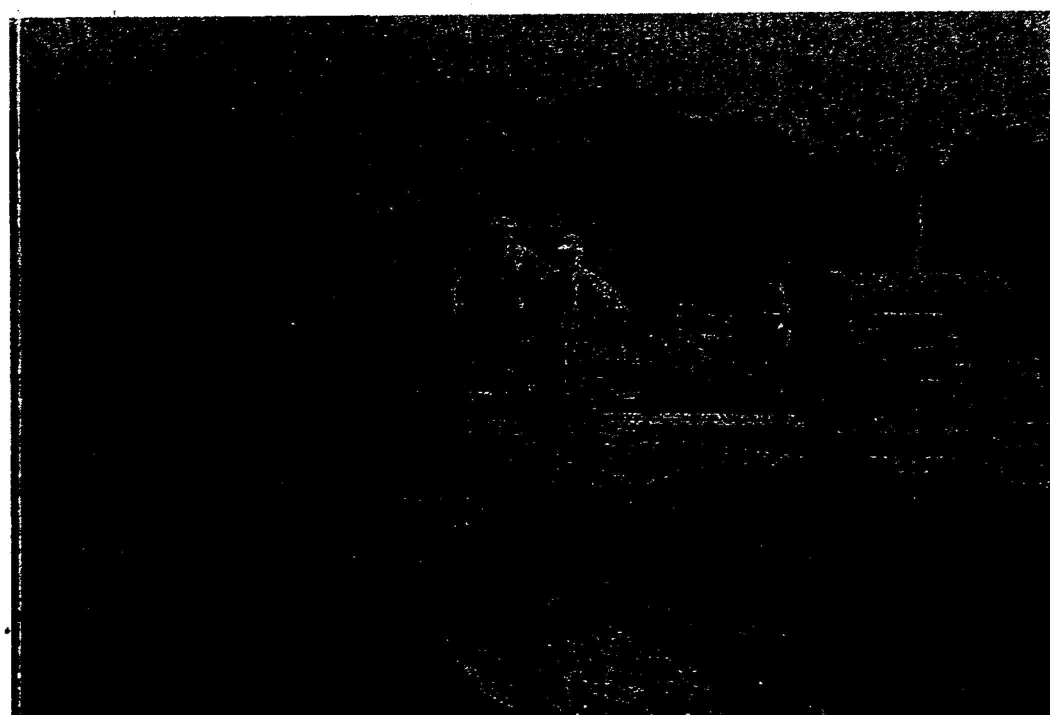
PROCEEDINGS

Of the Eighth Annual

RIO GRANDE VALLEY HORTICULTURAL INSTITUTE

Weslaco, Texas

January 26, 1954



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THE EIGHTH ANNUAL

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RIO GRANDE VALLEY HORTICULTURAL CLUB
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COVER PICTURE: Pumping water from a deep well into an irrigation canal. Many such wells were drilled during the 1952-53 drought.
(Picture: Courtesy of The Ray Drilling Co., McAllen)

Program for the Horticultural Institute

January 26, 1954

Texas A&I Training Center, Weslaco

MORNING SESSION, R. O. Roberts, C.P.&L. Co., Chairman

President's Welcome — R. H. Cintron
New Developments in Vegetable Insect Control — George Wene
Present Status of Black Fly and Mexican Fruit Fly in Mexico and U. S. – Nate Berry
Discovery of Tristeza in Meyer Lemon in Texas – E. O. Olson
New Developments in Weed Killers — Harold Gausman
Water Quality Influences Growth of Fruit & Vegetables – W. C. Cooper

AFTERNOON SESSION – G. W. Adriance, Texas A&M, Chairman

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- M. M. Ishmael – Propagation of Flowering Tropical Plants
- Carl J. Klinger – Tropical Foliage Plants
- Dr. Mabel Gwillim – Roses
- Ben Chambers — Orchids
- Joe Barrera – Wild Flowering Plants Native to Mexico

What's New in Citrus (PANEL DISCUSSION)
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- Norman Maxwell – Citrus Varieties
- P. W. Rohrbaugh – Orchard Soil Management
- Art Shull – Orchard Irrigation
- W. H. Friend – Pruning Citrus Trees
- Bailey Sleeth – Virus Diseases of Citrus
- E. O. Olson – Tristeza Survey in the Valley
- W. C. Cooper – Tristeza-tolerant Rootstocks
- Herbert Dean — Biological Control of Citrus Insects

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What's New in Vegetables (PANEL DISCUSSION)
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- R. T. Correa – Cantaloupe and Watermelon Varieties
- J. S. McManus – Vegetable Problems of Valley Shippers
- William Sims – Soil Conditioners in Vegetable Production
- Harold Gausman – Fertilizers and Herbicides for Vegetables
- G. H. Godfrey – New Vegetable Diseases in the Valley
- W. H. Friend – New Developments in Vegetable Production

Address of Welcome

Dr. R. H. Cintron, *President, Rio Grande Valley Horticultural Club*

It is indeed a great privilege and a great pleasure to welcome you to this our Eighth Rio Grande Valley Horticultural Institute. We sincerely hope that today's program will be interesting and useful.

I would like to express the appreciation of the Rio Grande Valley Horticultural Club to all those who have made this Institute possible. Our thanks to the club membership and particularly to the different Institute Committees, to the Texas Experiment Station staff, the staff of the Texas A. & I. Training Center, the Valley Chamber of Commerce, Valley Farm Bureau, Valley newspapers and Valley radio stations.

We are greatly indebted to those business organizations who have so splendidly contributed financial support in the past and have most graciously done it again this year. To them our everlasting testimony of gratitude.

Through most of 1953 our Valley experienced the most unfavorable conditions for the development of all horticultural enterprises. A record drought brought great economic hardships and would have destroyed the hopes and faith in the future in a less sturdy race of people. The lack of irrigation water, the life of our Magic Valley, forced many to tap every possible source of water. Some of this water was fair, most of it bad and some awful. Valley farmers did the most they could with what little they could get.

Timely rains, a grace of God, and the efforts of man impounding for future use what God has given us, brightens our future. This precious water we have now should be used judiciously and effectively. All efforts should be made to save what we have and to store more if and when we get more to store. May the methods be called gravity canals, Lower Dams or any other means. Names and places should be of secondary importance.

With more water and more acres available due to acreage restrictions on cotton, there will be an ever increasing tendency to increase planting of horticultural crops. If this is overdone, prices will slide down as supply increases, and they are already going down. Certainly we can produce quite a variety of horticultural products; but can we sell them at a profit. With lower prices to be expected and higher costs of production, the only other alternative to profitable farming is more efficient farming. Less acres, but more and better products per acre. Better farmers and better farming practices. More knowledge of what we want to do and more knowledge on how to do them. Better farming tools behind out tractors and better tools under our hats. Our purpose in presenting this program today is to help you, even in our small way, to attain these goals.

Again, may I extend our sincere welcome to all of you.

The Rio Grande

Karl F. Keeler, *International Boundary Commission, United States and Mexico, United States Section, Laredo, Texas*

The Rio Grande from its source 12,000 feet above the sea in the mountains of South Central Colorado follows a meandering course for over 600 miles south to El Paso, from whence at 3,700 feet above sea level it flows as an international river for over 1,200 miles through great bends of hundred-mile amplitude to the Gulf of Mexico. The overall length of the river is about 1,900 miles.

The Drainage Basin

The setting of the Rio Grande Basin in the North American continent is shown on the following map. The western edge of its basin forms the Continental Divide for about 2,000 miles from latitude 38½° near Salida in Southern Colorado to a point southwest of the City of San Luis Potosi, Mexico, just south of latitude 22°. The total area within the outer rim is 335,500 square miles. This is equal to practically half of the area of the Republic of Mexico, or about equal to the area of Colorado, New Mexico, and Arizona combined, or larger than Texas and Oklahoma combined. But vast areas along the western and southern side of the basin either have no streams or yield no run-off to the Rio Grande. Closed sub-basins, or sub-basins non-productive of water to the Rio Grande, (shown in dots) constitute about 48.8% of the total area encompassed by the outer rim of the Rio Grande Basin, leaving, however, 171,887 square miles (shown cross-hatched) of productive watershed, 88,968 or 51.8% being in the United States and 82,919 or 48.2% being in Mexico. The area of this productive watershed is about equal to all of the eleven states of the Union lying north and east of the western and southern line of Pennsylvania and Maryland.

Below Fort Quitman the drainage area actually tributary to the Rio Grande is 139,897 square miles, 58,362 being in the United States and 81,535 in Mexico.

Reservoirs

In speaking of reservoirs I first want to mention only those of notable size, that is, those of over 15,000 acre feet capacity. An acre foot is a unit of volume just like a gallon except it is bigger. It is enough water to cover 1 acre of land 1 foot deep.

In its basin above El Paso the flow of the Rio Grande and its tributaries is empounded in 11 reservoirs of notable size. The largest of these reservoirs is the great Elephant Butte of over 2 million acre feet capacity. The capacity of all 11 being 3,065,500 acre feet. On the Pecos River there are 4 such reservoirs with a total capacity of 485,700 acre feet. On the Devils River there are 2 power reservoirs but these are too small for us to mention here. Then in the Lower Rio Grande Valley the Willacy County irrigation district has 25,000 acre feet of reservoir storage capacity.

Drainage map of the Rio Grande river.

Thus there is a total on the United States side of 3,576,200 acre feet of water storage capacity.

Similarly on the Mexican side there are 10 such large reservoirs having a total water capacity of 4,664,800 acre feet — about a million acre feet of capacity more than on the U. S. side. The largest reservoir on the Mexican side, La Boquilla, has just about the same water capacity as Elephant Butte – over 2 million acre feet. Thus the combined capacity of all large reservoirs in the Rio Grande Basin on both sides is 8,241,000 acre feet.

You already know a great deal about the Falcon Reservoir now being built by the I.B.W.C. 75 miles down river from Laredo. Here I will merely say that its maximum water storage capacity is to be 4,085,000 acre feet including 2,100,000 acre feet of conservation storage. You also know that other reservoirs, to be built jointly with Mexico, are provided for by Treaty.

Hydro-Power Development

Above El Paso there is only one hydro-power development of consequence and that is at Elephant Butte Dam where a capacity of 27,000

K.W. is installed. At Red Bluff Dam on the Pecos River 3,000 K.W. are installed. On the Rio Grande from El Paso to the Gulf there is only one hydro-power development and that is on the Maverick Canal near Eagle Pass where there is an installed capacity of 12,000 K.W. On the Devils River near Del Rio there are two small power plants with a combined capacity of 3,100 K.W.

On the Mexican side there are 3 power plants all on the Rio Conchos, with a combined capacity of 23,400 K.W.

This gives a total power capacity on the U. S. side of 45,100 K.W. and on the Mexican side 23,400 K.W. or a grand total for the entire river of 68,500 K.W.

Of these power plants only the 3 plants near Del Rio and Eagle Pass can develop power uninterrupted by droughts.

You know, of course, of the two equal sized power plants being constructed at Falcon Dam with a combined capacity of 63,000 K.W. which may later be raised to 84,000 K.W. It is expected that power may be developed in connection with the additional reservoirs to be built on the Rio Grande under the Treaty between this country and Mexico.

Irrigated Areas

Near the lower end of the El Paso-Juarez Valley is Fort Quitman, the site of an old fort of the pioneer days. There is no settlement or no ruins there any more, but this remains an important point on the river because of the Treaties with Mexico concerning the waters of the Rio Grande above Fort Quitman. I will mention Fort Quitman several times so keep its location in mind. It is 81 river miles below the point (near El Paso) where the Rio Grande emerges from the United States and becomes an international boundary stream.

Above Fort Quitman in 1950 there were about 904,500 acres of irrigated land in the United States and 45,000 acres in Mexico. On the U. S. side of the Rio Grande basin below Fort Quitman there were about 905,000 acres of irrigated land and 847,000 acres in Mexico. Thus in 1950 the irrigated land on the U. S. side of the entire basin was roughly 900,000 acres above and 900,000 acres below Fort Quitman and nearly 900,000 acres in Mexico, making a total of 2,700,000 acres.

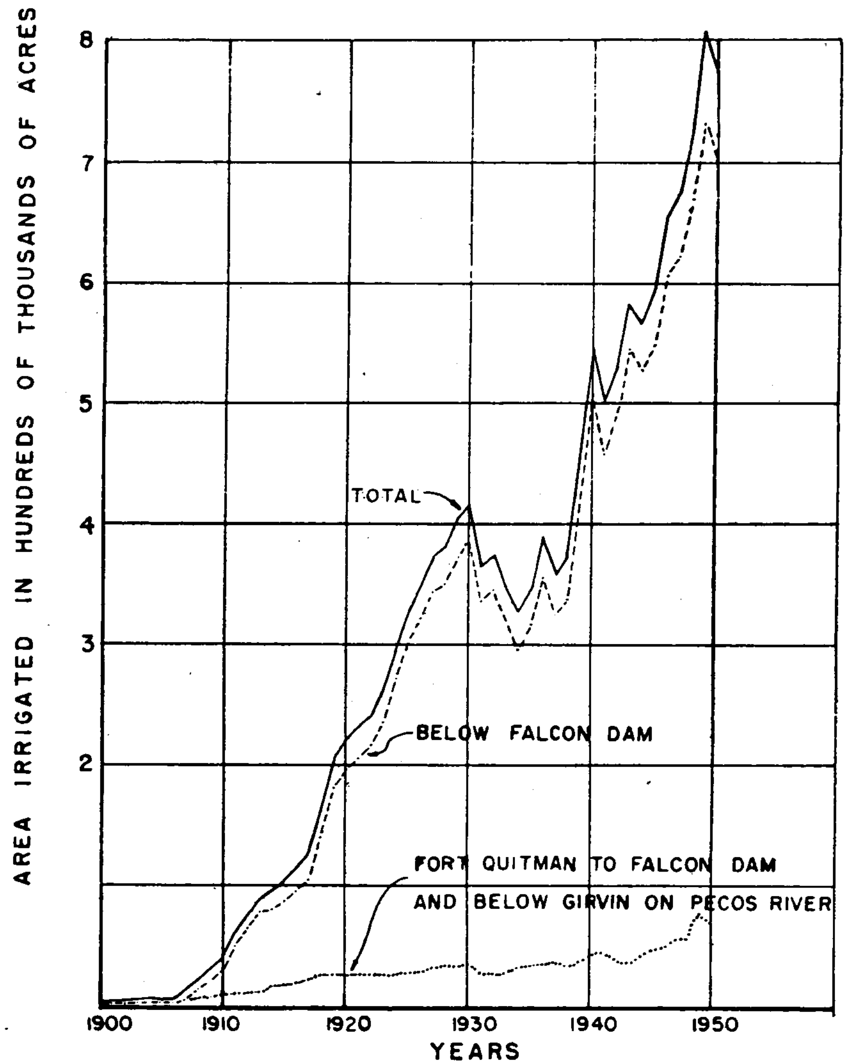
If we eliminate everything above Fort Quitman and also the Pecos River basin above Girven and then look a moment at the historical growth of irrigated land on the U. S. side since 1900 and also on the Mexican side and if we divide the basin at Falcon Dam we will see the situation as shown on the two graphs, herewith.

The graphs show that in the 12 years 1938 to 1950 Mexico and the U. S. have expanded their irrigated lands at about the same rate: that is at about 35,000 acres per year. That is about 420,000 acres each in the 12 years.

Our figures for 1951 and 1952 are not complete but they are showing a continuing growth.

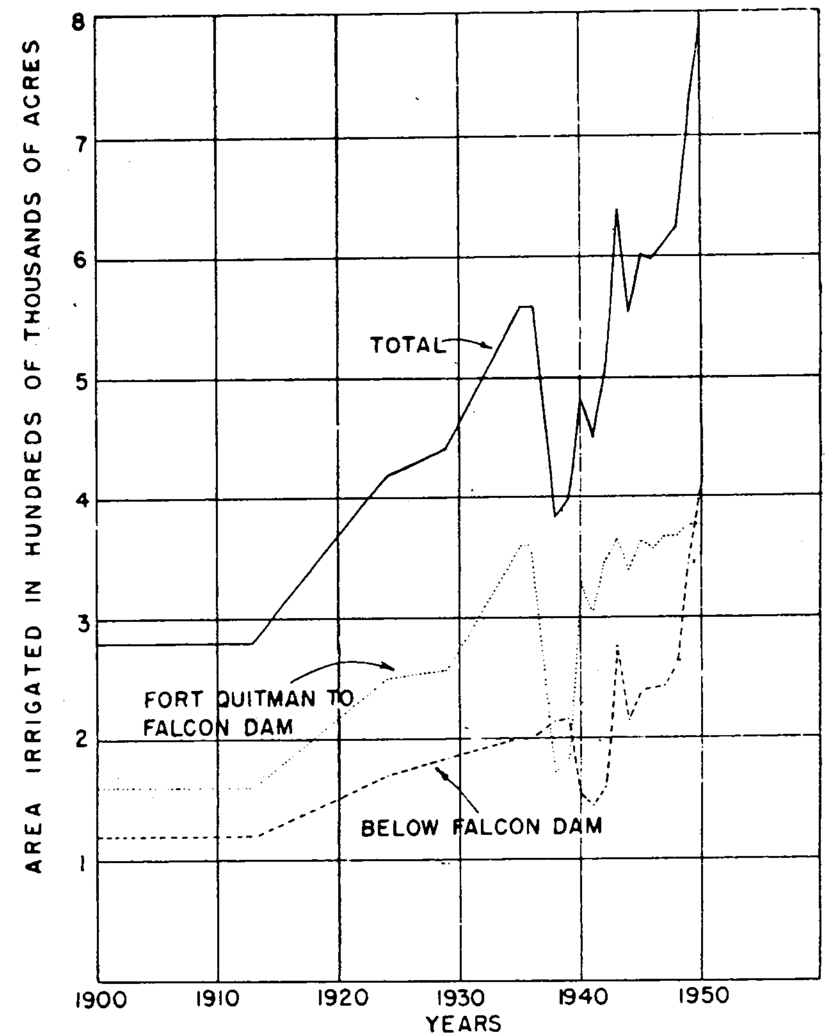
AREA IRRIGATED FROM RIO GRANDE AND TRIBUTARIES IN UNITED STATES

BELOW FORT QUITMAN ON THE RIO GRANDE AND GIRVIN ON THE PECOS RIVER



AREA IRRIGATED FROM RIO GRANDE AND TRIBUTARIES IN MEXICO

NOTE: VALUES ARE APPROXIMATE FOR PERIOD 1900—1938



The Division of The Basin at Fort Quitman

In the last half of the last century settlers moving into the upper Rio Grande basin in Colorado and New Mexico so dried up the summer flow of the River in the rich valley in southern New Mexico (the Mesilla Valley) and the El Paso-Juarez valley where vineyards and farms had been grown for many generations, that the United States government was compelled to take action to protect the rights of the prior users of the water in both countries. The United States enacted the Reclamation Law in 1902 and proceeded with plans to build a big reservoir to empound the snow water runoff in the spring. In 1906 the U. S. entered into a Treaty with Mexico promising Mexico 60,000 acre feet per year of water out of Elephant Butte Reservoir which was then nearing the construction stage.

Since the completion of Elephant Butte Dam in 1916 the Mexican side of the El Paso-Juarez valley has gotten its water from Elephant Butte and the Reclamation Bureau and the U. S. farmers have developed irrigation on about 178,000 acres between Elephant Butte and Fort Quitman. Also the three States of Colorado, New Mexico and Texas have entered into a compact concerning their rights in the Rio Grande above Fort Quitman and which compact conforms to the expanded use of water by the three states. The result of this expansion and development and of these international and interstate agreements is to divide the Rio Grande basin and the flow of the Rio Grande at Fort Quitman. The 1944 Treaty between the U. S. and Mexico takes this into account and divides the flow of the Rio Grande below Fort Quitman between the two countries and divides the residual flow reaching Fort Quitman 50-50. But since the middle of last century that flow has been averaging less and less until it is now sometimes zero or practically zero for months on end. The melting snows of Colorado and New Mexico do not increase the Rio Grande flow below Fort Quitman.

River Straightening and Flood Control

Several years ago, by agreement with Mexico, the I.B.W.C. straightened the meandering river channel in the El Paso region above Fort Quitman to about 1/2 its former length, lessening by thousands of acre feet the amount of water lost by evaporation and transpiration in swamps and river bends and improving land drainage. Also, by agreement between the I. B. & W. C. and the Bureau of Reclamation, they built the Caballo flood control dam giving a high degree flood protection to that valuable agricultural and metropolitan area which extends throughout the Mesilla Valley and the El Paso-Juarez Valley.

Rainfall

Because there is no snow water runoff in the springtime below Fort Quitman you will see that the flow of the Rio Grande below Fort Quitman is almost entirely and directly from rainfall: except as that flow is modified by storage in or release from reservoirs. These reservoirs may be man-made reservoirs on the surface of the ground or natural reservoirs under ground.

The average annual precipitation in the Rio Grande Basin is about 40 inches per year in the mountains at the river's source in Colorado and at the source of the Rio San Juan near Monterrey in Mexico. It approaches 30 inches at the source of the Rio Conchos in the Mexican State of Chihuahua and at the point where the river empties into the Gulf of Mexico. In the trough of the Valley along the upper half of the length of the Rio Grande the rainfall averages only 8 to 15 inches per year and minimums of 5 inches per year are experienced. In fact an average rainfall of 5 to 7 inches is common to large areas in Mexico within the outer rim of the basin, but comparatively small parts of such low rainfall areas lie within the effective watershed tributary to the river. Along the trough of the Valley below Fort Quitman the rainfall averages from near 8 inches at Fort Quitman, to near 10 inches at Langtry, to near 20 inches from Del Rio to Laredo, to near 26 inches at the Gulf.

The Flow of the Rio Grande

I have previously mentioned the development of reservoirs and greatly expanded irrigation since the middle of the last century in the basin above Fort Quitman. When man began irrigation *there* is not known for it is shrouded in the ages of pre-history. So the river's virgin flow of nearly a million acre feet of water per year at Fort Quitman has been depleted – gradually at first and then more rapidly in this century until now it is about one tenth of its virgin flow at Fort Quitman.

