

The first Institute was a joint endeavor of Texas A&M University and the Rio Grande Valley Horticultural Club. At that time Dr. Adriance was head of the A&M Horticultural Department. He asked the Horticultural Club to assist in setting up a short course in citrus and vegetables that later became the Annual Horticultural Institute.

Guy Webb Adriance was born on the campus of Texas A&M College, June 19, 1895. He was the son of Duncan Adriance, an Experiment Station chemist, and grandson of John Adriance, a member of the A&M College Board of Directors. He received a Bachelor's Degree in Horticulture in 1915 from A&M College; a Master's Degree in Citriculture from the University of California and his Ph.D. degree in 1929 from Michigan State University.

Dr. Adriance served in the Horticultural Department from 1920 until his retirement in August 1960 from Texas A&M University. He became Professor Emeritus on September 1st following retirement. The same year, the American Society for Horticultural Societies awarded him the L. M. Ware Distinguished Teacher Award.

Upon his retirement from the University in 1960, Dr. Adriance went to Brazil under a U. S. Aid Program and was concerned with vegetable production around Brasilia, the new capital. He also worked in Chile and in 1961 traveled to Yugoslavia on USAID to advise on citrus culture there. He has been to Tunisia to consult on red grapefruit.

Dr. Adriance has devoted 40 years to conscientious and enthusiastic teaching and training of students in horticulture. He was not confined to the classroom but took a genuine interest in his students and was ever ready to help them with their personal problems. He was a student's professor, respected and loved by all.

In 1958, Dr. Adriance bought a small tract of land near Brenham, on which he has planted a small orchard and raises a garden. As a hobby he raises Arabian horses, which his grand-daughter delights to ride and show.

This year's award was presented to Dr. Adriance for many reasons. He inspired and lent assistance and encouragement to organizing the Rio Grande Valley Horticultural Club. This, later, became the Rio Grande Valley Horticultural Society. He, also, was the inspiration in the establishment of the Annual Horticultural Institute. He attended every Institute, participated as a speaker and as chairman of many different sessions up until the time of his retirement. He taught horticulture to a large number of Texas Aggies from the Valley; many of whom are still active in this field. They will carry on his good work.

Dr. Adriance was ill at the time of the award presentation, January 19, 1971, and was unable to receive it in person. Presentation of the award was made by Dr. R. H. Cintron, one of his early students and a very close friend. Fred Brison, a colleague and long-time friend, was present to receive the award for Dr. Adriance.

GEORGE PETER WENE
1913-1971

George Peter Wene, Associate Entomologist in the Agricultural Experiment Station of the University of Arizona was killed in a multiple-car collision during a dust storm near Casa Grande, Arizona, on May 12, 1971, while returning from work on a field experiment.

Dr. Wene was born in Cleveland, Ohio, April 15, 1913. He received his bachelor's degree from Park College in 1934, his master's degree from Ohio State University in 1939, and his doctorate from Cornell University in 1946. Before coming to Arizona in 1957 he served as field aide in the Ohio Agricultural Experiment Station (1939), research entomologist at the Chatham field station of the Virgina Agricultural Experiment Station (1940-42), graduate assistant in entomology at Cornell University (1942-46), and research entomologist at the Weslaco field station of the Texas Agricultural Experiment Station (1946-57).

His work in Virginia was concerned with tobacco insects and their control. In Texas his work largely involved research for the control of insects affecting the principal commercial vegetable crops of the lower Rio Grande Valley. From 1957 to 1967 he was engaged in field research on cotton insects at the Phoenix Cotton Center of the University of Arizona. In 1967 he moved to the main campus of the University of Tucson to begin a new and effective career dealing with urban insect problems. At the time of his death he was particularly concerned with the study of insects affecting tuffgrass, trees, and ornamental plantings.