We are now in a period of rapidly expanding irrigation development in the Rio Grande basin below Fort Quitman. If, in this process of building reservoirs and expanding irrigation and urban areas we deplete the flow of the Rio Grande reaching the Gulf from a virgin flow of around 5½ million acre feet per year to one tenth that amount, we will only be following what has already been done with the river's flow at Fort Quitman. The difference, of course, is that above Fort Quitman the river and its basin lies almost wholly in the United States while below Fort Quitman the entire river and the basin is common to the United States and Mexico.

Throughout the entire length of the Rio Grande the sovereignties over the flow of the river and its tributaries, or the rights to the use of such waters, are covered by interstate compacts or international treaties.

Throughout the entire length of the Rio Grande from southern Colorado to the Gulf, above Fort Quitman and below, the flow of the river and its tributaries are insufficient to serve the towns and villages that could be – and – insufficient to fructify the vast areas that would be put under irrigation if the rainfall and river flow were greater.

Floods

Because of reservoirs and irrigation diversions there are no more spring floods at Fort Quitman caused by melting snows in Colorado and New Mexico. The largest flood we know to have passed Roma on the Rio Grande occurred in 1865. We are almost certain that it came principally from Sycamore Creek near Del Rio with a great deal of water also from

Devils River and San Felipe and Pinto Creeks. The second largest known flood came in 1932 principally from Devils River. The third largest came in 1948 and came from the Devils River and Sycamore Creek. The fourth largest was in 1922. It came principally from Arroyos del Caballo and Arroyo de la Zorra which enter from the Mexican side a few miles above the mouth of Devils River.

All of these largest floods and many of the others have originated near Del Rio where the Balcones escarpment meets the Rio Grande. This great escarpment at the head of the ancient Rio Grande embayment causes the surface of the earth to rise a thousand feet in a relatively short distance. The warm moist air from the Gulf is raised and cooled by this geomorphic feature. At times this results in the most rapid rates of rainfall experienced in the United States. Thirty four inches of rain is known to have fallen here in the storm that caused our 1948 flood.

Once a great flood is debouched into the channel and valley of the Rio Grande its movement in a downstream direction is both destructive and interesting. It is interesting because its front end travels faster than the ordinary flow and thus it overtakes and sort of scoopes up the ordinary flow in front of it. And if the ordinary flow in front of the flood is fairly large the flood shoves a gradually rising mass of "push water" in front of the flood water. Such push water accumulation in front of the flood causes the apparent front of the flood to move downstream faster than the particles of water in the flood stream. And so it takes experience and acumen to tell how fast a given flood will move downstream. This is also true because the rate of foreward flood movement varies in an inverse manner to the average width of the flood stream.

Because the downstream slope of the water surface at the rear part of a flood is flatter than the normal stream slope the velocity of the water is slower than normal. So the back part of a flood moves slower than normal and the front part moves faster than normal. This causes the body of flood water to be stretched over a greater reach of channel as it passes downstream. As a result the crest of the flood gets lower as the flood moves along the channel. So it takes experience to tell how high the crest of a given flood will reach at any given place along its course.

Because large floods depend upon the simultaneous happening of so many different weather elements their frequency of occurrence is both rare and eratic.

Hydrology

Let me present to you some hydrologic material and then let's see what that material indicates with respect to the hydrology of the Rio Grande basin below Fort Quitman. I do not mean to presume that you men are good hydrologists, but I do mean that there are some hydrologic ideas that you should know about and if you grasp these ideas yourselves they will stay with you longer.

These graphs represent every month of the 81 years from 1871 to 1951. They show the rainfall history for that period. As you come down

the basin from El Paso to the Gulf so you come down the page from the top to the bottom. There are 5 sub-basins shown. The top one extends from El Paso to Fort Quitman, the next one from Fort Quitman to Presidio, the next includes the Pecos River basin from Sheffield to the Rio Grande River, the next one the entire Devils River water-shed and the last one covers the Lower Rio Grande Valley from Rio Grande City to the Gulf. Here then are 5 sample sub-basins and for each sub-basin the graph shows its monthly rainfall history for the last 81 years since reliable rainfall records began to be collected in 1871.

The horizontal direction of these graphs represents months and years. The up and down direction represents departures from normal monthly rainfall. Those months when the average rain over the sub-basins is more than normal the line slopes up. When less than normal it slopes down. And the steepness of the slope represents the size of the surplus or shortage of rainfall. When rainfall is just normal the line goes horizontal. The monthly segments of line are tacked on to the ends of each other in chronological order so the amounts of surplus or deficiency are cumulative from the beginning to the end of the graph. These graphs, then, show the trend of the rainfall and how long the trend lasted. In looking at these trends you can generalize them over a short period or over a long period.

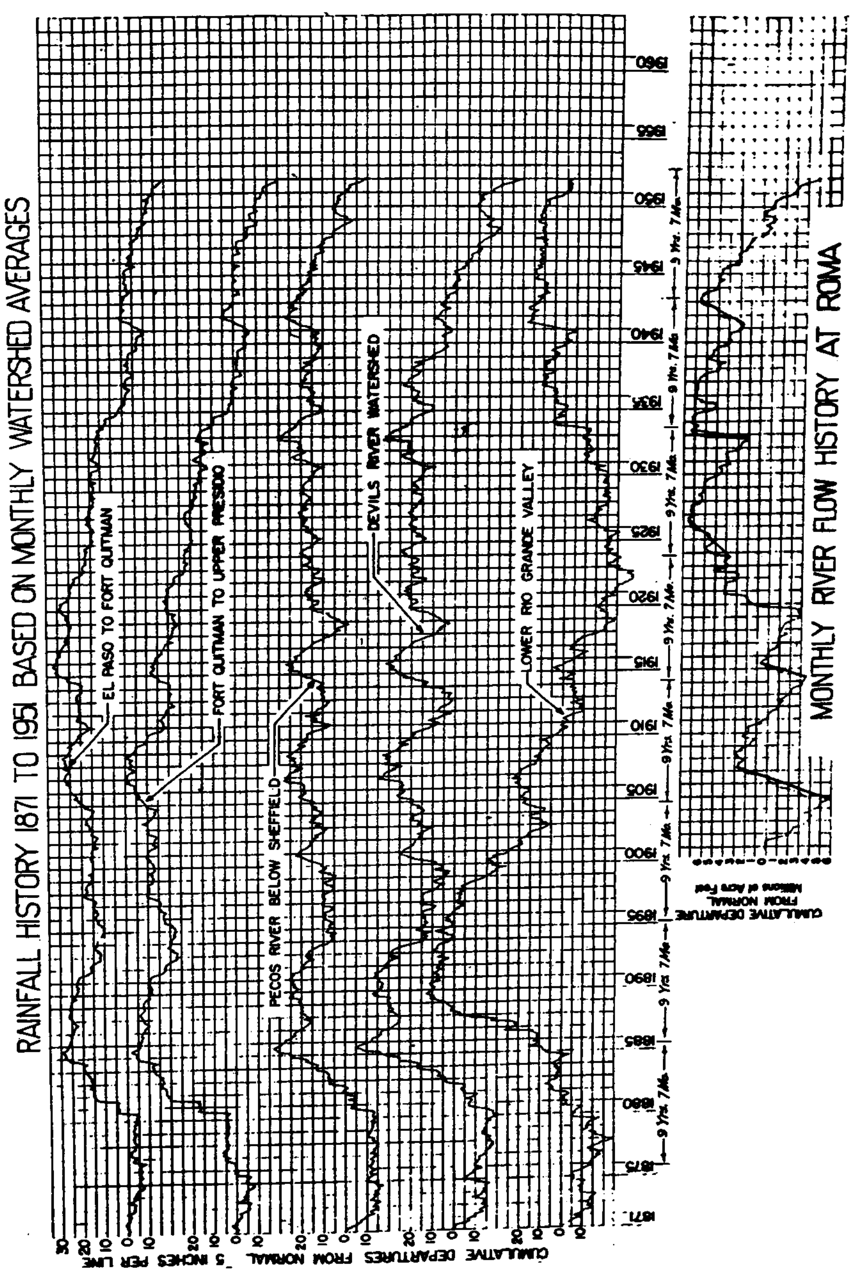
In general you will observe that the rainfall is hardly ever normal and certainly not for very many months in succession. You will also note that usually the downward sloping portions of the lines, that is, the portions which represent the droughts, are flatter and of longer duration than the upward sloping portions of the lines which represent the plentitudes. So generally the periods of plenty are short and more violent and the periods of drought are longer and more vapid.

Notice that in the sub-basin from Fort Quitman to Upper Presidio the last 43 years have been droughty. Notice the 33 year drought in the Lower Rio Grande Valley from 1889 to 1922. Notice the plentitude in all of the sub-basins in the early eighteen eighties. Notice the drought that prevailed in all sub-basins in the last 10 years of record.

Attached to the bottom of this exhibit is a similar graph showing the cumulative monthly history of river flow at Roma.

If you are looking for random variations of rainfall you can see them easily here. If you are looking for regular cyclic variations you apparently will not find them. If you are satisfied with a very loose cyclic rhythm you may find one with approximately 9 years and 7 months between plentitudes. If this holds true in the future then our current drought may be ended this fall or winter.

But lest you grasp the idea that these cycles are real and fully dependable let me point out that the large plentitude in 1919 and 1920 does not fit this cycle. Nor do the very large floods of 1922 and 1948. Also this supposed cycle is very faulty unless our current drought ends within the next few months. However it looks as though this loose cyclic period of 9 years and 7 months may have prevailed from 1866 to the present time.



Now let us turn to another aspect of Rio Grande hydrology.

If we take the Rio Grande watershed below Fort Quitman, eliminating the Pecos above Girvin, and on the Mexican side eliminating the Rio Conchos basin, the Rio Salado basin and the Rio San Juan basin we will have about 51,412 square miles of watershed remaining. Over this watershed the average rainfall is a little over 15 inches per year. Of this 15 inches only about one thirtieth or ½ inch gets into the Rio Grande and runs down the river. The other 29/30 or 14½ inches leaves the watershed as evaporation, and transpiration from the desert vegetation. In other words, a little over 96% of the rainfall does not flow down the river but goes directly back into the desert air and less than 4% runs off as stream flow.

For the average irrigated land on the U. S. side the average annual diversion of water is equivalent to about 25½ inches deep over the area. So you can see that it takes, on the average, about 51 acres of this part of the watershed to produce enough water for one acre of irrigated land or 51 square miles of such watershed for one square mile of irrigated land. Therefore this 51,412 square miles of watershed will produce, on the average, enough river flow to serve about 1,000 square miles or 640,000 acres of irrigated land.

Now, of course, if the rainfall on the watershed and the resultant river flow do not occur just at the time when the water is needed for irrigation then the flow is wasted to the Gulf unless it is empounded in a reservoir.

Now that you have even a limited idea showing that one square mile of watershed may provide enough river flow for about 13 acres of irrigated land you can begin to see how the supply of irrigation water in the river is effected by the building of small reservoirs or tanks on the watershed: especially if you have seen, from the air, the hundreds and hundreds of such tanks dotting the landscape, and if you have any idea of how many hundreds of square miles of watershed drain into these tanks.

Forecasts

Since construction work started on Falcon Dam forecasts of flow are made daily for 5 days in advance to protect that work and to serve the water users along the river below Laredo and in the Lower Rio Grande Valley. These forecasts are based upon daily information of flow up and down stream from Laredo and on flow travel time.

Monthly forecasts of flow are made once a month based upon monthly weather forecasts and information on river flow up stream to El Paso.

During floods forecasts are made of the time of arrival of flood peaks at important points and the height of the peak and the peak discharge.

You may be interested to know that the travel time for a rise in river flow to travel the 1,004 miles from Fort Quitman to McAllen varies from 7-1/3 days when the river is high to 18 days when the flow is low.

Water Quality

The quality of the water of the Rio Grande has three principal aspects, its chemical content, its bacteria content and its silt. The flow of the river is sampled by the I. B. & W. C. at various points along its course from El Paso to the Gulf and these samples are analyzed for their chemical, bacteria and silt content. This work has been carried on for years.

It might interest you to know that the greatest contributor of salt to the river flow is the Pecos River, that the fluorine content of Rio Grande water below Fort Quitman is about right for making good teeth in growing children, that the bacterial content is not governed so much by the sewage of up-river-cities as by the surface washings of the desert watersheds by rain storms, and that, at times of rain storms over Tornillo Creek and the lower end of San Francisco Creek in the Big Bend the river may carry enough bentonitic clays in suspension to make it very difficult for city water plants to clarify the water for municipal use.

Citrus Rootstocks in the Winter Garden Area of Texas

E. Mortensen, *Formerly Superintendent*
Winter Garden Experiment Station, Winter Haven, Texas

Early citrus plantings in the Winter Garden area were either sweet orange seedlings or varieties budded on trifoliate rootstock obtained from nurseries along the Upper Gulf Coast. In the past 25 years, practically all commercial plantings of orange, tangerine or grapefruit were trees on sour orange rootstock obtained from nurseries in the Lower Rio Grande Valley. Satsumas budded on trifoliate rootstock were obtained from Upper Gulf Coast nurseries, since citrus on trifoliate rootstock did not grow well in the Lower Rio Grande Valley.

The failure of the trifoliate rootstock in the Lower Valley and its excellent growth in the Winter Garden area suggested a need for rootstock studies in the Winter Garden area. Furthermore, various trifoliate hybrids, supplied by the late Dr. Walter T. Swingle of the U. S. Department of Agriculture, were relatively untested as rootstocks in Texas and other areas. Over 50 rootstocks were included in this study and the orchard performance of certain of these is reported for the first time.

These results probably do not apply to the Lower Rio Grande Valley, where warmer winter temperatures, high soil salinity and other unidentified factors may limit the use of rootstocks successful in the Winter Garden area (Cooper et. al., 1951).

Plant Materials

Rootstocks used in the first plantings were seedlings supplied by Swingle; those used after 1936 were grown from seed obtained from local plantings. A detailed description of all but 3 of these varieties may be found in "Citrus Industry" (Swingle 1943; Webber 1943). The Carrizo and Uvalde citranges have not previously been described.

The Carrizo citrange is a hybrid obtained from Swingle, who gave its origin as a cross of Washington Navel orange with trifoliate pollen. The trees grew rapidly and are very productive. The oval yellow fruits are seedy and valueless for eating.

Uvalde citrange seed were obtained in 1930 from a tree growing in Uvalde, Texas. The variety, which does not fit any published description, was named Uvalde at the suggestion of Swingle. The leaves are trifoliate and the tree has the vigor and growth habits of the citranges. It is a regular producer of moderate to heavy crops of deep orange colored fruits, oblate in shape with deep furrows in the rind. It has no value for eating.

Lemonquat is a chance hybrid found by Leslie Cude at Beeville, Texas. One tree budded on sour orange in 1942 was 8 feet tall with a

7-foot spread at 10 years of age. It is fairly open and thorny with flowering habits like the kumquat. Fruits are round to pyriform, ranging from 1½ to 3 inches in diameter, and orange yellow when ripe. The interior of the fruit is lemon-like, has a pleasant acidity, and becomes sweeter in March and April. It is highly cold resistant, and the remarkably uniform seedlings develop rapidly. Swingle considered this variety as a probable hybrid of Meyer lemon and kumquat.

Methods

The seedlings, grown from seed collected at Winter Haven as the fruit ripened, were lined out in nursery rows. Seedlings were usually ready to bud in October, 10 or 11 months from planting. The stock seedling was left unpruned to keep the buds dormant through the winter. In the spring the seedlings were lopped over to encourage growth of a shoot from the bud. The young scion growth was trained to light stakes and the stem of the seedlings just above the bud was cut off when the scion reached the top of the stake. At the end of 1 year's growth, the budlings were selected for uniformity and set into the orchard in February. All trees were transplanted bare-rooted and were watered at once to settle the soil and prevent drying of the roots.

The soil in which these trees were planted was mostly Webb fine sandy loam, a moderately shallow soil with a tough clay subsoil. One orchard was located on Crystal fine sand, a soil about 2 to 3 feet deep.

Clean cultivation was practiced, with an annual application of 2 to 3 pounds of nitrogen per bearing tree in February. Irrigations averaged 8 applications per year.

Table 1. Rootstocks for Hamlin orange (25' x 25' spacing).

Rootstock	*Budded Trees set* *Year*	*No.*	*Yield per Tree through 1950, total pounds*	*Growth*
Cunningham citrange	1934	4	4520	Normal
Trifoliate	1934	7	4369	Slightly dwarfed
Uvalde citrange	1934	2	5230	Strong
Calamondin	1944	2	447	Normal
Carrizo citrange	1943	3	756	Normal
Changsha	1943	2	776	Normal
Kansu	1944	1	62	Dwarfed
Sacaton citrumelo	1943	3	1110	Strong
Savage citrange	1943	2	567	Normal
Sour orange	1943	3	925	Strong
Swatow	1943	3	504	Normal
Thomasville citrangequat	1943	3	789	Normal
Trifoliate	1943	2	987	Slightly dwarfed
Uvalde citrange	1943	3	765	Strong

Individual tree yields of fruit were obtained annually. Notes on tree size, condition and survival were kept.

Observations on Rootstock Seedlings in the Nursery

Growth of the Seedling Top: The most vigorous growth occurred on seedlings of the citranges, citrumelos, citranguma, sweet oranges, Rangpur lime, Palestine Sweet lime and Rough lemon. Moderate growth occurred on the tangelos, sour orange, mandarins, calamondin, calashu, Ermolemon, lemonquat and citrangequats. Seedlings of shaddock, trifoliate orange, Kansu, lemon, limequat and citrangedin grew poorly and few survived in the nursery. Seedlings with a caliper of 5 mm. at 2 inches above ground level in October were considered usable for budding. The vigorous and moderately vigorous varieties, in general, produced a high percentage of usable seedlings for budding.

Character of the Root System: Notes were made of the root system of nursery trees 1 year after budding. Sour orange had a deep root system, usually with several tap roots; lateral root development was less than in sweet orange, rough lemon or grapefruit. Sweet orange did not develop deep tap roots and was moderately shallow-rooted. Mandarins tended to have dense shallow-root systems, which are favorable for transplanting. Trifoliate orange had a well-branched, moderately shallow root system. Grapefruit had a widely-spreading root system. Rough lemon had no marked tap root, but had a widely-spreading root system with good lateral rooting.

Citranges varied in the type of root system. Carrizo and Uvalde had deep penetrating tap-roots with comparatively sparse lateral roots. Savage citrange had a good lateral root system with less tap root development. Citrumelo and citrangequat also had a good lateral root development. Calamondin tended to have deep tap roots with fewer lateral roots.

Cold Resistance of Seedlings in the Nursery: A severe freeze on February 8, 1933, with a minimum temperature of 18°F., occurred after a long warm spell and gave an opportunity to observe damage to young

Table 2. Rootstocks for Joppa orange (25' x 25' spacing).

Rootstock	*Budded Trees set* *Year*	*No.*	*Yield per Tree through 1950, total pounds*	*Growth*
Rusk citrange	1934	7	5980	Strong
Thomasville citrangequat	1934	5	4408	Normal
Trifoliate	1934	15	1681	Stunted
Calamondin	1944	1	392	Normal
Carrizo citrange	1944	3	428	Normal
Trifoliate	1944	2	188	Stunted
Uvalde citrange	1944	3	315	Normal

rootstock seedlings. Varieties showing no injury were Carrizo, Cunningham, Morton and Rustic citranges and trifoliate orange. Slight injury to foliage occurred on Rusk citrange, Thomasville citrangequat, Ichang and Changsha tangerine. Considerable injury occurred on Uvalde citrange, citradia and Kansu. Varieties frozen to the ground were sour orange, Savage citrange, calamondin and Glen citrangedin.

In the winter of 1950-51, another lot of nursery seedlings was subjected to two freezes. The December 7th freeze had a minimum temperature of 21°F. and occurred before the plants were dormant. Heavy losses occurred on 1-year-old seedlings of Kinnow mandarin, Oneco tangerine, Swatow 14054 tangerine and the 52018T2A tangelo. Seedlings of citrangedin, 48032 citrangequat, trifoliate orange, citrangeuma, Norton citrange, Swatow tangerine (TS 11434), *Severinia*, and Webber tangelo showed slight injury. A week of below-freezing temperatures occurred later in the winter, with a low of 12°F on February 2. Following this freeze, good survival was noted only on Norton citrange, citranguma and satsuma seedlings. All other year-old seedlings, mostly tangelo varieties, were killed to the ground. After the freeze, at least 50 percent of the seedlings of the following varieties recovered: *Severinia*, Minneola, Thornton, 52018W6F and Webber tangelos; and Swatow (TS11434) tangerine. Varieties with almost 100 percent losses included citrangedin; the Kara, Kinnow and Wilking mandarines; Altoona, 52018K12G, and 52018T2A tangelos; and Chinotto orange.

Nursery trees of Washington Navel oranges budded on trifoliate orange and Cleopatra mandarin rootstocks had good survival from the 1951 freeze.

Influence of Rootstock on Cold Hardiness of Scion: Observations on freeze damage to trees were made following a freeze in 1951 with a minimum of 12°F. on February 2 after 4 days of freezing temperatures. Seventeen-year-old Hamlin orange trees on trifoliate rootstock suffered less damage than those on Cunningham or Uvalde citrange rootstocks. Eight-year-old Hamlin trees on Changsha or Thomasville citrangequat rootstocks showed less damage than those on calamondin or trifoliate rootstocks.

Table 3. Rootstocks for Texas Navel orange (25' x 25' spacing).

Rootstock	Budded Trees set: Year	Budded Trees set: No.	Yield per Tree through 1950, total pounds	Growth
Cunningham	1934	7	3382	Normal
Morton citrange	1934	5	3800	Strong
Rusk citrange	1934	3	4500	Strong
Trifoliate	1934	16	2732	Normal
Uvalde citrange	1934	4	3038	Normal
Calamondin	1944	1	6	Normal
Sacaton citrumelo	1944	1	145	Normal
Thomasville citrangequat	1944	2	104	Normal
Trifoliate	1944	1	66	Normal

Seven-year-old Joppa orange trees on calamondin rootstock were killed; those on Carrizo citrange showed less damage. Seventeen-year-old Texas Navel trees on Morton citrange and trifoliate suffered less damage than those on Cunningham citrange. Seven-year-old Texas Navel trees on Sacaton citrumelo and Thomasville citrangequat showed less damage than those on calamondin rootstock. Freeze damage was more severe on 10-year-old Washington Navel orange on Cunningham citrange than on Carrizo citrange rootstock.

When the top was Owari satsuma, the freeze damage was light and no significant rootstock effect was noted. This was also true of other satsumas used as scions, except that trees on calamondin rootstock were severely injured by the cold.

Meyer lemon trees on their own roots froze to the ground, while Meyer lemon on Carrizo citrange rootstock froze back to the trunk.

In January 1935, a freeze with a minimum of 19°F. preceded by 14 days of unusually warm weather, rootstocks did not have a noticeable effect on the cold tolerance of 1- and 2-year-old trees. However, scion varieties varied in their cold-tolerance. Calamondin and Eustis limequat suffered the most damage, the oranges were intermediate, the satsumas and Kansu suffered only foliage injury, while citrangequat, citranges, citrangedin, citradia and Changsha tangerine were not injured.

Table 4. Roostocks for Owari satsuma.

Rootstock	Budded Trees set: Year	Budded Trees set: No.	Budded Trees set: Spacing	Yield per Tree through 1950, total pounds	Growth
Cunningham citrange	1933	1	20'	4014	Normal
Morton citrange	1933	1	20	2523	Normal
Rusk citrange	1933	1	20	186	Stunted
Savage citrange	1933	1	20	978	Normal
Uvalde citrange	1933	1	20	3702	Normal
Calamondin	1936	3	25	2319	Normal
Carrizo citrange	1936	1	25	4212	Normal
Kansu (Ichang)	1936	2	25	2122	Normal
Meyer lemon	1936	1	25	34	Stunted
Rustic citrange	1936	2	25	2522	Normal
Savage citrange	1936	1	25	1815	Normal
Sour orange	1936	3	25	2921	Strong
Trifoliate	1936	3	25	2847	Normal

Orchard Performance of Scions on Various Rootstocks

Hamlin orange tops: Fruit yield and tree growth, shown in Table 1, was better when Uvalde citrange rootstock was used, in comparison to trifoliate and Cunningham citrange stocks in 1934 plantings. Of the 11 stocks compared in the 1943-44 plantings, the best yields were from trees on Sacaton citrumelo rootstock; high yields were also obtained from trees on trifoliate and sour orange rootstocks.

Joppa orange tops: Trees on 3 rootstocks were set out in 1934; yields of fruit, shown in Table 2, were highest on Rusk citrange, somewhat lower on Thomasville citrangequat and low on the trifoliate rootstock. Trees on trifoliate rootstock were dwarfed and 9 of the original 15 trees on this rootstock died by 1951. Trees on Thomasville citrangequat were smaller than those on Rusk, and the fruit ripened two weeks later. Trees of 4 rootstocks were set out in 1944; those on trifoliate rootstock were stunted compared to those on the other rootstocks.

Purvis orange tops: One tree on trifoliate stock, planted in 1932, was dwarfed and died in 1947 after producing 1,281 pounds of fruit. Of the 1937 plantings, 3 trees on Sacaton citrumelo average 2,284 pounds of fruit per tree, while 2 trees planted on Glen citrangedin averaged 2,006 pounds for the same period.

Rico No. 6 orange tops: Trees of this Valencia strain, planted in 1939, were dwarfed on Kansu rootstock, grew normally on Thomasville citrangequat, and had the best yields on Rusk citrange rootstock.

Texas Navel orange tops: Of trees set on 5 different rootstocks in 1934, losses from "decline" occurred on all rootstocks except Rusk citrange which had the best yield of fruit (Table 3). No stunting of trees occurred on trifoliate orange rootstock.

Washington Navel orange tops: Four trees on trifoliate, set in 1932, had normal growth and yielded an average of 4,054 pounds of fruit through 1950. Satisfactory growth and yields were obtained from trees on Carrizo and Cunningham citranges, set in 1941.

Owari satsuma tops: Of trees on 5 rootstocks set in 1933, the data in Table 4 show that the highest yields were from trees on Cunningham and Uvalde citrange rootstocks. One tree on Rusk citrange was badly stunted.

Eight rootstocks were compared in 1936 plantings; the best yield was from the tree on Carrizo citrange. Trees on sour orange had equal yield and a stronger growth in comparison with trees on trifoliate.

Silverhill satsuma tops: The average yield of fruit of the 1933 planting was greater from trees on Cunningham citrange rootstock than from any of the other 4 rootstocks (Table 5). Of the 7 rootstocks compared in the 1936 plantings, the best growth was on sour orange rootstock and the best average yields were from trees on Savage and Cunningham rootstocks. The yields on sour orange were approximately equal to those on trifoliate rootstock.

"Kawano Wase" satsuma tops: This scion is probably not the true Kawano Wase variety, but probably a "reverted" form. Seven rootstocks were compared in the 1936 planting; the highest yields were from those trees on Thomasville citrangequat and Carrizo citrange (Table 6). A single tree set in 1934 on Rustic citrange rootstock on a deeper soil yielded an average of 3,615 pounds of fruit through 1950.

Grapefruit varieties as tops: Trees on sour orange rootstock had good yield and growth characteristics when John Garner (probably a Marsh White nucellar strain) and Marsh Pink scions were used. Carrizo citrange rootstock was satisfactory for Redblush and Little River; with Marsh tops this rootstock also gave strong growth and good yields. Redblush trees and Little River trees on Cunningham citrange rootstock were stunted

Table 5. Rootstocks for Silverhill satsuma.

	Budded Trees set			*Yield per Tree through 1950,*	
Rootstock	*Year*	*No.*	*Spacing*	*total pounds*	*Growth*
Cunningham citrange	1933	7	20'	3488	Normal
Morton citrange	1933	4	20	3097	Normal
Rusk citrange	1933	5	20	2114	Normal
Rustic citrange	1933	2	20	2069	Normal
Savage citrange	1933	4	20	1504	Slight dwarfing
Calamondin	1936	3	25	2018	Normal
Changsha	1936	1	25	2660	Normal
Cunningham citrange	1936	1	25	3015	Normal
Savage citrange	1936	3	25	3564	Slight dwarfing
Sour orange	1936	3	25	2880	Strong
Trifoliate	1936	3	25	2992	Normal
Uvalde citrange	1936	3	25	2586	Normal

Table 6. Rootstocks for "Kawano Wase" satsuma. Set in 1936.. (25' x 25' spacing).

Rootstock	*No. budded Trees*	*Yield per Tree through 1950, total pounds*	*Growth*
Carrizo citrange	2	3626	Normal
Cunningham citrange	2	3279	Normal
Meyer lemon	1	1399	Normal
Savage citrange	3	2690	Normal
Sour orange	3	2770	Normal
Thomasville citrangequat	1	3826	Normal
Trifoliate	3	2136	Normal

and lacking in vigor. Marsh Pink and Redblush trees on Sacaton citrumelo rootstock had normal growth and good yields; Redblush trees on Rusk citrange rootstock also had normal growth and good yields.

Clementine mandarin tops: Four trees on trifoliate rootstock had normal growth; while the average yield was higher from a single tree on Uvalde rootstock, also planted in 1934. A single tree on Swatow rootstock, planted in 1943, was dwarfed.

Tangelo varieties as tops: Cunningham citrange rootstock was satisfactory for Minneola, Wekiwa and Thornton tangelo trees planted during 1939-40; it was unsatisfactory for the Sunshine tangelo top. Minneola tangelo trees on Meyer lemon rootstock showed relatively weak growth and gave poor yields. Carrizo citrange rootstock gave only fair results when Sunshine and Webber tangelo tops were used.

Influence of Rootstock and Scion on Susceptibility to Disease

After the plantings were about 10 years old, some trees began to decline in vigor and show chlorosis. The leaves turned dull green in appearance, often in only one portion of the tree. Defoliation of the affected part was gradual and the younger growths died back. This was followed by sucker growth from the scaffold limbs and main trunk, which sometimes continued as long as 4 or 5 years before the tree died. An examination of the roots of diseased trees showed that the trouble was correlated with death of small feeder roots. The larger roots of dead trees sometimes had a sour smell coming from the decayed bark. The disease spreads outward from a central area in an manner similar to the spread of cotton root rot until, in some areas, it killed 8 or 10 trees. The fungus *Pythium ultimum* has been isolated from the feeder roots and is considered a possible cause of the "decline" (Sleeth, 1953). Rootstocks susceptible to "decline" have been reported (Mortensen 1947, 1952).

A disease of Joppa orange on trifoliate rootstock at Winter Haven has been identified by Dr. E. O. Olson, U. S. Department of Agriculture, Weslaco. This disease, exocortis, is characterized by stunting of the tree, bark scaling on the trifoliate rootstock, and by greatly reduced rootstock trunk diameter in comparison to the usual overgrowth occurring on trifoliate rootstocks. The source of the Joppa orange budwood used at Winter Haven was one vigorous tree on sour orange located at Winter Haven; this parent tree was propagated from budwood obtained in the Lower Rio Grande Valley. All Joppa orange trees on trifoliate rootstocks at Winter Haven were dwarfed (Table 2) and showed exocortis. Nine of 15 trees on this stock died by 1951; two trees became scion rooted in recent years and immediately grew at a normal rate. Rusk, Carrizo and Uvalde citranges, Thomasville citrangequat, calamondin and sour orange rootstocks with Joppa orange tops from the same sources have grown normally and did not exhibit the symptoms of exocortis.

Trees of Diller orange on trifoliate orange rootstock in one commercial orchard near Carrizo Springs were also stunted and died about 15-20

years after setting. All exhibited exocortis. Inarching with sour orange seedlings saved some of the trees.

Exocortis has been studied in Australia (Benton et al, 1950) where it is called "scaly butt" and in California (Klotz and Fawcett, 1948). The Australians found evidence of a symptomless virus in some scion varieties which is injurious to the trifoliate rootstock. In Australia, Washington Navel orange and Thompson grapefruit are reported to produce "scaly butt." In the Winter Haven area, Joppa and Diller oranges caused exocortis on trifoliate rootstock; Washington Navel, Texas Navel, Hamlin oranges and 3 satsumas on trifoliate stock have grown normally and showed no symptoms of exocortis (Tables 1, 3, 4, 5 and 6). In Australia the scaling symptoms show up between the 4th and 8th year from budding. Trees older than 8 years do not develop the disease. The obvious control is to select budwood from healthy trees on trifoliate rootstocks, provided the trees are at least 8 years old.

General Adaptability of Rootstocks

Calamondin, Glen citrangedin and Meyer lemon rootstocks show little promise. Changsha and Swatow tangerines and Kansu lemon rootstocks require further testing before proper evaluation. Cunningham citrange was an unsatisfactory rootstock for grapefruit, but useful for satusmas. Since Morton citrange fruit bear few seeds (Mortensen and Riecker, 1942) and the rootstock was susceptible to "decline", commercial propagation on this rootstock is not recommended. The Savage citrange rootstock was susceptible to "decline" also.

Rustic citrange and Thomasville citrangequat are promising rootstocks. The best yields, however, were from trees on these rootstocks: Rusk, Carrizo and Uvalde citranges; Sacaton citrumelo and sour orange. Trifoliate orange was a useful rootstock for oranges and satsumas; if orange scions are desired, the budwood should be free from the causal agent of exocortis. Washington Navel oranges were especially productive on trifoliate rootstock.

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Effect of Light Duration and Hydrogen-Ion Concentration on the Growth, Total Iron Content and Phosphorus Content of Cleopatra Mandarin

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Cleopatra mandarin shows promise as a citrus variety rootstock in the Lower Rio Grande Valley. Propagation by seed, however, is sometimes difficult because the seedlings often become chlorotic, particularly on calcareous soils (Cooper, 1952). Many seedlings may perish and others remain diminutive because of arrested growth.

Although chlorosis of mature citrus trees is not as extensive as on young trees, it has been reported by McGeorge (1948) to be prevalent on mature trees in Arizona during fall or spring months. In relation to this, Hibbard (1941) found that short day conditions enhanced the transport of iron from roots to leaves. Gericke (1925) also reported that a greater quantity of light was conducive to a greater need for iron by wheat plants.

The purpose of this investigation, summarized herein, was to ascertain what effect quantitatively varying light conditions had on the growth of Cleos with nutrient cultures having different hydrogen-ion concentrations.

Experimental Procedure

Cleopatra mandarin seeds were planted February 24. Vermiculite (Terralite brand) was used as the substrate in number 8 unglazed plots. A slop-culture technique was employed using the number 2 nutrient solution and supplemental solution of minor elements as given by Hoagland and Arnon (1950. Ferric sulfate was added to the supplemental solution at a rate of .4 gm. in one liter of water. Steinburg (1951) found no differences in the utilization of iron compounds at different hydrogen-ion concentrations if the solutions were vigorously stirred before using to coat the plant roots. Ample drainage was provided and the waste-filtrate was caught in cans placed below the unglazed pots and discarded. Enough of the nutrient solution was added each time to ensure leaching.

The nutrient solution was divided into three equal portions which were adjusted with either HCl or NaCH to give solutions having an initial hydrogen-ion concentration of a pH of 6, 7, or 8. New solutions were used five times during the investigation. The conductivity of each solution was adjusted to 2.8 millimhos/cm. with NaCl.

Treatments were replicated four times, and three Cleo seedlings were used for each treatment. Treatments consisted of growing the seedlings with solutions having the three different hydrogen-ion concentration under 8 and 16 hours of artificial light in a growing chamber. The light intensty for both light conditions was approximately 500 f.c. Temperature between light compartments was constant within a range of + or − one degree C.

The seedlings were harvested and separated into roots and tops when the first chlorosis became noticeable June 4. The plant material was carefully cleaned, but the roots were not washed with dilute HCl. Immediate growth measurements of the roots and the tops were taken at the time of harvest.

The colorimetric O-phenathroline method was used to determine total iron (Saywell and Cunningham, 1937). An adapted colorimetric procedure using the methods of Toth, *et al.* (1948) and Cotton (1945) was employed for phosphorus. The three Cleo seedlings for each treatment of each replicate were composited for chemical analyses.

Results and Discussion

Growth measurements of the Cleo seedlings were made approximately 3 months after planting, see Table 1. Seedling growth was significantly affected by the initial hydrogen-ion concentration of the culture solution,

Table 1. Growth measurements and green weights on the roots and tops of Cleo seedlings.

	Average per Plant					
Initial pH of Nutrient Solution	*No. of Leaves*	*Height of Tops inches*	*Terminal Length of Root inches*	*No. of Lateral Roots*	*Green Weight Tops mean gm*	*Green Weight Roots mean gm*
	16 hours of light					
6.0	4.6	3.15	4.56	11.19	.19	.071
7.0	5.0	2.75	3.54	7.50	.21	.073
8.0	5.0	2.91	3.63	6.16	.25	.095
	8 hours of light					
6.0	4.83	2.58	4.29	10.00	.21	.075
7.0	4.83	2.70	3.66	8.16	.22	.060
8.0	4.80	3.05	4.50	10.20	.21	.070
L.S.D. for Light, P ⟨ .01	N.S.	.088	N.S.	.88		
	Average for Treatments (pH)					
6.0	4.72	2.87	4.43	10.60		
7.0	4.92	2.73	3.60	7.83		
8.0	4.90	2.98	4.07	8.13		
L.S.D. for Treatment, P ⟨ .01	N.S.	.147	0.72	1.47		

bottom of Table 1. It is pertinent that the longest primary roots occurred at a pH of 6; while the best top growth occurred at a pH of 8. The data further indicate that the poorest root growth resulted with the nutrient solution which had an initial pH of 7. The results are in agreement with those of Reed and Haas (1924) who reported that the best growth of Rough lemon and grapefruit seedlings occurred at a pH of 8.

The effects of the two different light periods and their interaction with the three hydrogen-ion concentrations are given in the top portion of Table 1. The data indicate that 16 hours of light, compared with 8 hours of light, significantly increased the number of lateral roots, when the nutrient solution had a pH of 6. The number of lateral roots were decreased at a pH of 7 and a pH of 8. In addition, 16 hours of light increased the height of seedlings grown in solutions at a pH of 6 and decreased the height at a pH of 8.

Table 2 gives the analyses for total iron content of the tops and roots in mg/gm. In general, as the hydrogen-ion concentration of the nutrient solutions increased, the total iron in the roots also increased irrespective of the light period. Iron tended to be more abundant in the seedlings which received 8 hours of light, and a greater share of this iron was contained in the tops. This is in agreement with the results as given by Hibbard (1941) who reported that short days are conducive to the transfer of iron from roots to tops in peas.

The interaction of hours of light with the hydrogen-iron concentrates of the nutrient solutions is of further interest (Table 2). The length of the light period did not significantly affect the total iron in the roots at any one treatment (pH). As shown in Table 3, the primary contribution to statistical significance was the variance due to the differences in total iron content of the tops which received 8 hours of light. These plants at a pH of 8 and 7 had a large share of iron in the tops, and they showed slight chlorosis. Plants grown with 8 hours of light at a pH of 6 and a pH of 7 were the most chlorotic. Seedlings which received 16 hours of light had less total iron in the tops, but they were not chlorotic. Leeper (1952)

Table 2. Total iron content of dry tissue from roots and tops of the Cleo seedlings expressed in Mg/gm.

	16 hours of light			8 hours of light		
Initial pH of Nutrient solutions	*Tops*	*Roots*	*Ratio Top:Root*	*Tops*	*Roots*	*Ratio Top:Root*
6.0	.068	1.138	16.7	.121	1.014	8.4
7.0	.069	.538	7.8	.069	1.082	15.7
8.0	.093	.402	4.3	.385	.726	1.9
Total	.230	2.078	28.8	.575	2.822	26.0
L.S.D. pH, p ⟨ .05	.015	.426		.015	.426	
p ⟨ .01	.020	.589		.020	.589	

has reported that the amount of iron in chlorotic plants may be high but in a form not accessible for metabolism.

The percentage of dry plant material which was P_2O_5 is given in Table 4. Eight hours of light significantly increased the amount of P_2O_5 in both roots and tops. The significant interaction of light and pH is shown in Table 3. Although not statistically significant, the amount of P_2O_5 in the tops of seedlings which received 16 hours of light tended to increase as the hydrogen-ion concentration increased. The amount of P_2O_5 in the roots of seedlings which received 8 hours of light increased as the hydrogen-ion concentration decreased.

Table 3. Partition of significant components of variance for interactions of light periods with hydrogen-ion concentrations.

Source of variation	*Degrees Freedom*	*Mean squares* Compounded Tops-Fe	Compounded Roots-P_2O_5	Partitioned Tops-Fe	Partitioned Roots-P_2O_5
Photoperiod X treatment	2	.263**	.413*		
Treatment	2	.068**	.143		
Components of variance:					
16 hours of light					
Linear	1			.004	.050
Deviation from linear	1			.002	.058
8 hours of light					
Linear	1			.243**	.895**
Deviation from linear	1			.417**	.054
Total		.331	.556	.666	1.057
Error				.0095	.0702

*P ⟨ .05
**P ⟨ .01

Table 4. Percentage of P_2O_5 in roots and tops of the Cleo seedlings.

Hours of Light	*Initial pH of nutrient solution* 6	7	8
		Tops	
16	.179	.166	.129
8	.352	.262	.356
Difference	–.173	–.096	–.227
L.S.D., P ⟨ .01	.095	.095	.095
		Roots	
16	.386	.528	.245
8	.680	.872	1.349
Difference	–.294	–.344	–1.104
L.S.D., P ⟨ .01	.318	.318	.318

Since the P_2O_5 content was approximately two times greater for seedlings which received 8 hours of light and showed chlorosis, it is probable that the phosphate : iron balance of the plants may have been upset thus inducing chlorosis. Biddulph and Woodbridge (1952) have demonstrated that at a high pH (7.0) phosphorus may accumulate in conductive tissues and impede the passage of iron to metabolic tissue of beans. These investigators found evidence that both phosphorus and iron may be immobilized at the root surface and in the veins. Below a pH of 6, the immobilized precipitate on the root surfaces was predominantly ferric phosphate. Other ions, however, may have interfered with metabolism also. Sideris (1950) found by using radio-active Fe^{59} that manganese impeded the translocation of the iron which was mainly associated with the protein constituents of plant tissues from *Ananas Cosmosus*.

Summary

Cleopatra mandarin seedlings were grown under two light periods of 8 and 16 hours duration with three treatments of nutrient cultures having initial hydrogen-ion concentrations of a pH of 6, 7, and 8.

1. In general, best growth of the Cleos occurred with 16 hours of light and a nutrient solution having an initial pH of 8.
2. The 8 hour light period enhanced the total iron content in the seedling tops compared with the roots, even though chlorosis occurred.
3. Eight hours of light increased the P2O5 content of seedling tops approximately two-fold over plants which received 16 hours of light.
4. A phosphorus-induced chlorosis is discussed.

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A Crown Rot of Citrus Rootstock Seedlings Caused by *Sclerotium Rolfsii*[1]

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Sour orange seedlings are highly resistant to cotton root rot, caused by *Phymatotrichum omnivorum* (Bach, 1931). However, occasional sour orange seedlings lined-out in nursery rows showed symptoms similar to those of cotton root rot; these symptoms included a softening of the bark of the crown roots and persistence of dried leaves on the dead plant. Only a few dead or dying plants were noted. A study of the relation of *Sclerotium rolfsii* to this disease is reported.

Methods and Results

Several dying seedlings of sour orange were obtained from each of 3 nurseries, located near Weslaco, Mercedes and Monte Alto. Fungi growing from pieces of decayed bark, placed on corn meal agar, included *S. rolfsii* on one or more plants from each location.

S. rolfsii was grown on a mixture of soil and milo maize for 3 weeks. Sour orange seedlings were transplanted to unsterilized soil in gallon cans, and *S. rolfsii* inoculum was added to the soil the day after transplanting. No inoculum was added to the soil of the control plants. The transplanted seedlings were watered frequently during the duration of the experiment.

After 30 days 32 of 48 seedlings in the soil infested with *S. rolfsii* were dead as compared with 0 of 48 in soil not infested with this fungus. Infected plants showed girdling at or below the soil line, the root bark becoming mushy and brown at this point; the dried leaves remained on the plant. Sclerotia formed on some dead seedlings at the soil level. *S. rolfsii* was cultured from the advancing margins of the decayed bark of dying plants.

Sour orange seedlings with several inches of stem buried in moist soil appeared to be more suceptible to crown rot under field conditions. In order to study the effect of depth of planting on infection, two series of sour orange seedlings were planted. One series was planted at the same depth as in the seedbed; the other series was planted 2 inches deeper so that a portion of the stem was buried in moist soil. These seedlings were grown for 5 weeks in unsterilized soil and then the soil was infested with *S. rolfsii*. No inoculum was added to the soil of 5 control plants for each of the two treatments.