Dr. Wene was the author of over 150 technical publications, reports, and popular articles. He was a member of the Entomology Society of America, the Ohio Academy of Science, the Arizona Academy of Science, and the Rio Grande Horticultural Society. From 1953 to 1957 he served as editor of the Journal of the latter society. At the time of his death he was a member of the Arizona Board of Pesticide Control and secretary of the Men's Garden Club of Tucson.

He is survived by his widow, the former Janet Hedrick, by a daughter, Cathy, by three sons, Gregory, Jack and Peter, and by two grandsons. He will be missed by a wide circle of friends and colleagues and particularly by those he served in his unique and effective manner during his wide-ranging field career in applied entomology.

L. A. Carruth, University of Arizona, Tucson

RIO GRANDE VALLEY HORTICULTURAL SOCIETY
PAST PRESIDENTS AND
ARTHUR T. POTTS AWARD RECIPIENTS

On the occasion of its 25th Anniversary the Rio Grande Valley Horticultural Society gratefully recognizes its presidents and A. T. Potts Award recipients.

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1946 W. H. Friend*
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1948 W. H. Hughes*
1949 D. J. McAlexander
1950 William C. Cooper
1951 D. E. Kornegay
1952 E. B. Dubuisson
1953 Norman P. Maxwell
1954 R. H. Cintron
1955 E. O. Olson*
1955 George P. Wene*
1956 Stanley B. Crockett
1957 George Schulz
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1960 Orval Stites
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1963 Bruce Lime
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1966 Noel E. Ryall
1967 Clay Everhard, II
1968 Richard A. Hensz
1969 Tom Longbrake
1970 Glenn White
1971 Arthur Hentz

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1962 W. H. Friend*
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1967 O. F. Marrs
1968 P. W. Rohrbough*
1969 Arthur V. Shull
1970 Frank J. Schuster
1971 Guy W. Adriance

* Deceased

RIO GRANDE VALLEY HORTICULTURAL SOCIETY
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The RGV Horticultural Society gratefully acknowledges the support of its Patron and Sustaining Members, which makes the publication of the Journal possible. Also, these members are recognized for their outstanding contributions to the Horticulture Industry of the Valley.

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TWENTY-FIVE YEAR INDEX PROCEEDINGS AND JOURNAL 1946-1971 VOLUMES 1 TO 25

By

BAILEY SLEETH

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This is an index of the Proceedings of the First Annual Citrus Institute held in 1946; the Citrus Vegetable Institutes of 1947 and 1948; the Annual Horticultural Institutes of 1950-55; and the Journal, 1956-71. The Proceedings were published by the Rio Grande Horticultural Club until 1955. At that time this organization was superceded by the Rio Grande Valley Horticultural Society which now publishes annually the Journal—a single copy volume. Many of the papers given at the subsequent Annual Horticultural Institutes plus other papers in the field of horticulture are published in the Journal. Thus, the scope of the material is broadened and its usefulness greatly enhanced.

The Index has been divided into three parts: author, citrus variety and subject index. The author and subject indexes need no explanation. The citrus variety index may appear to be redundant to some, but to the compiler of the material, it was apparent that citrus was the dominant subject. It seemed expedient to put citrus varieties in a separate listing, rather than under citrus in the subject index.

The general scheme for the citrus index was to place the citrus varieties in the general groups that was most consistent with those used by the authors. The groupings were not always consistent and in some cases variation in spelling occurred. No claim is made as to the authenticity of the groupings, or in some cases as to the correctness of spelling of a variety. However, it is felt that a reasonable accuracy has been obtained. An effort was made to cite all citrus varieties mentioned in any given article, but only once and that early in the paper.

Regardless of the inadequacies that are certain to appear to those who make use of the Index, it is hoped that it will be useful to many in many ways and a reminder that the Rio Grande Horticultural Club and its successor, the Rio Grande Valley Horticultural Society have contributed much that is worthwhile to both scientific and practical horticulture.

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CITRUS INDEX — VARIETIES

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