[1]These investigations are a part of the Cooperative Citrus Rootstock Investigations conducted by the Texas Agricultural Experiment Station and the U. S. Department of Agriculture, certain phases of which were carried on under the Agricultural Marketing Act (R M A Title II). Rio Farms, Inc., Monte Alto, Texas, also cooperated in this study.

After 30 days there were no dead seedlings in the uninfested controls; in soil infested with S. *rolfsii*, 12 of 20 deep-planted seedlings were dead as compared with 5 of 20 seedlings planted at the same level as in the seedbed.

Six kinds of seedlings grown for use as rootstocks were also exposed to infection by S. *rolfsii*; inoculum was added to the soil the day after the seedlings were transplanted. No inoculum was added to the soil of 5 control plants of each of the 6 seedling varieties.

Ten days after infestation of the soil, some seedlings wilted. The numbers of dead plants 30 days after infestation are recorded in Table 1. There were no dead seedlings in the uninfested controls; these plants grew more vigorously than the plants in infested soil. Pieces of decayed bark from infected plants were placed on corn meal agar and S. *rolfsii* was reisolated from sour orange, Savage citrange, Louisiana Sweet orange and Rough lemon seedlings. The fungus was not reisolated from Duncan grapefruit or Cleopatra mandarin seedlings which wilted; Wolf (1916), however, isolated S. *rolfsii* from small grapefruit seedlings. The most consistent recovery of S. *rolfsii* in these trials was from the sour orange seedlings planted 2 inches deeper than they were in the seedbed.

Discussion

S. *rolfsii* is widely distributed in many parts of the world, especially in subtropical regions. It is a soil-inhabiting fungus which attacks many crop plants at or below the surface of the soil. Taubenhaus (1919) recorded 32 host plants in addition to citrus. Under very moist conditions the vegetative growth of the fungus can be seen at the base of infected plants as a delicate white mycelium on which the sclerotia are produced. These are hard globular masses of fungus tissue, yellow to brown in color and much resembling mustard seeds.

S. *rolfsii* attacked citrus seedlings in Florida (Fawcett, 1936), in Puerto Rico (Stevenson, 1918) and in Alabama (Wolf, 1916). Godfrey (1953) listed S. *rolfsii* among the fungi he recovered from decaying bark of the trunks of 2-year-old citrus trees in Texas; the trunks had been covered with soil for freeze protection and the banks of soil were warm and moist in April when 40 odd trees died.

Table 1. Condition of various kinds of citrus seedlings 30 days after infestation of unsterilized soil with S. *rolfsii*.

	Seedlings	
Kind of Seedling	*Dead Number*	*Living Number*
Sour orange	6	14
Cleopatra mandarin	3	37
Duncan grapefruit	1	19
Savage citrange	7	13
Louisiana Sweet orange	10	6
Rough lemon	2	18

While sour orange is highly resistant to cotton root rot, certain symptoms of *P. omnivorum* infection were duplicated by S. *rolfsii* attack. Therefore, sour orange seedlings with rotted bark and dried leaves remaining on the dead plant are not necessarily affected by cotton root rot. Deep-planted sour orange seedlings appeared to be more susceptible to attack than those planted at the same level as in the seedbed. Seedling varieties grown for use as rootstocks probably vary in their susceptibility to S. *rolfsii* infection.

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History of the Meyer Lemon in the Valley

W. H. Friend, *Associate County Agent*

The Lower Rio Grande Valley is the only place in the world where extensive commercial plantings of the Meyer lemon have been made. This dwarf type of cold resistant lemon was discovered by the famous plant explorer, Frank Meyer, near Canton, China. It was grown in its native country principally as a pot plant, and it has been used for that same purpose in California. The variety was introduced into this country in 1908, and rooted cuttings and budlings of this dwarf Chinese lemon were sent out to cooperators with the Office of Plant Exploration and Introduction a few years later. Fruiting trees of this variety, which later became known as the Meyer lemon, were in the Valley when the Valley Experiment Station was established in 1923.

A sizeable shipment of rooted cuttings of Meyer lemon were received from the Plant Quarantine greenhouses of the U.S.D.A. in 1924. Some of this same shipment went to the Substations at Beeville, Angleton, and Beaumont where the hardier types of citrus were being grown at that time. The hedge row planting of these dwarf Chinese (Meyer) lemons at the Valley Experiment Station attracted a great deal of attention because of the big crops of smooth juicy lemons produced by these small trees.

Many trees of this variety were propagated for use in dooryard plantings; but commercial producers became interested in the variety, and rather extensive commercial plantings were made during the early "thirties". A Meyer Lemon Grower's Association was formed at Mercedes to assist in marketing this new type of lemon that required no "curing" period to release its juice. However, the marketing of colored Meyer lemons was not successful, and the idea of green-ripe lemons didn't go over too well. The mature green fruit is thin skinned, very juicy, and has very tender pulp. It is a poor shipping variety, but has been in fairly good demand for processing. Appreciable quantities of the canned and chemically preserved juice of Meyer lemons have been sold. The development of a frozen concentrate industry in this area might create a demand for this cold resistant, juicy type of lemon.

It was soon discovered that the original type of Meyer lemon was easily started from cuttings but appeared to be incompatable with the commonly used sour orange root stock. Because of this fact, most of the early plantings were on their own roots. Some trees of Meyer lemon on sour orange understock were planted so that the bud unions were below the surface of the soil. These "scion rooted" trees survived and produced normal crops of fruit even though they were budded on sour orange understocks.

About 1930, a "sour orange tolerant" strain of the Meyer type of lemon was discovered in the Valley. Since this so-called Rickert strain of cold resistant lemon could be budded on sour orange, it became the

most commonly propagated strain. The fruit of the Rickert lemon is not as smooth as that of the original Meyer variety and seems to justify the thought that it might be a seedling of the original strain. The fact that mild Tristeza virus has been found in the original introduction and not in its "offspring" lends credence to this idea. A program is under way to certify trees of Meyer lemon which are free of the Tristeza virus. Such trees can be used as sources of propagating material for expanding Meyer lemon plantings in the Valley.

Pre-Emergence Investigations With Alanap-1 (N-1 naphthy l phthalamic acid) for Weed Control in Cucurbits

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The chemical properties and herbicidal effects of Alanap have been summarized by the United States Rubber Company (1953). Reports from several states have indicated that Alanap is a promising pre-emergence herbicide for weed control in some cucurbits. The first investigations in the Rio Grande Valley were conducted by Livingston (1953). Alanap-1, -2, and -5 were effective in controlling careless weeds (*Amaranthus* spp.) and Johnson grass (*Sorghum halepense*) in cantaloupe plantings. Gausman, Cain and Cowley (1953) likewise obtained good weed control in cantaloupe plantings. All Alanap formulations significantly decreased the number of careless weeds and bur-grasses (*Cenchrus pauciflorus* Benth.). Alanap-1 was the most effective formulation.

This paper presents results of trials conducted during the fall of 1953 to further evaluate Alanap-1 as a pre-emergence herbicide for weed control in cucurbit plantings.

Materials and Methods

A split-plot design with treatments in quadruplicate was employed. Rates of Alanap-1 served as the main plots, and plantings of different cucurbits were given sub-plot status. Control plots were arranged for nonorthogenal comparisons with rates of Alanap-1 and plantings of different cucurbits. Individual plots consisted of a bed 18 inches wide and 15 feet long. Replications were separated by borders 5 feet in width.

Alanap-1 was applied as a pre-emergence spray directly after planting four kinds of cucurbits in a Willacy fine sandy loam soil on October 1. Equivalent acre rates were 4 and 8 pounds of Alanap-1 in 100 gallons of water. The cucurbits planted were cucumbers (Marketer), watermelon (Black Diamond), squash (Caserta), and cantaloupe (Imperial 45).

Plots were irrigated approximately 2 hours after the spray application. In addition, 1.75 inches of rain fell during the period of October 3 to 5. The average soil temperature (6 inches below the soil surface) was approximately 23 degrees C. during the time between planting and emergence of the cucurbits.

Results and Discussion

Results of weed and grass counts made October 19 and 28 are depicted in Table 1. It is noteworthy that almost perfect control of careless weeds was effected, compare treated plots with control plots. No statistical difference of significance occurred between times of plant counts.

The control of careless weeds was still excellent at the time the experiment was terminated, which was 36 days after initiation. The 8 pound rate of Alanap-1 usually tended to decrease the number of careless weeds when compared with the 4 pound rate of the October 28 plant counts. Differences between the two rates were small, but they were of statistical significance. It is evident, however, that the main contributions to significant variance were differences between controls and treated plots.

A fair evaluation of Alanap-1 regarding its herbicidal action on grasses can not be made in this experiment. Table 1 reveals that more grasses were present in treated plots than in control plots. The profuse and rapid growth of careless weeds in the control plots probably eliminated the grasses by competition for light and other growth factors.

It has been noted by Livingston (1953), Gausman *et. al.* (1953) and other investigators that Alanap-1 induces a stunting of cantaloupe plants for a short time after germination. Recovery, however, has been found to be rapid unless other depressing factors such as a severe nematode infestation are present. Results of this experiment revealed different tolerances of cucurbits to Alanap-1 as a pre-emergence spray. The emergence and growth of the Caserta variety of squash was greatly retarded and recovery did not occur with either the 4 or 8 pound rate of Alanap-1. However, the Marketer variety of cucumber, the Black Diamond variety of watermelon, and the Imperial 45 variety of cantaloupe were not affected to any appreciable degree by the 4 pound rate of Alanap-1. Some retardation in emergence did occur with the 8 pound rate of Alanap-1 on all cucurbits.

Table 1. Number of careless weeds and grasses per square foot of bed surface[1] after spraying with Alanap-1 at 4 and 8 pounds per acre.

	Watermelon		*Cucumber*		*Cantaloupe*		*Squash*	
Date of counts	*Careless weeds*	*grasses*[2]	*Careless weeds*	*grasses*	*Careless weeds*	*grasses*	*Careless weeds*	*grasses*
				8 lbs. per Acre				
Oct. 19	1.5	.25	.2	.8	4.5	0	.5	.2
Oct. 28	.47	.34	.8	1.0	.15	.4	.4	.7
Control	20.3	0	25.3	0	21.0	0	23.3	0
				4 lbs. per Acre				
Oct. 19	.3	1.2	.2	1.3	.7	1.9	.5	.2
Oct. 28	.8	1.1	.2	1.5	.6	.75	.2	.57
Control	20.3	0	25.3	0	21.0	0	23.3	0

L.S.D. for comparison of date of counts of carlesss weeds with appropriate controls.

P ⟨ .05 – 2.2 careless weeds
P ⟨ .01 – 2.9 careless weeds

[1]Average of 4 replications of three quadrat readings per plot.
[2]Dominant grass was nut grass (*Cyperus rotundus* L.).

Summary

Alanap-1 is a promising pre-emergence herbicide for the control of careless weeds (*Amaranthus* spp.) in plantings of cucumbers, watermelon, and cantaloupe in the Lower Rio Grande Valley. Alanap-1 at 4 pounds in 100 gallons of water per acre gave almost perfect control of careless weeds for a period of 36 days at which time the experiment was terminated. The 8 pound rate of Alanap-1 caused some retardation in emergence of all cucurbits but this was not true with the 4 pound rate of Alanap-1. The Caserta variety of squash was extremely susceptible to both rates of Alanap-1 and recovery of growth did not occur.

Acknowledgement

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Weeding Carrots and Related Crops with Oil Sprays

W. H. Friend, *Associate County Agent*

Grower interest in the use of labor saving, selective, herbicides to weed carrots and related crops dates back about ten years. The shortage of farm labor during the war years tended to focus grower attention on any procedure that would reduce the amount of hand labor required to grow a crop. Hand weeding was definitely the most costly item in the proudction of carrots and parsley. These crops are so constituted that they are resistant to mineral oils which are toxic to most weeds and grasses. This selective action of certain petroleum oils on weed and grass seedlings that are usually found intermingled with drill plantings of carrots, parsley, dill, and celery is the basis for the spraying programs to control weeds in these crops.

The development of efficient, low cost spray rigs for applying low volume – low pressure sprays on row crops helped to popularize the idea of using selective, herbicidal sprays. Such power spray rigs are usually equipped to apply from 5 to 10 gallons per acre of insecticidal spray, at pressures around 40 pounds per square inch, on row crops. By reducing the number of nozzles and by changing the nozzle tips and screens, these low volume rigs can be converted to medium volume applicators that will apply from 40 to 60 gallons of spray per acre at pressures ranging from 30-40 pounds per square inch.

The earlier spraying was done with stove oil; but it soon developed that certain types of cleaning naphthas did a better job, and they left no objectionable oily residue on the crop. The smelly types of petroleum fractions must be used before the carrots pass the four-leaf stage to avoid oil contamination of the mature crop. However, the high flash naphthas with relatively low aromatic content, can be safely used at a much later stage in the development of the crop. Naphthas cost more by the gallon than stove oil but fewer gallons per acre are required to control weeds than are required with the cheaper fractions. The amount required will depend on the size of the weeds, and may range from 15 to 40 gallons per acre. Since these quantities are applied on from 30 to 65 per cent of the land area, the actual rate might be as great as 60 gallons per acre in the sprayed strips. It is customary to spray bands about 12 inches wide on single rowed carrots and 24 inches wide on those planted in double rows.

Nozzle tips that throw an 80 degree, fan shaped spray are preferred for the application of herbicides. Coarser screens than those used for low volume applications of insecticidal sprays are desirable. The orifice size of the tips must be large enough to permit the passage of the necessary volume of oil at pressures around 40 pounds per square inch and at practicable working speeds for the tractor.

Best results are secured when the naphtha spray is applied after the dew has disappeared from the plants. Late afternoon is the preferred time. However, wind interference is frequently a factor late in the day; and it may be necessary to apply the oil spray on damp plants. Placing the nozzles close to the plants (12 inches above the ground line) and the use of hoods on the spray booms will tend to minimize the undesirable effects of excessive wind movement.

The idea of weeding carrots with selective oil sprays has made it possible for the Valley to develop a carrot production enterprise which occasionally occupies 36,000 acres of irrigated land.

Weeding Onions with Sulfuric Acid Spray

Jack L. Hubbard, *Texas Agricultural Experiment Station, Weslaco*

Sulfuric acid has been known to possess herbicidal properties for many years. Some of the earliest workers in the weed control field reported the use of this material but for unknown reasons, it never was used to any great extent. In 1935, research workers in California first reported its value as a selective herbicide on onions. New York State Experiment Station workers found it to be satisfactory for killing most of the weeds growing on the muck soils in that State.

Excessive hand weeding costs in onion production in the Lower Rio Grande Valley of Texas pointed up the need for a cheap yet satisfactory weed control program for this crop. Hand weeding costs often are the difference between profit or loss at the end of the season.

In the fall of 1952, an intensified weed control program on onions was started at the Texas Agricultural Experiment Station at Weslaco. Several chemicals were used but dilute sulfuric acid gave the best results over a wide range of conditions. Sulfuric acid is not the complete answer to weed problems in onions but will give satisfactory results when properly applied. The search for a better and more satisfactory chemical will continue.

Sulfuric acid acts as a selective herbicide killing most of the annual broad-leaved weeds found growing in onions. The upright growing habit, waxy covering and concealed growing point tend to prevent the onion plants from being seriously damaged by the acid spray. Grasses are not easily killed since they too grow upright and have a concealed growing point. The major weed found growing in this area is pigweed (*Amaranthus sp.*). Fortunately, the pigweed is easily killed by dilute sulfuric acid spray.

Tests have shown that a 4 percent by volume sulfuric acid spray, made from concentrated (66° Baume') sulfuric acid and water, applied at the rate of 60 gallons to the acre, will give good weed control. It is essential that the 66° Baume' acid be used since weaker acid will not give satisfactory control.

The dilute acid should be thoroughly mixed in a crock or wood container before putting it in the spray tank. When mixing acid and water always pour the acid into the water and never pour water into concentrated acid. Concentrated acid should be handled with caution since it can cause severe burns and is destructive to most clothing. The dilute 4 percent spray can destroy cotton, silk and rayon clothing, but it is not harmful to the skin of the operator. It is a good practice to always have a supply of fresh water nearby in case some of the concentrated acid gets on the operator.

The spray may be applied with most low volume sprayers with a few modifications. There should be one nozzle above each row of onions. Fan type nozzles with a large enough orifice to give 60 gallons per acre have given best results. Best operating pressure has been 60 psi but 40 to 60 psi are adequate. Complete coverage of the weeds with the spray is necessary for good weed control.

Sulfuric acid may be used to a very good advantage as a pre-emergence weed killer in onion fields. Many weeds will germinate before the onions and they are easily killed at this time. The grower should watch his fields and if weeds are up ahead of the onions, apply a 4 percent sulfuric acid spray at the rate of 60 gallons to the acre. It is important to wait until the day before the onions start emerging for this pre-emergence spray in order to kill more of the weeds. This practice has been very satisfactory in many Valley fields and has reduced hand weeding costs significantly.

As a post emergence treatment the onions should be approximately three weeks old at the time of spraying. At this age, the first true leaf will be out and the acid spray will have very little affect on the onions. Sometimes the onions may become wilted soon after spraying but will appear fresh and turgid after the first night. If the onions have a tendency to lay down within an hour after spraying, more than likely the spray concentration is too strong.

Sulfuric acid is corrosive to most metals thus making it necessary to follow a few rules when using it. The acid should never be left in the sprayer after use. It is advisable to pump fresh water through the sprayer and then a neutralizing solution at the end of each day. Galvanized or zinc containers should never be used since the acid is very active on these metals and will weaken the spray concentration.

Control of Some Lepidopter us Larvae Which Attack Vegetables

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Various species of lepidopterous larvae are very destructive to vegetables. Because of the great amount of damage caused by these insects, growers are not willing to allow these infestations to develop to the point at which they can be used for undertaking control experiments. However, a number of experiments were conducted during the past three years, and are reported in this single paper.

Diamondback Moth Larvae, *Plutella maculipennis* (Curt.)

An infestation of diamondback moth larvae, *Plutella maculipennis* (Curt.), was found on cabbage in a field that was just beginning to head. A low volume sprayer that used 15 gallons of spray per acre, was used in applying the insecticides at the rate shown in table 1. Each plot was one acre in size and each treatment was replicated three times. Three days after the treatment 10 plants in each plot were selected at random to record the number of surviving larvae. The data in table 1 show that parathion at 0.25 pounds per acre and DDT at 0.5 pounds per acre gave excellent control of the diamondback moth larvae while aldrin, at 0.5 pound per acre, failed to give commercial control.

Cabbage Looper, *Trichoplusia ni* (Hbn.)

Until the fall of 1951 cabbage loopers were easily controlled with DDT. Wene (1949) obtained excellent cabbage looper control with a helicopter application of a 1-percent impregnated DDT dust. Because of the numerous reports of DDT failing to control cabbage looper, two experiments were conducted in order to determine the best insecticide for the control of the cabbage looper. These experiments were conducted in a cabbage field in which the heads were approximately one inch in size. Each plot was 0.02 acre in size. Each of the treatments, shown in tables 2 and 3, was replicated three times. The insecticides were applied with rotary hand dusters at approximately 18 pounds per acre. Three days after treatment applications 20 plants were selected at random from each plot and the surviving number of larvae were counted. The weather was warm for the first day after treatment application in the first experiment whereas cool weather prevailed during the course of the second experiment.

In the first experiment 20 percent toxaphene dust gave much better cabbage looper control than did either 5 or 10 percent DDT dust. Endrin at a 1 percent concentration (which is now considered too low for use as a dust), dieldrin at 1.5 percent, and isodrin at 1 percent were as efficient as 10 percent DDT in controlling the cabbage looper. Parathion dust at 1 per cent concentration failed to give commercial control.

The second experiment was conducted during a period of cool weather as can be seen by the weather data at the bottom of table 3. The 1 per cent impregnated DDT dust did not give the control of cabbage loopers as reported previously by Wene (1949). However, 5 and 10 per-cent concentration of DDT did give commercial cabbage looper control when applied during cool weather. Comparison of this data with that in table 2 gives some supporting evidence to the current idea that DDT

Table 1. Control of diamondback moth larvae on cabbage. 1951.

Insecticide per acre, sprays	*Diamondback moth larvae per plant*	
	Number	*Percent Reduction*
0.5 lbs. Aldrin	0.7	42
0.25 lb. Parathion	0.3	75
0.5 lb. DDT	0.2	83
Untreated	1.2	—

Table 2. Control of cabbage loopers with insecticidal dusts. 1951.

Treatments[1]	*Cabbage loopers per plant*	
	Number	*Percent Reduction*
5% DDT	0.7	41
10% DDT	0.2	83
1% Parathion	0.4	66
1.5% Dieldrin	0.1	91
1% Isodrin	0.2	83
1% Endrin	0.2	83
20% Toxaphene	0	100
Untreated	1.2	—

[1]Maximum temperature following treatments: 1st. day, 86; 2nd. day, 57; 3rd. day, 54.

Table 3. Control of cabbage loopers with insecticidal dusts. 1951.

Treatments[1]	*Cabbage loopers per plant*	
	Number	*Percent Reduction*
1% DDT, Impregnated	0.8	58
5% DDT	0.1	95
10% DDT	0.2	90
5% Rothane	0.4	79
5% Methoxychlor	0.2	90
5% Heptachlor	0.7	63
1% Endrin	0.8	58
Untreated	1.9	—

[1]Maximum temperature following treatments: 1st. day, 57; 2nd. day, 54; 3rd. day, 60.

tends to lose some of its effectiveness during warm weather. Methoxy-chlor and TDE were about as effective as 5 percent DDT whereas endrin was not as effective as DDT under these low temperatures. Heptachlor at a 5 percent concentration failed to give control.

Yellow-striped Armyworm, *Prodenia ornithogalli* Guen., and Corn Earworm, *Heliothis armigera* (Hbn.)

Seedling blackeyed peas are often attacked by yellow-striped army-worms, *Prodenia ornithogalli* Guen., and corn earworm larvae, *Heliothis armigera* (Hbn.). When the peas are small a few of these worms can do a considerable amount of leaf damage. An infestation of both were found on blackeyed peas that were approximately five inches tall. Plots, 0.02 acre in size, were dusted with the treatments shown in table 4. Each treatment was replicated three times. The insecticides were applied with rotary hand dusters at approximately 20 pounds per acre. The next day a fifty foot section of a row from each plot was examined for the number of surviving larvae. The data in table 4 show that 10 per cent DDT and 20 per cent toxaphene dusts gave excellent control of both the yellow-striped armyworm and the corn earworm. Dieldrin at 1.5 percent, and aldrin and heptachlor at 2.5 per cent concentration failed to give commercial control of these insects.

Table 4. Control of yellow-striped armyworms and corn earworms on blackeyed peas. 1953.

Treatments	*Number per 50 feet of row*	
	Yellow-striped armyworm	*Corn earworm*
10% DDT	0.3	0.7
20% Toxaphene	0.7	0.7
1.5% Dieldrin	2.7	3.0
2.5% Heptachlor	4.7	4.7
2.5% Aldrin	5.0	3.3
Untreated	9.0	3.3

Table 5. Control of the variegated cutworm on seedling cotton with low volume sprays. 1951.

Amount insecticide per acre	*Average number dead larvae per square yard*	
	Experiment 1	*Experiment 2*
1.5 lbs. Toxaphene	1.6	1.2
0.37 lb. Aldrin	1.2	0.9
0.37 lb. Heptachlor	—	1.2

Variegated Cutworm, *Peridroma margaritosa* (Haw.)

The variegated cutworm, *Peridroma margaritosa* (Haw.), is a destructive pest of vegetables. Because of the high value of the crop involved many growers will not allow cutworm experiments to be conducted in their fields. In April 1951, severe cutworm outbreaks were noticed in a number of cotton fields. Two experiments were conducted with low volume sprays. The insecticides were applied in 5 gallons of water at the rate as shown in table 5. Each treatment was applied to a single block five acres in size. One and two days after treatment applications a thirty square yard area was selected at random in each plot and the number of dead larvae recorded. The results are shown in table 5. Toxaphene killed more larvae than did aldrin, however, aldrin gave commercial control. In a single test heptachlor was as efficient as toxaphene.

Summary

Good control of the diamondback moth larvae was obtained with DDT and parathion sprays. Aldrin was not as effective as either DDT or parathion.

A 20 percent toxaphene dust gave better cabbage looper control than did DDT. The data indicated that temperatures may be a factor in the efficiency of various insecticides used for cabbage looper control.

A 20 percent toxaphene dust and a 10 percent DDT dust were more effective than 1.5 percent dieldrin, 2.5 percent aldrin or 2.5 percent heptachlor dusts in controlling yellow-striped armyworms and corn earworm larvae attacking blackeyed peas.

Toxaphene, as a spray, gave better cutworm control than did aldrin as a spray. In a single test heptachlor killed as many larvae as did toxaphene.

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Control of the Corn Budworm

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The fall armyworm, *Laphygma frugiperda* (A. & S.), locally called the corn budworm, causes considerable amount of injury to sweet corn. If the sweet corn happens to be a weak growing variety, heavy infestations will sometimes reduce the stand, especially if an infestation occurs when the sweet corn is very small. Other times heavy infestation will give the sweet corn a ragged appearance. Kelsheimer *et al.* (1950) states that vigorously growing corn in Florida will often support an infestation of budworms and make a good crop whereas slow growing corn plants are usually killed by budworms. Brett (1953) obtained excellent control of the fall armyworm with six applications of methoxychlor, endrin and DDT applied as a spray. Hayslip (1948) reported that high volume spray applications of DDT were more effective than DDT applied as dusts. For small acreage Kelsheimer *et al.* (1950) recommends 35 pounds of 5 percent DDT dust per acre, applied with a rotary hand duster and directed into the buds of corn.

The fall armyworm usually feeds in the bud or whorl of the corn plant before it tassels. Because of this feeding habit on young corn growers have considerable difficulty in getting an effective amount of insecticide into the corn bud, especially when the insecticide is applied by airplane. Because of numerous complaints of insecticide failures to control fall armyworms a number of experiments were conducted in order to determine if these failures were due to the insecticides or to the method of applications.

Methods and Results

In the fal lof 1950 a fall armyworm infestation was found in field corn which had not tassled. An Iron Age corn sprayer was used in applying the treatments shown in table 1. The sprayer put out a total of fifty gallons of spray per acre. The nozzles, three in number, were directed towards the corn bud. The treatments were applied twice at an interval of seven days. Each treatment block was an acre in size. Because of the size of the field each treatment was replicated only twice. Seven days after the second application of treatments, ten plants from three areas in each block were examined for the number of living budworms. The data in table 1 show that all treatments gave commercial budworm control, however, parathion at 0.25 pound per acre and DDT at a pound per acre were slightly more effective than toxaphene at one pound. An examination made three hours after the first treatment application showed that parathion had killed 80 percent of the budworms whereas DDT had not affected the budworms in the three-hour period.

Two spray experiments were conducted in the fall of 1953 on field corn which was approximately three feet in height. Each plot consisted of a single row of corn 30 feet in length. A three gallon hand garden sprayer was used in applying the spray at the rate of 100 gallons per acre. The spray was directed towards the bud of the corn plant. Each of the treatments, shown in tables 2 and 3, were replicated three times. Two days after the treatment applications ten plants in each plot were examined for the number of surviving fall armyworms. The data in table 2 show that toxaphene and DDT at the rates used gave excellent control of fall armyworm. Endrin at the rate of 0.1 pound per 100 gallons of water was also effective. Effective control was also obtained with dieldrin, heptachlor, and dilan. The data in table 2 show that gamma benzene hexachloride applied as a spray also gave good fall armyworm control. However, both concentrtions burned the corn leaves, and therefore cannot be considered safe to use on corn. A mixture of .06 pound lindane and 0.28 pound chlordane also gave effective control. Methyl parathion at 0.25 pounds per 100 gallons of water was more effective than toxaphene used at the 1.5 pound rate. Methoxychlor and malathon were less effective than the toxaphene spray.

One dust experiment was conducted in the fall of 1953 on field corn three feet in height. Each treatment plot consisted of a single row of corn

Table 1. Control of fall armyowrms in buds of corn with high volume sprays. 1950.

Amount of Toxicant per 50 gallons water	*Average number Fall Armyworms per 10 plant sample*
0.25 lb. Parathion	1
1.0 lb. DDT	2
1.0 lb. Toxaphene	6
Untreated	34

Table 2. Control of fall armyworms in the buds of corn with high volume sprays. 1953.

Amount of Toxicant per 100 gallons water	*Average number Fall Armyworms per 10 plant sample*
0.1 lb. Endrin	0.3
0.2 lb. Endrin	0
0.3 lb. Endrin	0
0.25 lb. DDT	0.7
0.5 lb. DDT	0
0.2 lb. Dieldrin	1.0
0.4 lb. Dieldrin	0
0.75 lb. Toxaphene	0.7
1.5 lb. Toxaphene	0.3
0.25 lb. Heptachlor	1.0
0.5 lb. Heptachlor	0.0
0.5 lb. Dilan	0.3
Untreated	13.3

30 feet in length. Each of the treatments, shown in table 4, was replicated three times. A small hand plunger type of duster was used in applying a small amount of dust to the bud of each corn plant. The corn plants were spaced three to four inches apart in the rows. Dusts were applied at approximately 35 pounds per acre. Two days after treatment applications ten plants in each plot were selected at random from which the number of surviving fall armyworms were recorded. The data in table 4 show that toxaphene, endrin, dieldrin, heptachlor, and DDT applied as dusts in the concentrations at which they are sold commercially, gave effective fall armyworm control of infestations located in the buds of corn. Pellitized dusts did not have any advantage over the regular formulated dusts in this experiment.

Table 3. Control of fall armyworms in buds of corn with high volume sprays. 1953.

Amount of Toxicant per 100 gallons water	*Average number Fall Armyworms per 10 plant sample*
0.12 lb. gBHC	0.2
0.25 lb. gBHC	0.7
0.25 lb. Methoxychlor	2.3
0.5 lb. Methoxychlor	4.7
0.5 lb. Malathion	3.0
1.0 lb. Malathion	2.3
0.12 lb. Methyl Parathion	4.3
0.25 lb. Methyl Parathion	0.3
0.03 lb. Lindane plus 0.14 lb. Chlordane	3.3
0.06 lb. Lindane plus 0.28 lb. Chlordane	1.0
1.5 lb. Toxaphene	1.0
Untreated	14.3

Table 4. Control of fall armyworms in buds of corn with dusts. 1953.

Insecticides	*Average number Fall Armyworms per 10 plant sample*
20% Toxaphene	0.3
20% Toxaphene, Pelletized	0.3
2.5% Heptachlor	0.7
5.0% Heptachlor	1.3
5.0% Heptachlor, Pelletized	0.3
2.5% Dieldrin	0.0
5% Dieldrin, Pelletized	1.3
2.0% Endrin	0.0
2.5% Aldrin	1.0
5% DDT	0.7
10% DDT	0.3
Untreated	18.0

The data in these experiments indicate that the commonly used insecticides will control the fall armyworm or budworm in corn. Failures in commercial plantings are probably due to the method of application rather than the insecticide used.

Summary

The following insecticides gave effective control of fall armyworms in the buds of corn: Endrin; DDT; dieldrin; heptachlor; toxaphene; parathion; methyl parathion; and a mixture of lindane with chlordane. Methoxychlor and malathion were less effective than the above mentioned materials.

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Earworm Control with DDT, Oil and Water Emulsions Sponged on Individual Ears

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Most of the sweet corn grown in the Lower Rio Grande Valley is treated for earworms with the sponge method as described by Wene and Blanchard (1953). The method consists of dipping a small synthetic rubber sponge in a solution of 0.5 percent DDT in mineral oil and then pressing the sponge on top of the milk mass until 1 ml. of the solution runs into the silk mass. It is recommended that this treatment be applied nine days after the first silk appears. Timing is very important because if the DDT-oil solution is applied too early the oil will prevent kernel development on the ear tip. If applied after the recommended time the earworm control will not be as good as desired. Because of the possibility of oil damage to ear tips, growers have been delaying treatment applications 2 or more days longer than has been recommended and as a result have been obtaining poor earworm control. Wene and Blanchard (1949) with high pressure sprayers obtained excellent earworm control with emulsions containing DDT, water and a low concentration of oil. A series of experiments were conducted to determine whether or not DDT-oil emulsions, containing low concentrations of oil, would fit into the sponge method control program.

Materials and Methods

The DDT-oil emulsions and DDT-oil solutions were made in gallon lots in the proportions shown in the tables. Emulsifiable formulations of DDT, endrin, and EPN were used. The oil used was a white mineral oil with a 65 second Saybolt viscosity. The emulsifiers used were commercial products obtained locally.

The DDT-oil solutions were applied with the sponge at the rate of one ml. per silk mass whereas the DDT-oil emulsions were applied at approximately two ml. per silk mass per treatment application.

All the experiments were conducted in fields of sweet corn which had been planted to the hybrid, Calumet. A plot consisted of a single row of corn 30 feet in length. Each treatment was replicated four times.

Data was taken two days before the corn was harvested. A fifteen ear sample was taken from each plot. Notes were taken on the percent of earworm damage, effect of treatments on pollination, oil injury on ear tips, and effect of treatments on ear husks.

Discussions

Emulsions made from DDT, oil and water were very unstable, with the oil separating as soon as agitation was discontinued. Consequently, these emulsions can be used for sponge applications only if they are constantly agitated. Laboratory tests showed that an addition of a 1 percent concentration of a common emulsifier will prevent the oil from separating for a period of thirty minutes.

In the first experiment various concentrations of oil and emulsifier, Triton X 155, were used in a one percent DDT-oil emulsion for earworm control. The formulations used in this experiment are shown in table 1. The emulsion treatments were applied with a sponge on the following dates: April 13, when 34 percent of the plants were in silk; 2nd. application on April 15, when 55 percent of the corn plants were silking; with the third application being applied on April 18 when 95 percent of the plants were in silk. On April 20, the plants in one series of plots were sponged with the regular one percent DDT-oil solution treatment.

The single application of the DDT-oil solution caused an inch and half oil injury on the ear tips but did not damage the husks. The emulsion treatments which contained triton X 155 damaged the husks even in those formulations which contained no oil. The damage was actually a burning on the husks near the tip of the ear. A combination of 7.5 and 5.0 percent oil with various concentrations of Triton X 155 prevented pollination.

In the second experiment 0.25 percent concentrations of various emulsifiers were added to an emulsion consisting of 1 percent DDT, 10 percent oil and water. These emulsions were applied by the sponge method. The plots receiving three applications were treated on April 24,

Table 1. The effect of Triton X155 on the efficiency of various DDT-oil emulsion formulations "sponged" on for the control of the corn earworm.

Formulation				Percent	
Percent DDT	Percent oil	Percent Triton X155	Percent water	worm-free ears	Notes
1	7.5	0.5	91.0	80	Husk injured; poor pollination
1	5.0	0.5	93.5	90	Husk injured; poor pollination
1	2.5	0.5	96.0	71	Husk injured
1	0	0.5	98.5	23	Husk injured
1	7.5	0.25	91.25	90	Husk injured; poor pollination
1	5.0	0.25	93.75	85	Husk injured; poor pollination
1	2.5	0.25	96.25	83	Husk injured
1	0	0.25	98.75	65	Husk injured
1	7.5	0.13	91.37	85	Husk injured; poor pollination
1	5.0	0.13	93.87	83	Husk injured
1	2.5	0.13	96.37	83	Husk injured
1	0	0.13	98.87	37	Husk injured
1	99.0	—	—	90	1.5 inches oil injury on ear tips
Untreated				7	

27, and 30. The plots receiving two treatments were treated on April 27, and 30. The percent of corn silking was: April 24, 55 percent; April 27, 85 percent; while all the corn plants were in silk on April 30. A single sponge treatment of one percent DDT in mineral oil was applied on May 1. Two days before the sweet corn was harvested 15 ears were examined in each plot for earworm injury.

The data in table 2 show that two applications of DDT-oil will give better earworm control than a single application of the DDT-oil solution. Furthermore, the DDT-oil emulsion applications caused less oil injury on ear tips than the straight DDT-oil solution. The addition of emulsifiers to the DDT-oil emulsions stabilized the emulsions so that very little agitation was required. However, Triton X 177 and Atlox 2081 gave some objectionable husk injury and increased the amount of oil injury on the ear tips slightly, indicating deepr emulsion penetration in the silk mass by the emulsions. No husk injury was noticed when Visco 2086 was added to the emulsion. In these plots there was little or no oil injury on the ear tips.

Timing is very important in the single application of DDT-oil solution sponged onto the silk mass. In experiment 3, as shown in the data in table 3, 70 percent worm-free ears were obtained when sponged on

Table 2. The effect of emulsifiers on DDT-oil emulsions used for the control of the corn earworm.

Treatments	Number applications	Percent worm-free ears	Notes
1% DDT, 10% Oil, water	2	85	0.25 inches oil injury on ear tips
	3	92	0.5 inches oil injury on ear tips
1% DDT, 10% oil, 0.25% Visco 2086, water	2	83	
	3	98	
1% DDT, 10% oil, 0.25% Triton X177, water	2	86	0.5 inches oil injury on ear tips; husk damaged
	3	86	1.0 inches oil injury on ear tips; husk damaged
1% DDT, 10% oil, 0.25% Atlox 2081, water	2	92	0.5 inches oil injury on ear tips; husk damaged
	3	98	1.0 inches oil injury on ear tips; husk damaged
1% DDT, 99% oil	1	67	1.5 inches oil injury on ear tips
Untreated	—	0	

April 29. Only 33 percent worm-free ears were obtained when the treatments were delayed one day. The data also show that an application of an DDT-oil emulsion when 77 percent of the corn plants are silking will improve the efficiency of the DDT-oil solution, especially when the DDT-oil solution is delayed a day or so. Furthermore, delaying the DDT-oil solution application a day will decrease the amount of oil injury on the ear tip. The data in table 3 also show that an emulsion containing one percent DDT, 50 percent oil, and 49 percent water was as effective as the

Table 3. Effect of early sponge applications of a DDT-oil emulsion on the efficiency of the recommended sponge application of the DDT-oil solution for the control of the corn earworm.

Treatments	*Date of application*	*Percent corn in silk*	*Percent worm-free ears*	*Inches oil damage on ear tips*
1st. appli., 1% DDT, 10% oil, water	4-23	77		
2nd. appli., 1% DDT, 99% oil	4-27	97	100	2.0
1st. appli., 1% DDT, 10% oil, water	4-23	77		
2nd. appli., 1% DDT, 99% oil	4-28	100	98	1.5
1st. appli., 1% DDT, 10% oil, water	4-23	77		
2nd. appli., 1% DDT, 99% oil	4-29	100	90	0.5
1st. appli., 1% DDT, 10% oil, water	4-23	77		
2nd. appli., 1% DDT, 50% oil, water	4-27	97	95	1.5
1st. appli., 1% DDT, 10% oil, water	4-27	77		
2nd. appli., 1% DDT, 50% oil, water	4-28	100	97	0.8
1st. appli., 1% DDT, 10% oil, water	4-27	77		
2nd. appli., 1% DDT, 50% oil, water	4-29	100	90	0.8
1% DDT, 99% oil	4-28	100	70	1.0
1% DDT, 99% oil	4-29	100	33	1.0
Untreated	—	—	0	—

straight DDT-oil solution. However, it was very difficult to keep the oil from separating.

In table 4 the data show that an emulsion containing 5 percent oil may be used for the early application. The data also indicates that an emulsion containing 33 percent oil may be substituted for the DDT-oil solution for the second application. Data in the table 4 show that at one percent concentrations endrin and EPN were as effective as DDT when sponged on in oil solutions.

Results indicate that sweet corn growers can sponge their corn with an emulsion of one percent DDT, five percent oil and water when approximately half their corn plants are silking, and then apply the regular DDT-oil application for better earworm control. However, the emulsion must be constantly agitated in order to prevent separation of the oil from the water.

Table 4. Effect of an early sponge application of a DDT-oil emulsion on the efficiency of the recommended sponge application of the DDT-oil solution for the control of the corn earworm.

Treatments	*Date of application*	*Percent corn in silk*	*Percent worm-free ears*	*Inches oil damage on ear tips*
1st. appli., 1% DDT, 5% oil, water	4-15	55		
2nd. appli., 1% DDT, 99% oil	4-19	96	97	2.0
1st. appli., 1% DDT, 5% oil, water	4-15	55		
2nd. appli., 1% DDT, 99% oil, water	4-21	100	97	1.5
1st. appli., 1% DDT, 5% oil, water	4-15	55		
2nd. appli., 1% DDT, 33% oil, water	4-19	96	98	0.5
1st. appli., 1% DDT, 5% oil, water	4-15	55		
2nd. appli., 1% DDT, 33% oil, water	4-21	100	93	0.5
1% DDT, 99% oil	4-21	100	88	1.5
1% EPN, 99% oil	4-20	100	95	2.0
1% Endrin, 99% oil	4-20	100	92	2.0
Untreated	—	—	0	—

Summary

Good control of the corn earworm has been obtained with 2 or 3 sponge applications of an emulsion containing one percent DDT, 10 percent oil, and water.

Growers who sponge their corn with an application of one percent DDT in 99 percent mineral oil would obtain more earworm-free ears if an emulsion, containing one percent DDT, five percent oil and water, is sponged on the silk masses when approximately half the plants are in silks.

Addition of emulsifiers to the emulsions will prevent the oil from separating. However, more work must be done to determine which materials can be used safely on corn plants.

Endrin and EPN at one percent concentrations were as effective as the same concentration of DDT, when used in oil and sponged on for the control of the corn earworm.

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Lesser Cornstalk Borer Injury to Blackeyed Peas

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The lesser cornstalk borer, *Elasmopalpus lignosellus* (Zell.), causes considerable amount of damage to blackeyed peas and canning beans in the Lower Rio Grande Valley. This insect has also caused severe damage to newly emerged stands of corn, sorghum and broom corn which had been planted in the fall. Johnsongrass, *sorghum halepense,* is a favorite host of this insect. Crosley and Leonard (1918) recommend clean cultural practices prior to planting of susceptible crops as a method of controlling this insect.

Injury

The larva of lesser cornstalk borer does its greatest damage to blackeyed peas in the seedling stage of growth, especially when the stems are succulent and hollow. The larvae bores into the stem of the bean seedling approximately one inch below the soil surface, usually eating up the stem to where the leaves branch. When not feeding the larva can be found in a silken tube, which is covered with fine particles of sand and attached to the larval entrance at the base of the seedling. The feeding of the larva kills the plant in a short time, and many times seedlings have been found in a wilting stage three or four days after they have emerged from the soil. When the seedling has reached the wilting stage the larva will leave the plant through the exit hole and move through the soil to a healthy plant. If the larva is fully developed it may make an exit hole in the stem just below where the leaves branch off from the stem. All the larvae observed damaging seedling blackeyed peas were almost mature.

Occasionally lesser cornstalk borer larvae will damage half grown or older blackeyed peas. The larvae bore into the stalk approximately 2 or 3 inches above ground level. The larvae will then feed just under the epidermal layer, forming tunnels as they feed. Only one larva was found in a tunnel. These tunnels are usually directed upwards, although a few will circle the stem. This feeding destroys the cambium layer, and as a result plant growth is retarded, and sometimes the plant may be killed. Larvae in all stages of growth have been found, which leads one to assume that infestations start from eggs laid on the bean stalks.

Ecological Notes

As stated before the injury to blackeyed pea seedlings is done by mature larvae. A number of pea and bean fields were seen damaged by the lesser cornstalk borer larvae three or four days after the plants had emerged from the ground. It was obvious that larvae were in the soil at the time the seed was planted because there wasn't enough time in the four day period after the beans had emerged for the eggs to be laid, hatched, and the larvae to reach maturity. Diggings in a severely injured field showed the presence of partly decayed Johnson-grass with lesser cornstalk borer larvae feeding on it. Furthermore, eight days after a field of seedling blackeyed peas had been destroyed a soil examination revealed the presence of lesser cornstalk borer larvae at a depth of three to four inches.

Field observations showed that the lesser cornstalk borer were more destructive in fields which had previously been planted in sorghum or which had been allowed to produce a growth of Johnson-grass following a spring vegetable crop, such as tomatoes. Very little injury was noticed in blackeyed pea fields which had been planted on fallow ground or after a cotton crop. This was well illustrated in a 20 acre pea field observed in late September, 1952. Five acres of this field previously had been an old citrus orchard with a rank growth of Johnson-grass while the remaining 15 acres had been planted in cotton. Less than one percent of the peas following cotton were injured by the lesser cornstalk borer. In the section which had previously been in orchard and had had a rank growth of Johnson-grass an estimated 40 percent of the seedlings had been destroyed. Furthermore, in the old orchard area one could dig in the soil and find half decayed pieces of Johnson-grass with some lesser cornstalk borer larvae while none were found in the section which had cotton prior to planting.

Mature lesser cornstalk borer larvae were placed in pill boxes with very dry soil, soil that had sufficient moisture to plant blackeyed peas, and soil that contained so much water that it was muddy in texture. No food was placed in these boxes. The data in table 1 show that the greatest larval survival was in the moist soil. Adults emerged in a shorter time from moist soil than from either the dry or wet soil. Larvae placed in dry soil immediately spun a closed cocoon, while those in moist soil closed theirs three or four days later. The cocoons in the moist or dry soil were usually on the bottom of the container. The larvae which had been placed in muddy or wet soil did not make cocoons but pupated on top of the soil, indicating that the lesser cornstalk borer does not like wet soil. These data show that lesser cornstalk borer larvae can exist a number of days in the soil without food. The high mortality of larvae in wet soil supports the belief of many farmers in that a good irrigation will reduce lesser cornstalk borer injury to blackeyed pea seedlings.

Table 1. Effect of soil moisture on development of mature lesser cornstalk borer larvae.

	Dry Soil	*Moist Soil*	*Wet Soil*
Number of mature larvae	15	15	12
Percent emerged as adults	33	53	25
Average life of larvae in the pill boxes with	6.8 Days	9.9 Days	8.2 Days
Average time for larvae to develop into adults	18.5 Days	14.9 Days	18.5 Days

Control Experiments

Prior to 1952 there existed conflicting reports as to the value of insecticidal dusts for the control of lesser cornstalk borer larvae, so a number of experiments were conducted in order to determine the value of the available insecticidal dusts for the control of this insect. The dusts were applied with rotary hand dusters, at approximately 25 pounds per acre, as soon as lesser cornstalk borer injury appeared on blackeyed peas. In the majority of the experiments the treatments were applied only once. However, in two experiments the treatments were applied twice at three day intervals. The following insecticides applied as dusts failed to give control: 2.5 percent concentrations of aldrin and dieldrin; 5 percent concentrations of chlordane and heptachlor; 20 percent toxaphene; 1 percent parathion; and 3 percent gamma benzene hexachloride.

Since the lesser cornstalk borer larvae bores into the pea plant an inch or so below the ground level an experiment was designed to test the value of seed treatments and of planting seed in a band of insecticide. Each treatment plot consisted of a row three feet in length and spaced three feet apart. Each treatment was replicated three times. A small furrow, three inches in depth, was dug the entire length in each row-plot. The first type of treatments consisted of dropping seed one inch apart in the furrow and then placing a band of insecticide, at the rates shown in table 2, over the blackeyed pea seed, and then covering the seed immediately. In the other types of treatment the seed was mixed with the insecticide, then dropped in the furrow and covered. The treatments are shown in table 2. As the seedling emerged from the ground the lesser

Table 2. Effectiveness of various insecticides in controlling lesser cornstalk borer injury to blackeye peas.

Insecticide	*Method of applications*[1]	No. of Plants *per yard*[2]
100 lbs. 2.5% Aldrin	Furrow, on seed	7.0
200 lbs. 2.5% Aldrin	Furrow, on seed	10.0
100 lbs. 1.5% Dieldrin	Furrow, on seed	8.5
100 lbs. 5.0% Heptachlor	Furrow, on seed	13.0
100 lbs. 20.0% Toxaphene	Furrow, on seed	4.3
1 lb. 2.5% Aldrin	Mixed with bushel seed	8.3
1 lb. 2.5% Dieldrin	Mixed with bushel seed	7.3
2 oz. 25% Lindane dust	Mixed with bushel seed	13.0
Untreated		13.7

[1]Planted on September 18, 1952
[2]Data taken on September 30, 1952

cornstalk borer larvae injured a large number, which then dried up and as a result it was impossible to obtain an accurate count of the number of seedlings destroyed; so data were then taken on the number of seedlings which survived. The data in table 2 show that seed treatments with insecticides, and insecticides placed in a band over the seed failed to control lesser cornstalk borer injury.

Summary

The lesser cornstalk borer injury to blackeyed peas is described. Injury was more severe in fields which had a previous growth of Johnsongrass or sorghum than fields which were fallow prior to the planting of blackeyed peas.

Insecticides applied as dusts to newly emerged bean seedlings failed to give control. Dusting the seed prior to planting was of little value.

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Crease-Stem Abnormality of Tomato

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This abnormality apparently occurs only in Rutgers or very similar varieties. It has been called Rutgers bunchy top or short-internode abnormality. However, it deserves the descriptive name, crease stem, given to it in Florida.

The main symptoms are very short joints between the leaves on the stems, very compact bunchy appearance of the plants, and rigidly upright stems. The upper part of each main stem usually has a flattened spot with deep longitudinal crease or groove. Some of the creases extend through the stems like slit-windows. When the stems are cut lengthwise through the slits or creases, some brown discoloration or hollow areas are found in the pith. The affected plants are very late in producing fruits and the fruits have relatively few seeds. Late in the growing season, the tops of the crease-stem plants grow rapidly, so abnormal plants become difficult to identify. The symptoms usually appear about the time that the normal plants begin to bloom in the field.

Crease stem apparently is caused by the unusual response of Rutgers tomatoes to excellent growing conditions with abundant nitrogen, water and moderate temperatures. It is a physiologically very active variety with extra luxuriant vines, but it is less fruitful than many other varieties when conditions do not favor fruitfulness.

Crease stem can be avoided by growing varieties other than Rutgers. Stokesdale was immune to crease stem when it was growing in a field in which one third of the adjacent Rutgers tomatoes had crease stem. Avoiding excess nitrogen fertilizer and irrigation water early in the growing season may minimize crease stem in Rutgers tomatoes.

Containers Used to Ship Vegetables in Mixed Carload From the Lower Rio Grande Valley, 1951-52 Season

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All vegetables are represented in rail shipments of mixed vegetables. Rail shipments of mixed carloads of vegetables comprised 34.2 per cent of the rail movement of vegetables from the Lower Rio Grande Valley during the 1951-52 season. Between 1920-1952, over 200,000 cars of mixed vegetables were shipped from that area, an average of over 6,000 cars per year with a peak of 11,436 cars in 1944. The 1951-1952 movement was below 1944 with but 5,431 actual cars shipped, as reported in Texas Agricultural Experiment Station Progress Report 1616.

In the 1951-52 vegetable shipping season 31 vegetables were shipped in 11 named types of crates[1]. These named types are: cauliflower crates, lettuce and vegetable crates, pepper crates, radish crates, vegetable crates, wirebound vegetable crates, baskets, bushel hamper, sacks and two different types of cabbage crates.

In Table 1 it is shown that the lettuce and vegetable crates were the most extensively used with almost 40 per cent of the total or over a million containers. This was followed by the sacks with 24 per cent and the vegetable crates with 14 per cent. The cabbage crate, container 365, was exclusively for cabbage with 2.5 per cent for a total of 68,709 containers.

Cauliflower, dandelions, egg plant, endive, escarole, okra, peas (field and green), squash, turnip greens, collards, dill, kohlrabi, mustard, root parsley are shipped only in the vegetable mixed cars because of smaller production and demand. The basket is the most important container for these vegetables as shown in Table 2.

This is followed by the lettuce and vegetable crates with 33 per cent and the vegetables crates with 16 per cent and the cauliflower crates represented 10 per cent of the containers used to ship these minor crops. The above 4 types of containers represent the major percentage of the containers used for these vegetables.

The most important vegetables with distribution by type of character is shown in Table 3. All of the vegetables are shipped principally in one to four types of containers. The cabbage crate No. 365 is used exclusively for cabbage. The cauliflower crates are used principally for broccoli and radishes. Carrots, beets and turnips are the crops that are shipped in the lettuce vegetable crates. Parsley and radishes are the only crops using the vegetable crate.

[1]Work for the 1952-53 season will include the contents of the straight car and truck shipments.

Table 1. Containers used for shipping vegetables in mixed cars from the Lower Rio Grande Valley. 1951-52 season[1].

Containers by Name and Code Number		*Number*	*Percent*
Cabbage crates	365	68,709	2.5
Cauliflower crates	401	116,968	4.2
	404	29,525	1.1
Total		146,493	5.3
Lettuce and vegetable crates	926	587,740	21.4
	929	285	[3]
	930	10,257	.4
	935	6,909	.2
	950	484,345	17.7
Total		1,089,536	39.7
Pepper crates	1417	1,835	.1
Vegetable crates	1700	396,773	14.4
Wirebound vegetable crates	4050	8,845	.4
	4052-A	1,187	[3]
Total		10,032	.4
Cabbage crates	5102	186,601	6.8
Sacks	7500	668,458	24.4
Baskets	8026	53,209	1.9
	8035	94,572	3.5
	8050	14,382	.5
Total		162,163	5.9
Radish crate		10,329	.4
One bushel hamper	8501	2,437	.1
Total No. containers		2,743,366[2]	100.0

[1]Vegetables in report. Cabbage, lettuce, carrots, beets, broccoli, cauliflower, cucumbers, dandelions, eggplant, endive, escarole, okra, onions (dry and green), parsley, peas (field and green), peppers, potatoes, radishes, spinach, squash, turnip greens, turnips, anise, collards, green corn, dill, greens, kohlrabi, mustard, root parsley.

[2]Represents 5858.3 straight carload equivalents, vegetables computed in terms of minimum carload weights of the respective vegetables.

[3]Less than .1 percent.

Summary

Thirty-one different vegetables were shipped in 2,743,366 containers during the 1951-52 vegetable shipping season. These vegetables were shipped in eleven different named types of containers. The lettuce vegetable crate and sacks were the principal containers used accounting for 40 and 24 per cent respectively. The cabbage crate No. 365 was used exclusively for cabbage. Seven vegetables: cabbage, carrots, beets, broccoli, parsley, radish and turnips were packed in 82 per cent of the movement of vegetables shipped in mixed cars for the 1951-52 season.

Table 2. Containers used for vegetables shipped only in mixed cars from the Lower Rio Grande Valley. 1951-1952 season[1].

Containers by Name and Code Number		*Number*	*Percent*
Cauliflower crates	401	17,406	9.5
	404	836	.5
Total		18,242	10.0
Lettuce and vegetables crates	926	36,997	20.5
	929	215	.1
	930	547	.3
	935	73	[3]
	950	21,796	12.0
Total		59,628	32.9
Vegetable crates	1700	29,797	16.4
Wirebound vegetable crates	4050	743	.4
Sacks	7500	1,016	.6
Baskets	8026	12,032	6.6
	8035	57,230	31.5
	8050	2,452	1.4
Total		71,714	39.5
1 Bushel hamper	8501	329	.2
Total No. of containers		181,469[2]	100.00

[1]Cauliflower, dandelions, egg plant, endive, escarole, okra, peas (field and green); squash, turnip greens, collards, dill, kohlrabi, mustard, root parsley.
[2]Represents 313.6 straight carload equivalent, vegetables computed in terms of minimum carload weight of the respective vegetables.
[3]Less than .1 percent.

Table 3. Containers used for principal vegetables shipped in mixed cars from the Lower Rio Grande Valley. 1951-52 season.

Containers by Name and	*Code No.*	*Per Cent by Weight* *Cabbage*	*Carrots*	*Beets*	*Broccoli*	*Parsley*	*Radish*	*Turnips*
Cabbage crates	365	8.5						
Cauliflower	401	.1			98.1	.3	1.3	.1
	404			[1]	1.3	.1	40.2	.6
Lettuce and vegetable crates	926	2.7	85.8	2.2	.4			30.2
	929							.1
	930	.4	.8	.3				1.2
	935	.2	.7					.5
	950	4.8	.4	94.3	.2	[1]	.4	20.8
Pepper crates	1417	.2					.2	
Vegetable crates	1700					99.6	45.0	
Wirebound vegetable crates	4050	.4	.1				1.9	
	4052-A	.1						
Cabbage crates	5102	21.7	3.0					
Sack	7500	60.8	7.8	2.8				43.7
Baskets	8026		.3	.3	[1]		1.6	.4
	8035	.1		.1			1.2	1.3
	8050		1.1				.4	
Radish crates	8101						7.8	
I Bushel hamper	8501		[1]	[1]				1.1
		100.0	100.0	100.0	100.0	100.0	100.0	100.0
Straight car equivalent No.		1793.5	1651.5	585.5	301.9	266.6	78.3	339.6

[1]Less than .1 per cent.

Response in Yield of Squash to Different Levels of Nitrogen and Phosphoric Acid

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Information is needed concerning the nutrient requirements of cucurbits for optimum production in the Lower Rio Grande Valley. Observations of research workers in this area have indicated that cucurbits may be particularly responsive to applications of phosphoric acid. This paper presents results regarding responses in yield of squash to different levels of nitrogen and phosphoric acid. The data depicted should be regarded as preliminary but informative for subsequent research.

Materials and Methods

The Early Prolific Straightneck variety of squash was planted September 14, 1953, in a Hidalgo loam soil. Preplanting fertilizers were applied two days prior to planting. The fertilizers were banded approximately two inches aside and two inches below the probable seed area. Nitrogen (N) treatments were 0, 40, 80 and 120 pounds per acre; while phosphoric acid (P_2O_5) treatments were 0, 80, and 160 pounds per acre. The N and P_2O_5 treatments were used alone and in all possible combinations. The N was obtained from 33.5 per cent ammonium nitrate, and 45 per cent superphosphate was used to furnish the P2O5. In addition to the preplanting application of fertilizers, sidedressing treatments with 60 pounds of N from ammonium sulfate were applied to the appropriate plots, October 29, after the first harvest of squash.

The plots in the complete factorial design were in triplicate with replications separated by 7 feet alleys. Plots were 4 rows wide and 48 feet long. The 2 center rows of each plot were harvested for yield determinations. The squash was harvested a total of 7 times, beginning October 27 and ending November 19.

Cucurbit mosaic (*Marmor cucumeris*) became prevalent during the 6th and 7th times of harvesting. Fruits with visible symptoms of mosaic were included with the culls. Fruits free of mosaic and meeting other U. S. Standard specifications were included in the marketable grade.

Results and Discussion

Results are given in Table 1. It is extremely interesting and from a statistical viewpoint highly significant that 80 pound per acre of P_2O_5 without N produced the highest yield of marketable squash, which amounted to 3,974 pounds per acre. One hundred-sixty pounds of P_2O_5 per acre without the addition of N produced 3,644 pounds of squash, but this production was significantly lower than plots where 80 pounds of P_2O_5 were used. The application of N with P_2O_5 decreased the yields in every instance compared with the application of P_2O_5 only.

Table 1. Response of early prolific straightneck squash to differential fertilizers[1].

Pounds per acre of N:	Marketable	Culls	Total	Per Cent marketable	Marketable	Culls	Total	Per Cent marketable	Marketable	Culls	Total	Per Cent marketable	Average of totals
	Pounds of Phosphoric Acid per Acre												
	0				80				160				
0	1,892	485	2,377	79.6	3,974	642	4,616	86.1	3,644	595	4,239	86.0	3,744
100	1,407[2]	338	1,745	80.6	2,328	303	2,631	88.5	2,196	362	2,558	86.0	2,311
140	2,475	664	3,139	78.8	2,131	674	2,805	76.0	2,465	408	2,873	85.7	2,939
180	1,426[2]	293	1,719	83.0	2,182	454	2,636	82.8	2,640	495	3,135	84.2	2,497
Average	1,800	445	2,245		2,654	518	3,172		2,736	465	3,201		2,873

Differences necessary for Statistical Significance

	p = .05	p = .01
N	211 lbs.	278 lbs.
P_2O_5	246 lbs.	324 lbs.
N X P_2O_5	173 lbs.	228 lbs.
Grades X Fertilizer (Percent marketable)	3.2 %	4.3 %

[1]Total of 7 times of harvest and average of 3 replications.
[2]Plots had significantly lower plant populations.

It is also worthy of note that applications of P_2O_5 usually increased the percentage of marketable fruit and that the increase is of statistical significance.

Summary

The results of this experiment indicate that squash is highly responsive to applications of P_2O_5. The highest yield of 3,974 pounds of marketable squash per acre was obtained with the application of 80 pounds per acre of P_2O_5. The addition of N with P_2O_5 decreased yields, but further research is necessary concerning this effect.

Chlorosis of St. Augustine Grass

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Yellowing of St. Augustine grass, *Stenotophrum secundatum,* has been often observed in lawns and golf courses in the Lower Rio Grande Valley. This condition is prevalent during the summer months, and it can usually be corrected by providing ample moisture and nitrogenous fertilizers. A yellowing or chlorosis, however, develops in the fall or spring which is unresponsive to the usual cultural practices. The symptoms are typical to those given by Bonner and Galston (1952) for iron chlorosis. The interveinal areas of the grass leaf become yellow or white; while the veins of the leaf may retain a green color. Cooper (1953) refers to this type of chlorosis as lime-induced chlorosis, since it is associated in this area with alkaline soils which contain high amounts of calcium carbonate.

A series of investigations have revealed that chlorotic St. Augustine grass is highly responsive to foliar applications of ferrous sulfate. Applications of a 0.5 or 1.0 per cent solution of ferrous sulfate in water at rates of 100 or 200 gallons per acre have completely restored a uniform, green

Figure 1. Darker strip in center of photograph depicts portion of lawn which was sprayed five days earlier with a 0.5 per cent solution of ferrous sulfate.

color within 5 days (Fig. 1). The addition of a common household detergent, 1/4 teaspoon per gallon of water, as an adjuvant to the ferrous sulfate solution has been found advisable.

The use of a ferrous sulfate spray is being recommended in this area as a cultural practice for St. Augustine grass in lawns and golf courses. The spray should be applied in the fall or spring months as a preventive measure or when the commonly called iron chlorosis becomes apparent.

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Home Lawns for the Lower Rio Grande Valley

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A beautiful, well cared for lawn, not only adds to the material value of a home but is the basic requirement for an attractive landscape for the home.

Basic requirements such as adapted grasses, proper fertility, adequate water and its wise use, good drainage and correct mowing insure the success of a lawn. Other necessary steps include the establishment and maintenance of the lawn. This paper will attempt to discuss fundamentals in establishment and caring for the turf.

Description of Grasses

BERMUDA (Cynodon dactylon) is a narrow leaved, vigorous growing perennial, with both stolons and rhizomes. It is drouth resistant and a rapid spreader. Bermuda is resistant to most turf diseases. Weeds are not a problem in a properly managed Bermuda lawn. It makes a dense turf when adequately fertilized and mowed frequently at a height of one to two inches.

Bermuda, as a turf grass: (1) does not grow in the shade; (2) turns brown with frost; (3) is more of a nuisance in flower beds and gardens than other turf or lawn grasses.

Bermuda grass may be sprigged, seeded or sod. It should be: (1) seeded at the rate of 1/2 to 1 pound of seed per 1000 square feet; (2) sprigs placed 6 to 12 inches apart; or (3) sodded solid – lay sod as bricks.

ST. AUGUSTINE (Stenotophrum secundatum) is a wide leaved perennial spreading from stolons. It spreads rapidly where sufficient moisture and plant food are available. St. Augustine has a higher water requirement than Bermuda. It is more frost tolerant than Bermuda; however, it will not survive as low temperatures as will Bermuda.

St. Augustine, when supplied with adequate moisture and fertilizer, forms a dense turf, usually crowding out weeds and other grasses. It should be mowed to a height of 1 to 2 inches. St. Augustine spreads from stolons only, therefore, is not a pest in flower beds and gardens.

St. Augustine, as a turf grass: (1) is very susceptible to disease (2) is attacked by chinch bugs, leaf hoppers and at least two species of scale (3) is a coarse textured plant, therefore, forming a coarse lawn (4) will grow in shaded areas.

It does not produce live seeds; consequently must be established by sod or runners. Recommended sodding is by 2 inch blocks placed on 12 inch centers. Sprigging is done by runners either placed 6-12 inches apart or broadcast on prepared seedbed.

St. Augustine is often confused with and mistaken for carpet grass

(Axonopus affinis). The two are easily distinguished if seed heads are present. St. Augustine seed heads are single, flat, short corky spikes. Carpet seed heads are long, slender, heads resembling the inflorescence of crab grass.

Vegetatively, they can be distinguished by their leaves. The leaves of St. Augustine arise from the collar at a quarter angle while carpet grass leaves arise directly from the collar.

BUFFALO (Buchloe dactyloides) is a low growing perennial grass native to south central Texas and areas west and northward. It is a cold, drouth and heat tolerant dioecious plant. It is only recommended for areas where watering facilities are not available. Mowing is not necessary, however, well cared for Buffalo lawns are more attractive than poorly managed Buffalo lawns.

Because the plant spreads by stolons it is not a pest in flower beds or gardens. It does not grow in shaded areas.

Buffalo, as a turf grass: (1) has a dry unattractive appearance during periods of prolonged drouth, in late fall, winter and early spring (2) is not aggressive and may be invaded by weeds and other grasses.

The establishment of Buffalo is by seed broadcast at the rate of 1/2 to 3/4 pounds per 1000 square feet or 4 inch sod blocks placed on 18 to 24 inch centers.

ZOYSIA species, including Japanese lawn grass (Zoysia japonica) and Manila grass (Zoysia matrella) are excellent fine leaved turf grasses if properly handled. Both the Japanese and Manila grasses are adapted to the Lower Valley. Both are considered as slow growers when compared to Bermuda and St. Augustine. Two-inch sod blocks placed on 12 inch centers will require 12 to 24 months to completely cover an area that Bermuda will cover in 1 to 3 months.

Sod blocks is the recommended method of establishing Zoysia.

Zoysia: (1) forms a tough dense turf that is wear resistant (2) grows in the shade (3) requires little mowing. Its water requirement is approximately the same as Bermuda.

CENTIPEDE (Eremochloa ophiurodies), often called "Chinese lawn grass" or "lazy man's grass," is a creeping perennial with medium width leaves. Centipede is intermediate between Bermuda and St. Augustine in many respects; it is more shade tolerant than Bermuda but less than St. Augustine, the width of the leaf and color are also intermediate.

Centipede browns at frost, requires as much water as St. Augustine, and does not withstand low temperatures. It spreads by stolons, therefore, is easily controlled.

Centipede performance has been very eradic. Some users have been well pleased where others failed completely.

The beauty of the lawn depends upon constant care and attention. Four major factors – feeding, watering, aerating and mowing – are involved in maintaining a lawn. These factors are treated separately; however, it must be borne in mind that they are interrelated and cannot be separated in actual practice. None of these factors can be looked upon as more important as another. Inadequate attention to any one of these factors will result in a thin, ragged, unthrifty weed infested sod.

FEEDING, in this paper applies to the application of the major plant foods in their correct proportion.

Knowing the proper time to feed your grass is just as important as knowing what to feed it. Turf requires frequent feedings if it is to remain green and vigorous throughout the growing season. Turfed areas should receive an application of complete fertilizer in the spring and early fall. In general, a fertilizer with a 2-1-1 ratio should be used, and this should be applied at a rate to supply two to three pounds of nitrogen per 1000 square feet. If the lawn is to remain green and vigorous throughout the growing season, one pound of actual nitrogen per 1000 square feet should be added every 30 to 40 days. In addition, the lawn should be watered during preiods of prolonged drouth. Such a feeding program will, of course, necessitate more frequent clippings.

Additional nitrogen may be supplied from one of several sources. Slowly decomposing (organic) forms of nitrogen such as processed sewage sludge or cottonseed meal, while generally more expensive, are more desirable than readily available or soluble (inorganic) types, such as ammonium nitrate, ammonium sulfate and nitrate of soda because they are available longer and they avoid over stimulation. If inorganic types are used, smaller amounts must be applied more frequently than organic types. Inorganic types of nitrogen are likely to burn the grass unless properly handled. Cost of the actual amount of nitrogen contained should be carefully considered. For instance, one could afford to pay twice as much for a sack of ammonium nitrate, which contains 33 percent nitrogen, as for a sack of nitrate of soda which contains 16.5 percent nitrogen.

WATERING is the maintenance practice that is most often done incorrectly. Lawns should never be watered until the grass shows a definite need. Grass suffering from lack of moisture takes on a definite sheen and the plants wilt and curl. When this occurs, the lawns should be thoroughly soaked to a depth of 6 inches or more. Light sprinklings are never recommended except during excessively hot spells following a prolonged period of heavy rainfall. Light daily sprinklings at this time reduce scalding during such periods.

Deep watering of 6 inches or more encourages development of a deep root system capable of utilizing more efficiently the nutrients available deep in the soil.

Light frequent sprinklings produce shallow, weak root systems which encourage weed invasions. Shallow rooting does not allow efficient utilization of plant food or moisture in the soil. Disease incidence is more likely to be severe under conditions which produce shallow rooting. Light sprinklings continued over a long period may make the maintenance of a good lawn prohibitive. Also the root system is alive even though top-growth is dead; so water the lawn for a healthy root system.

AERATION: A good soil for growing plants is a mixture of soil solids, water and *air*. The solid particles of soil, under ideal conditions, adhere to each other with organic matter to form groups or granules. The solid portion should constitute about 50 percent of volume of a good soil, and the remaining 50 percent should be pore space. Air and water should occupy the pore space in equal proportions. A soil is said to be well or properly aerated when these conditions exist.

The practice of using a hollow-tined fork or a four-pronged spading fork on lawns to aerate the soil is not common; however, such practice will produce more desirable turf. Aerifying the soil is a means of loosening the soil to allow: (1) air (oxygen) to get into the soil, which is essential for root development; (2) water to move into and through the soil; and (3) the soil to hold more water. It also prevents compaction which in turn prevents soil erosion and plant food loss through surface runoff. Eliminating the compacted condition is necessary for proper oxygen-water relationships which make for vigorous healthy turf that is resistant to disease and drouth. Frequently used parts of the lawn should be aerated as often as necessary to keep the soil in a good physical condition.

MOWING is responsible for the deterioration of many lawns. Close clipping encourages thinning out of turf, shallow rooting and, subsequently, a lack of resistance to drouth, diseases and the invasion of weeds. Clipping too close also allows drying and baking of the soil during the summer.

The leaves not only produce the green color desired of a lawn, but are necessary for the manufacture of food required by the entire plant. When excessive amounts of the leaves are removed the entire plant suffers. The lawn should be clipped to a height of one and one-half to two inches, depending on the species of the lawn. Creeping types of grasses can withstand closer clipping than bunch types. Clipping at a height greater than two inches results in many of the same troubles as clipping too close.

Proper mowing requires a sharp, well adjusted lawn mower. The mower should be sharp enough to cut the tips of the leaves and not bruise or crush them. Both the cutting edge of the bedknife and the reel should be sharp. Time spent picking up stones and sticks ahead of mowing is well spent. Regular checkups on the adjustments of the reel and bedknife are necessary. The reel should be set firmly, yet not too closely against the bedknife. The height of the bedknife should be determined by placing the mower on a flat surface and adjusting the set screws so that each end of the bedknife is exactly the desired height.

Summary

A beautiful lawn is a definite asset. To establish a well cared for turf it requires knowledge, patience, effort and capital.

Four major factors to lawn care and maintenance are: (1) feeding (2) watering (3) aeration (4) mowing. All four are inseparable in actual lawn practice.

Weeds never become a problem on properly managed lawns.

Disease and insect control is necessary on some lawns, especially St. Augustine grass. At the first sign of disease or insects use definite knowledge and not home remedies or guess work.

Vinifera Grape Maturity in the Lower Rio Grande Valley of Texas

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In recent years considerable interest has developed in growing Vinifera grapes in the Valley. There are several reasons for this interest, the extreme earliness of Vinifera grapes in the Lower Rio Grande Valley and another crop to help diversify Valley agriculture. The Lower Rio Grande Valley is favorably located geographically for Vinifera grape production. However, there are many problems that need to be solved before large scale plantings can be recommended.

Grape samples were taken during April, May and June at weekly intervals from several small vineyards of American and Vinifera grapes in the Lower Valley and near Laredo. These samples were checked for total solids (sugar) with a refractometer and for flavor by tasting. Tartaric acid was not checked because of insufficient quantities of grapes for sampling.

Table 1 shows the car loads of grapes shipped during 1951 into 100 cities in the United States and to Canada, This table was compiled from information collected by the U.S.D.A. Production and Marketing Administration, Market News Division. April, May and June are the three months of the year when grape shipments in the United States are the least and correspondingly the prices should be at a premium. May and June are the months when the early varieties of Vinifera grapes mature under South Texas growing conditions.

Tables 2 and 3 give the total solids (sugar) and the flavor of the grape varieties tested in 1953. These figures will probably vary to some extent from year to year but they give an approximate date as to the maturity of the variety in the Rio Grande Valley.

In the author's opinion, Perlette and Thompson Seedless have the most possibilities for commercial development in the Valley. Perlette matures about the third or fourth week in May and Thompson Seedless matures the first or second week in June. These two varieties are white seedless grapes. Most of the other varieties that were checked had some feature about either the bunch or the berry that would eliminate them as having commercial possibilities. Some of these features were excessive berry splitting, uneven coloring of berries, uneven maturity of berries, bunches too small or too loose, and bunches poorly shaped or too compact. Some varieties of grapes that had home garden possibilities were Pearl of Csaba, Golden Muscat, Black Muscat, and Black Monukka.

One of the principal problems in growing Vinifera grapes in the

Table 1. Car loads of grapes shipped during 1951 into 100 cities in the United States and Canada.

Shipped from	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
California to 100 Cities	993	610	380	74	31	107	1180	2263	2795	8066	4553	1932
California to Canada	122	77	55	7	2	6	81	181	137	367	238	158
California Combined	1115	687	435	81	33	113	1261	2444	2932	8433	4791	2090
Arizona to 100 Cities	—	—	—	—	—	38	109	—	—	—	—	—
Arizona to Canada	—	—	—	—	—	—	8	—	—	—	—	—
Arizona Combined	—	—	—	—	—	38	117	—	—	—	—	—
Washington to 100 Cities	—	—	—	—	—	—	—	—	4	—	—	—
Iowa to 100 Cities	—	—	—	—	—	—	—	—	1	—	—	—
Argentina to 100 Cities	—	—	—	2	2	1	—	—	—	—	—	—
Argentina to Canada	—	—	—	3	—	—	—	—	—	—	—	—
Argentina Combined	—	—	—	5	2	1	—	—	—	—	—	—
Chile to 100 Cities	—	—	24	49	53	—	—	—	—	—	—	—
Chile to Canada	—	—	—	—	2	—	—	—	—	—	—	—
Chile Combined	—	—	24	49	55	—	—	—	—	—	—	—
South Africa to 100 Cities	—	—	34	—	—	—	—	—	—	—	—	—
Canada to 100 Cities	—	—	—	—	—	—	—	—	—	11	1	—
Australia to Canada	—	—	—	2	—	—	—	—	—	—	—	—
Total Grapes Shipped to 100 Cities	993	610	438	125	86	146	1289	2263	2800	8077	4554	1932
Total Grapes Shipped to Canada	122	77	55	12	4	6	89	181	137	367	238	158
Total Grapes Shipped Combined	1115	687	493	137	90	152	1378	2444	2937	8444	4792	2090

Table 2. Total solids of several vinifera grape varieties during the 1953 season.

Variety	*Area*	4/22	5/1	5/8	5/15	5/22	5/29	6/5	6/12	6/19	6/26	7/3	7/10	7/17	7/24
Pearl of Csaba	McAllen	13.0	16.0	20.1	—	—	—	—	—	—	—	—	—	—	—
Perlette	McAllen	—	—	18.0	18.8	17.4	18.6	21.1	20.1	22.5	—	—	—	—	—
Delight	McAllen	—	—	16.1	16.8	16.4	17.5	19.1	18.1	18.6	18.0	20.4	—	—	—
Thompson Seedless	McAllen	—	—	—	—	12.9	15.0	17.1	17.1	18.5	18.5	19.9	18.7	18.0	—
Thompson Seedless	Laredo	—	—	—	—	13.8	—	18.0	18.2	—	19.1	—	—	—	—
Thompson Seedless	Mercedes	—	—	—	—	12.9	13.2	19.0	18.3	19.2	—	—	—	—	—
Cardinal	McAllen	—	—	13.1	12.8	12.4	14.1	16.0	18.1	16.4	16.0	16.4	16.2	—	—
Golden Muscat*	Laredo	—	—	—	—	3.9	—	—	13.7	—	15.1	—	—	—	—
Golden Muscat*	McAllen	—	—	—	—	—	—	18.0	18.2	18.5	19.0	19.9	—	—	—
Black Muscat	McAllen	—	—	—	—	—	—	16.0	16.1	18.1	17.5	17.9	18.1	18.5	—
Black Monukka	McAllen	—	—	—	—	—	—	18.0	16.6	17.2	17.5	17.9	17.0	—	—
Ribier	McAllen	—	—	—	—	—	—	13.5	13.1	14.2	14.5	15.5	15.6	—	—
Dattier	McAllen	—	—	—	—	—	—	—	12.1	12.1	16.1	16.4	17.1	17.5	—
Independence	Donna	—	—	—	—	—	—	—	—	—	19.0	17.5	—	17.5	—
Red Malaga	McAllen	—	—	—	—	—	—	—	—	—	—	—	—	19.1	20.1
Emporer	McAllen	—	—	—	—	—	—	—	—	—	—	—	—	—	16.1

*Vinifera X Labrusca hybrid from New York Experiment Station at Geneva.

Table 3. Flavor of several vinifera grape varieties during the 1953 season.

Variety	*Area*	4/22	5/	5/8	5/15	5/22	5/29	6/5	6/12	6/19	6/26	7/3	7/10	7/17	7/24
Pearl of Csaba	McAllen	A	F	G	—	—	—	—	—	—	—	—	—	—	—
Perlette	McAllen	—	—	A	SA	G	E	E	E	OM	—	—	—	—	—
Delight	McAllen	—	—	A	SA	F	G	E	E	E	E	E	—	—	—
Thompson Seedless	McAllen	—	—	—	—	A	SA	G	G	E	E	E	OM	OM	—
Thompson Seedless	Laredo	—	—	—	—	A	—	G	E	—	E	—	—	—	—
Thompson Seedless	Mercedes	—	—	—	A	A	A	G	E	E	—	—	—	—	—
Cardinal	McAllen	—	—	F	F	F	F	G	G	G	G	G	G	—	—
Golden Muscat*	Laredo	—	—	—	—	A	—	—	A	—	E	—	—	—	—
Golden Muscat*	McAllen	—	—	—	—	—	—	G	G	E	E	E	—	—	—
Black Muscat	McAllen	—	—	—	—	—	—	SA	G	E	E	E	E	E	—
Black Monukka	McAllen	—	—	—	—	—	—	G	G	E	E	E	E	—	—
Ribier	McAllen	—	—	—	—	—	—	F	F	F	F	G	G	—	—
Dattier	McAllen	—	—	—	—	—	—	—	SA	F	G	G	G	E	—
Independence	Donna	—	—	—	—	—	—	—	—	—	E	E	—	E	—
Red Malaga	McAllen	—	—	—	—	—	—	—	—	—	—	—	—	G	E
Emporer	McAllen	—	—	—	—	—	—	—	—	—	—	—	—	—	SA

SA—Slightly Acid; A—Acid; F-Fair; G—Good; E—Excellent; OM—Over Mature.
*Vinifera X Labrusca hybrid from New York Experiment Station at Geneva.

Valley is cotton root rot. Commercial vineyards need to be grafted on rootstocks that are resistant to this disease. Cotton root rot has caused the failure of all commercial plantings in the past because the varieties were not on resistant rootstocks. Several rootstocks have been found that are either completely or partially resistant to cotton root rot but their congeniality with vinifera grapes still remains to be tested. This information must be obtained before recommendations can be made for planting commercial vineyards.

Desert Damp-Wood Termites as a Threat to Young Citrus Planted on Recently-Cleared Brushland

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Under certain conditions, the desert damp-wood termite, *Kalotermes (Paraneotermes) simplicicornis* (Banks) has been known to be a serious pest of young citrus in the Lower Rio Grande Valley of Texas. The pest is of minor importance as far as total acreage of citrus is concerned in the area but when found in damaging numbers the insect may cause serious loss to the individual grower. Bynum (1951) reported the damage and distribution of the termite particularly in the dry-lands areas, recently cleared of brush. More than 5,000 acres of young citrus was reported by growers in January, 1952 as being planted on termite-infested soil. Investigation of the problem was begun in order that the problem might be lessened.

A citrus grower, north and west of Edinburg, Texas, complained of losing several young trees day after day as a result of termite attack. Their leaves would suddenly wither and the banked, young trees would die. The continued loss of trees was of great concern to this grower.

Orange and grapefruit trees had been planted in 1946 and 1947 immediately following the removal of brush. The trees had been subjected to heavy damage as a result of two freezes; so the top growth of the trees was still small. The grower interplanted cotton for several years in order that some income might be had until the trees had grown to the productive stage. Vegetation had been allowed to grow in the tree row area for wind protection for the trees and to reduce wind erosion of the soil.

A real problem seemed to develop when the trees were banked for freeze protection. The weed coverage in the tree row area had apparently been adequate to maintain the termites for the previous years. The termites no doubt moved when the vegetative area became too dry to the moist area around the trees, which was kept from drying by tank watering. It seemed apparent, too, that in many cases the termite infested soil was thrown about the trees while banking.

The first observable symptom of termite attack was the withering of the leaves. Such trees, when dug, most often showed the tap root had been cut off by the termites below the main laterals. After severing the tap root, the termites would start feeding upward toward the trunk of the tree. Trees dug early at the first signs of the leaves withering, treated for termites and planted again were found to be capable of growing a new tap root. Dead wood in the area just below the main lateral roots must be considered an unhealthy condition for the future welfare of the tree.

Materials and Methods

Although the danger of freezing was not over during January, the banks of trees in every other tree row were removed to compare the treatment of three insecticides of banked versus unbanked trees. Dosages of insecticides were figured on the basis of water applied to six-foot watering rings. Since 60 gallons of water seemed to be the necessary dosage to distribute the diluted insecticide in the root zone of 14 to 15 inches in depth, dosages were figured for the distribution of 0.5, 1.0 and 2.0 pounds chlordane per 50 trees. Aldrin and parathion dosages were figured at 1/4 the above amounts. Tank trucks with a capacity of 1800 gallons were made available for application of diluted insecticides. The tanks were filled from a five-inch head of water connected to a well with poor water. Thorough mixing of the solutions seemed assured as the tanks were filled in less than three minutes. Since watering was a necessary operation, cost of application was considered to be only that of the insecticide. A total of 478 trees were treated.

Results

Termites were observed 20 and 77 days around vegetation between the trees in numbers roughly proportional to the amount of vegetation. The pest was not found in the cultivated, or interplanted, area.

After 5 hours, sixty gallons of insecticidal solution penetrated to a depth of 14 to 15 inches for the unbanked trees. The same dosage penetrated to a depth of 20 inches for the banked tree and no closer than 8 inches of the tap root.

Only six of the treated trees were found to have termites following application. Two, banked, untreated trees of a comparable number of trees per individual insecticidal treatment were killed by termites. Two, dead, unbanked trees that were known to have had termites before treatment with the low dosage of parathion, were found to have termites 3 months later. One unbanked tree treated with the high dosage of parathion was found infested with termites in June.

Two trees, one treated with a low dosage and the other with a high dosage of aldrin, were found damaged by termites at the close of the tests.

One low-dosage-chlordane treatment on an unbanked, dead tree failed to stop termites from working in the tap root just below the trunk. A banked tree, treated with the medium dosage of chlordane, was found on February 19th to have the tap root cut off. The tree had apparently recovered and had resumed growth.

Termites might have been present before treatment although records did not indicate their presence, as initial samples for the presence or absence of termites represented only a mere fraction of the total treated area. Success of treatment indicated kill of the termites at the time of treatment and/or prevention of movement of termites from outside the ring.

The banks of trees prevented lateral penetration of the solutions closer than 8 inches of the tap root. Such treatment of banked trees would probably fail to kill termites immediately around the tap root, unless fumigation was possible.

After distribution of the insecticide in the root zone, subsequent waterings would be expected to dilute the insecticides by leaching. Reduction in dosage below the level of effectiveness would permit the termite to move into the ring from the vegetative area. Subsequent treatment was not considered necessary since little to no rain fell and water was short from the well.

Summary

Distribution of the insecticidal solution only in the root zone was observed to be very important. Penetration of the solution below the lateral root zone was considered valueless. The banking of trees prevented the liquid from penetrating laterally to the tap root.

Termites were found around the roots of 6 trees, 18 days or more following the application with the following treatments: two, low parathion and one, high parathion; one, low aldrin and one, high aldrin; and one, low chlordane. Termites were not found about the roots of those trees treated with a dosage of one pound, or greater, of chlordane per 50 trees.

Observations indicated that planting citrus in this area on recently-cleared brushland is a poor practice, particularly in the dry lands area with the lighter soils. The termite problem would seemingly be greatly lessened if such land was worked to row crops for at least 3 years with particular care being given to the removal of wood from the soil, before citrus is planted.

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Methyl Bromide Injury to Citrus Seedlings

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Methyl bromide is widely used as a soil fumigant to control soil pests as fungi, insects, nematodes and weeds. The fumigant is comparatively expensive, which limits its use to greenhouse soil, seedbeds and for special purposes where a highly effective fumigant is required. In some instances injury to certain crops as celery, cauliflower, conifers, carnations and chrysanthemums (Williamson, 1953; Anon., 1953) have occurred in soil treated with methyl bromide. Apparently a similar type of injury has been observed during the past two years in the Lower Rio Grande Valley in citrus seedlings. In one instance, Cleopatra mandarin seedlings did not grow as well in that part of the nursery bed treated with methyl bromide as in the non-treated area. In another case, 4-month-old sour orange seedlings planted in methyl bromide-treated soil failed to make as good growth as those planted in untreated soil. The older leaves developed a yellowish spotted condition, similar to boron injury on citrus, turned yellow and fell off. Other instances of apparent injury to citrus seedlings growing in soil fumigated with methyl bromide have been observed. In any single case observed, one might question the validity of the observation for lack of an adequate control and yet because of the consistency in the cases observed the injury would seem to be more than coincidental.

A test was made during the summer of 1953 to obtain some measure of the injury to citrus seedlings when grown in methyl bromide-treated soil. The soil was treated at the rate of 1 pound of methyl bromide to a cubic yard of soil. The soil moisture was good, soil temperature 85° to 90°F. and the air temperature 85° to 101°F. The plastic cover which was used to retain the fumigant was removed at the end of 48 hours, and the soil stirred to facilitate the escape of any free methyl bromide gas. The fumigated soil was allowed to areate 6 days before it was used. On July 29, bare-rooted citrus seedlings, six of each of Mexican lime, sweet orange, Cleopatra mandarin and sour orange, were transplanted to gallon cans filled with fumigated soil. A like number of seedlings of each variety was planted as controls in unfumigated soil from the same source. The plants of each variety were comparable in size when transplanted, although there were some differences between varieties. All seedlings were cut back to a height of 12 centimeters or about 5 inches. The transplanted seedlings were placed on a table in a screenhouse and all received similar care. Measurements on growth response in terms of height and diameter or cross-sectional area at 1 inch high on the stem were taken at the end of 4 months.

There was a pronounced retardation of growth in the seedlings of the 4 citrus varieties that grew in the methyl bromide-treated soil, table 1. This retardation of growth was evident in both height and stem diameter growth. However, the differences between fumigated and untreated soil were most pronounced in the stem measurements when expressed as

Table 1. Effect of soil fumigation with methyl bromide on growth of citrus seedlings[1].

	Comparative growth in height and cross-sectional area of stem					
	Height growth			Cross-sectional growth		
	Soil treatment			Soil treatment		
Citrus seedlings	*None Cm.*	*Methyl bromide Cm.*	*Reduced growth Percent*	*None Sq.mm.*	*Methyl bromide Sq.mm.*	*Reduced growth Percent*
Cleopatra mandarin	56.50	33.50	40.7	26.24	8.05	69.3
Mexican lime	56.66	34.16	39.7	26.14	12.89	50.7
Sweet orange	43.16	32.16	25.5	30.17	19.63	34.9
Sour orange	38.00	29.00	23.7	25.39	17.05	32.8

[1]Data based on average of six seedlings of each citrus variety.

cross-sectional area of the stem. The retardation of height growth ranged from 40 percent for Cleopatra mandarin to 23 percent for sour orange. The basal stem growth, as measured by the cross-sectional area, was retarded even more, 69 percent for Cleopatra mandarin to 32 percent for sour orange. The reduced growth was intermediate for Mexican lime and sweet orange. These differences in growth response would tend to indicate that citrus species and varieties differ in their sensitivity to injury from methyl bromide.

The observations reported and the data in table 1 indicate that methyl bromide, as commonly used, is not a satisfactory soil fumigant for citrus seed beds or for treating soil for citrus seedling transplants. This is an unfortunate situation since methyl bromide is an efficacious soil fumigant in controlling soil inhabiting pests. In the case of citrus the adverse affect of methyl bromide as a soil fumigant offsets the benefits usually expected from soil fumigation.

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Tristeza Virus Carried by Some Meyer Lemon Trees in South Texas[1]

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Meyer lemons have been grown commercially in the Lower Rio Grande Valley for many years. One type, grown in the Valley since 1924, has developed a reputation of growing poorly on sour orange rootstock but of growing well on its own roots. A second type, known locally as either the Ricketts or Rickert Meyer lemon, grew well on either sour orange rootstock or its own roots.

Methods and Results

In a routine investigation of tree declines in the Lower Rio Grande Valley, weak and chlorotic Meyer lemon plants on sour orange rootstock were observed and scionwood twigs collected to test them for tristeza virus. The twigs from each Meyer lemon plant were grafted to the stems of 10 Mexican lime seedlings growing in gallon cans of soil in an insect-proof screenhouse. Within 6 weeks, 6 of these Mexican lime seedlings showed vein clearing (Fig. 1) when young and mature leaves were viewed in transmitted light. Some cupping and yellowing of affected lime leaves also occurred. These initial results showed that a virus had been transmitted from the weak Meyer lemon field trees to the Mexican lime test plants.

An old Meyer lemon tree on its own roots was the original source of the budwood from which the weak and chlorotic field trees were propagated. Twigs from this healthy-appearing tree were grafted to 10 Mexican lime seedlings. Five seedlings on which the graft union was successful subsequently developed the same vein clearing shown by the grafted lime seedlings in the first test. These results showed that the original Meyer lemon tree carried the same virus as the trees tested earlier, even though the tree appeared healthy.

Two other old and apparently healthy Meyer lemon trees used as budwood sources for propagations in the 1930's were also located. These 2 trees were also on their own roots. Twigs from these 2 trees were grafted on Mexican lime seedlings. Nineteen of the 20 lime seedlings in this test subsequently developed distinct vein clearing, showing that these 2 Meyer lemon trees, although apparently healthy, carried a virus that was transmitted to limes by grafting.

Baker (1942) reported that the Ricketts Meyer lemon grew well on

[1]These investigations are a part of the Cooperative Citrus Rootstock Investigations conducted by the Texas Agricultural Experiment Station and the U. S. Department of Agriculture, certain phases of which were carried on under the Agricultural Marketing Act (R. M. A. Title II).

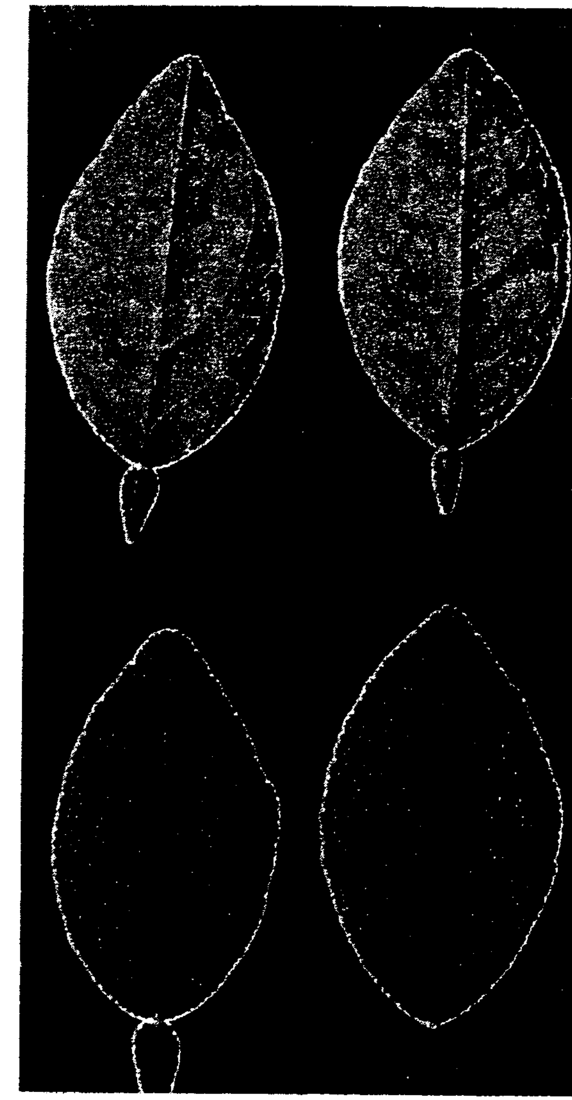

Figure 1. (Upper) Vein clearing on young leaves of Mexican lime seedlings grafted with Meyer lemon scions. (Lower) Symptomless leaves from ungrafted plants.

sour orange rootstock, while the old type did not. Twigs from 11 trees of the Ricketts were grafted to Mexican lime seedlings. The 20 lime seedlings failed to show disease symptoms in a 2-month period. This indicated that these budwood sources of the Ricketts Meyer lemon were free of the virus.

Redblush grapefruit and Valencia orange tops were propagated on Meyer lemon cuttings taken from a tree carrying the virus. Twigs were taken from the grapefruit and orange tops and from a branch of the unbudded Meyer lemon and were grafted on Mexican lime seedlings. Each of these 3 sources were found to be carrying the virus, as judged by the occurrence of vein clearing on the lime seedlings. These results showed that the virus in Meyer lemon was transmitted to the Valencia orange and Redblush grapefruit tops.

Discussion

The combination of vein clearing and stem pitting on Mexican or West Indian limes inoculated with tristeza, or quick decline, virus has been observed in tests in South America (Costa et al., 1950), South Africa (McClean, 1950), California (Wallace and Drake, 1951) and Florida (Grant and Schneider, 1953).

The vein clearing, cupping and yellowing of leaves on young, mature growth of the Mexican lime test plants used in Texas are similar to if not identical with the symptoms of tristeza described in the literature. Tiny but definite stem pits also have been observed on a few lime plants from which the bark has been removed. These symptoms on lime test plants plus the fact that virus-infected Meyer lemon trees grow vigorously on their own roots but grow poorly on sour orange rootstock indicate that a strain of tristeza virus exists in Texas. This is the first report of the occurrence of tristeza in Texas citrus.

It is now believed that the early reports of poor growth of Meyer lemon on sour orange rootstock can be explained in terms of infection with tristeza. McKee (1927) noted that both favorable and unfavorable reports were received from cooperators growing the Meyer lemon on sour orange rootstock. Workers at Weslaco reported that the Meyer lemon did not thrive on sour orange rootstock in South Texas (Anonymous, 1928). Baker (1942) noted that one Meyer lemon type "refused" to grow on sour orange rootstock, while the Ricketts type grew well on sour orange rootstock. Friend and Wood (1941) considered the "Rickert" Meyer lemon to be congenial with sour orange rootstock in South Texas. Webber (1943) reported that the Meyer lemon apparently grows well on sweet orange or rough lemon rootstocks; these two rootstocks are now known to be tolerant to tristeza virus. Grant (1953) mentioned that a Meyer lemon plant in Florida carried the tristeza virus.

The origin of the Ricketts strain has been reported by Baker (1942). Thirty two Meyer lemon trees on sour orange rootstock were planted near Weslaco. Twenty eight were sickly and scrubby from the start while 4 trees grew vigorously. These 4 trees, estimated to be 25 years old in

1942, were described as being "large and fine as any orange or grapefruit the same age." Ten- to 15-year-old trees on sour orange rootstock, propagated from the 4 vigorous trees of the Ricketts planting, were in equally good condition in 1942.

The damage caused to Texas citrus by tristeza virus has yet to be determined. However, it is encouraging that a Meyer lemon type on sour orange rootstock has shown decline symptoms for many years without apparent spread of the tristeza virus to other citrus varieties in adjacent plantings. From the limited information available at this time, it seems probable that tristeza virus has been in some Meyer lemon trees for more than 25 years and has been widely distributed in South Texas by subsequent propagations.

Steps are now being taken to determine where infected Meyer lemon trees occur and whether tristeza virus is present in surrounding citrus plantings. Grapefruit trees registered as psorosis-free budwood sources are being tested for the presence of tristeza virus. Observations are also being made to determine whether the strain of tristeza virus in Texas is like that in South America or similar to the relatively mild strain found in Florida (Grant and Schneider, 1953). Present indications are that the Texas strain is relatively mild.

Work in California (Dickson *et al.*, 1951) and Florida (Norman and Grant, 1953) indicates that the aphid vectors now known to be present in those states are relatively inefficient carriers of tristeza virus. Studies on the ability of insects to transmit the disease from infected Meyer lemon trees to healthy trees of other varieties have begun. Information from such studies may establish whether the virus can spread from infected Meyer lemon trees to healthy trees of other citrus varieties in Texas.

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The Reaction of Truck and Field Crops to Saline Well Water in the Rio Farms Area

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During periods of drouth and shortage of irrigation water, such as occurred in the Valley during the latter half of 1952 and the early half of 1953, it became necessary to rely on well water for irrigation purposes. In a large portion of the Valley, particularly that area lying in the Northern part, the water from these wells had high total salts, high sodium percentage and high boron. The percent of these minerals in well water increased progressively North from Highway 83.

Because of the known high sodium percentage of the water and the known deleterious effect of sodium on soil structures, Rio Farms, Inc. set up a number of salinity and boron test plots. In these plots the effect of water from a well located on that property was tested on various crops. Various soil amendments to counteract the injurious effects of the sodium deposits from the well water were also compared. This article reports the results of the studies in 1953.

Methods and Materials

One hundred and twenty 16 x 16 foot square plots were used in these studies. A border of 1 x 6 inch oak lumber was installed around each plot. The top edge of the lumber was set on a level four inches above the ground for the purpose of measuring the four inches of irrigation water applied.

Twenty-four plots were used for each of five crops; namely, cotton, corn plus sorghum, sesame, 4 grasses, and tomatoes. The cotton was planted on March 29, 1953 and all other crops were planted on April 7 and 8, 1953.

The irrigation water and soil ammendment treatments applied to these crops are given in table 1. There were 4 replicate plots of each treatment on each crop except as noted otherwise.

All plots were irrigated with 4 inches of water on April 11, April 30, and June 6. During this period there was 2.35 inches of rainfall — .50 inches on April 1, .75 inches on May 4, .70 inches May 13, and .40 inches May 14. A chemical analysis was made of the water at each irrigation.

Soil samples were taken of the 0 to 12" horizon from each plot at the beginning of the test and between each irrigation. These samples were analyzed for salt content and pH.

The single application soil amendments were spaded into the top foot of soil prior to planting the crop and before irrigation.

[1]The author greatly appreciates the helpful assistance of William C. Cooper for suggestions and the assistance of Ascension Peynado in conducting the tests.

Leaf samples were taken on May 14 after the second irrigation from the river water (Treatment 1) and well water (Treatment 2) plots of cotton, corn, sesame and tomatoes. Chloride content of these samples was determined by the standard A.O.A.C. procedure for plant tissue.

Results

A chemical analysis of the irrigation water used on April 11 is given in table 2. The composition of the water used on April 30 and June 6 was approximately the same as that on April 11.

The soil analysis for each crop and treatment is given in table 3. The salt content of the soil and pH (alkalinity) of the soil tended to increase as a result of the 3 four-inch irrigations.

The chloride content of the leaves of the crops grown in the river and well water plots (treatment 1 and 2) is given in table 4. There was a larger accumulation of chlorides in the plants grown in the well water plots than in the plants of the river water plots. There was, however, a rather large accumulation of chlorides in the river water plots.

A record of leaf burn, plant growth, and yield of the various crops for the 6 treatments is given in table 5. Plant growth and yield on all crops except sesame, and possibly tomatoes, was normal on all of the well water treatments. The differences between treatments were not significant.

Table 1. Description of irrigation and soil amendment treatments.

Treatment No.	Irrigation Water	Soil Ammendment			
		Material	Lbs. per Plot Per Application	Acre Equivalent	No. of Applications
1	River water	None	—	—	—
2[1]	Well water	None	—	—	—
3	Well water	Gypsum	12	2000	1
4	Well water	Gypsum	8	4000	3
5[2]	Well water	Sulfur	15	3500	1
6	Well water	Soylaid	6	1000	1

[1]Treatment 5 for tomatoes consisted of 6 lbs. of Krillium #6 per plot instead of sulfur.
[2]The well water used for treatment 2 on grain sorghum was conducted through an Evis Water Conditioner.

Table 2. Composition of river and well water used on test plots.

Source of Water	Total Salinity (p.p.m.)	Concentrations of ions				
		Cl (epm)	Na (epm)	Ca.+Mg. (epm)	%Na	Boron (p.p.m.)
River	1500	14.2	12.7	9.1	66	1.4
Well	3000	31.2	47.3	7.0	87	6.0

The well water treatments definitely inhibited germination of sesame seed and killed practically all of the young plants. On the other hand, the sesame seed germinated satisfactorily in the river water plots and growth of seedlings and yields were normal.

Table 3. Salt content of saturation extract and pH of saturated paste of soil before and after irrigation treatments.

Crop	Treatment No.	Total Salt (p.p.m.)		pH	
		Before Treatment	After Treatment	Before Treatment	After Treatment
Cotton	1	507	1596	6.91	6.96
"	2	535	2870	7.21	7.45
"	3	525	3042	7.22	7.44
"	4	532	3382	6.81	7.24
"	5	496	2800	7.55	7.21
"	6	539	2800	7.06	7.36
Sorghum	1	885	1405	6.76	6.83
"	2	595	2187	6.91	7.11
"	3	868	3267	6.40	7.18
"	4	763	3036	6.97	7.11
"	5	715	2472	6.88	7.01
"	6	714	2310	6.94	7.09
Sesame	1	672	1622	6.80	6.92
"	2	777	2124	6.81	7.57
"	3	564	2380	6.93	7.38
"	4	700	2455	7.06	7.29
"	5	682	2823	6.95	7.00
"	6	693	2091	7.09	7.14
Grasses	1	564	1470	7.07	7.16
"	2	546	2161	7.01	7.57
"	3	497	2538	6.87	7.28
"	4	483	2819	7.34	7.72
"	5	567	2080	7.30	7.44
"	6	539	1978	6.69	7.64
Tomatoes	1	553	1435	7.16	7.01
"	2	541	2383	7.57	7.43
"	3	574	2473	7.28	7.71
"	4	455	2424	7.72	7.55
"	5	469	2712	7.44	7.37
"	6	521	2777	7.64	7.45

Table 4. Chloride content of leaves of four crops grown with the river water (Treatment 1) and well water (Treatment 2) plots. The figures given are the average for the 4 replications of those treatments.

Crop	Percent of Chlorides in Dried Leaves	
	River Water Plots	Well Water Plots
Cotton	1.47	1.76
Corn	1.96	2.57
Sesame	1.94	2.79
Tomato	2.52	3.27

Table 5. A record of leaf burning, growth of plants and yields.

Crop	Treatment Number	Date Leaf Burn First Observed	Growth	Average Yield Lbs. per plot
Cotton	1	None	Normal	3.25
"	2	None	Normal	2.5
"	3	None	Normal	2.9
"	4	None	Normal	2.5
"	5	None	Normal	2.94
"	6	None	Normal	3.08
Grain Sorghum*	1	None	Normal	111
"	2	May 8	Normal	126
"	3	May 8	Normal	111
"	4	May 8	Normal	135.50
"	5	May 8	Normal	124
"	6	May 8	Normal	128.50
Sesame	1	None	Normal	2.62
"	2	April 22	Poor	None
"	3	April 22	Poor	None
"	4	April 22	Poor	None
"	5	April 22	Poor	None
"	6	April 22	Poor	None

(Continued)

Table 5. (Continued)

Crop	Treatment Number	Date Leaf Burn First Observed	Growth	Average Yield Lbs. per plot
GRASSES:				
Blue Panicum	1	None	Normal	75
"	2	None	Normal	61
"	3	None	Normal	68
"	4	None	Normal	67
"	5	None	Normal	63
"	6	None	Normal	68
Coastal Bermuda	1	None	Normal	40
"	2	None	Normal	41
"	3	None	Normal	41
"	4	None	Normal	37
"	5	None	Normal	34
"	6	None	Normal	43
Buffel Grass	1	None	Normal	43
"	2	None	Normal	45
"	3	None	Normal	45
"	4	None	Normal	39
"	5	None	Normal	45
"	6	None	Normal	41
Birdwood	1	None	Normal	35
"	2	None	Normal	34
"	3	None	Normal	34
"	4	None	Normal	36
"	5	None	Normal	35
"	6	None	Normal	34
Tomatoes**	1	None	Normal	None
"	2	April 28	Fair	None
"	3	April 28	Fair	None
"	4	April 28	Fair	None
"	5	April 28	Fair	None
"	6	April 28	Fair	None

*Corn was severely injured by corn borer and no records were made.

**Tomatoes were transplanted on April 8 immediately after salt plots were completed. Failure to yield probably due to high temperatures and strong winds which caused blooms to drop before fruit was set.

The tomato plants in both the river and well water plots were subnormal. This was probably due to the lateness of the season in which they were planted.

The high sodium percentage in the well water caused the soil in treatment 2 to fuse or "puddle" into a hard crust. These plots held rain water for as long as 12 days following a nine inch rain in August. At the same time there was no visible water held above the surface of the soil in the river water plots. The plots treated with Soylaid and those watered through the Evis Water conditioner held water above the surface of the soil comparable to the plots irrigated with well water and receiving no soil ammendment or other treatment.

The plots treated with gypsum and sulfur showed no marked improvement over the well water treatment without soil amendment.

The well water plots treated with Krilium, however, did not hold rain water and showed no puddling of the soil.

Discussion

The 3 irrigations with well water "puddled" the soil and made the soil impermeable to rain water. Plant growth and yield were normal on cotton, sorghum, and grasses grown on this soil. All of these crops, however, were germinated before the soil structure was damaged. Recent germination tests made on these puddled soils showed that there was no emergence of small vegetable seedlings because of the hard crust. Thus a serious problem of obtaining a good stand of plants from seed planted in this type of soil might be expected. However, at least during the first year, growth of some plants is normal once they emerge from the seed bed.

Sesame is an exception to the above statement. This crop is very intolerant of salt and in these tests there was a total loss of plants from salt burn. On the other hand cotton, sorghum, and the grasses showed no salt burn during the first year. General observations on most grasses in the Valley indicate that they are very salt tolerant and may be grown satisfactorily on salty soils.

Cleopatra Mandarin Seedling Response to Soil Amendments

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In investigating the use of soil fumigants in citrus nurseries to control the citrus-root nematode and their effect on citrus seedling growth, it was deemed advisable to include various soil amendment treatments. There were possibilities that one or more such treatments might be as effective as soil fumigation in increasing plant growth and be less expensive. Also, the effectiveness of a soil fumigant might be enhanced when combined with one or more fertility treatments. The data reported herein were obtained in an exploratory greenhouse test which had for its purpose the screening of a number of such treatments. These data should be regarded as preliminary but informative for nursery trials and subsequent research.

A highly calcareous soil from a citrus nursery was used in the test. This nursery as well as others in the Rio Grande Valley had encountered difficulty in growing Cleopatra mandarin seedlings and had little or no trouble with sour orange seedlings. Most of the Cleopatra mandarin seedlings were small, stunted and chlorotic after six months growth. Each soil amendment treatment, table 1, was mixed thoroughly with soil obtained from the nursery in December. The 15 treatments including the control were replicated 4 times. A single replicate consisted of 11 plant bands filled with treated soil. Each plant band was planted with two Cleopatra mandarin seeds and covered with sand. Emergence counts were taken at intervals and final measurements on growth were taken in August 1953. The data in table 1 show the comparative response of Cleopatra mandarin seedlings to the various treatments.

The data indicates that the most effective treatments contained manure with the exception of manure in combination with sulfur and ferrous sulfate. Of these combinations the most outstanding was the one in which ammonium phosphate was combined with manure. This treatment resulted in a high percentage of seedlings 10 cm. tall and taller, and seedling emergence occurred much earlier in the plant bands receiving the ammonium phosphate-manure treatment compared with the other treatments. Such treatment which will stimulate early and uniform emergence in the nursery is highly desirable. One month after planting in the greenhouse (data not shown in table 1) seedling emergence in the ammonium phosphate-manure treated plant bands was two times better than the control, four times better than sulfur, six times better than manure alone, and seven times better than manure with minor elements.

The poor response from the sulfuric acid, sequestrene and sulfur treatments was somewhat surprising and particularly so in the case of the manure-sulfur-ferrous sulfate treatment which was the poorest of all.

The difference in response between the best treatments and the poorest treatments cannot be explained on the basis of a change in soil pH, since the range of pH was 9.2 to 9.6 with a pH of 9.4 for the untreated soil. It seems well to point out that the commonly recommended panacea, that of applying sulfur to Valley soils, may not produce anticipated results. The results as shown in table 1 do indicate that a high level of soil fertility is necessary for Cleopatra mandarin seedling production and that further work is needed on the problem of producing Cleopatra mandarin.

Table 1. Comparative response of Cleopatra mandarin seedlings to soil treatments.

Treatments	*Pounds per acre rate*	*Number[1] seedlings*	*Seedlings 10 cm. and taller[1]*
Manure, cow Ammonium phosphate, 21-24	40000 2000	56	33
Manure, cow 5 minor elements[2], 100 lbs. of each	40000 500	56	34
Manure, cow	40000	51	26
Manure, cow Ammonium phosphate, 21-24 5 minor elements, 100 lbs. of each sulfate	40000 2000 500	46	25
5 minor elements, 100 lbs. of each, sulfate	500	41	18
Manure, cow Sulfur 5 minor elements, 100 lbs. of each, sulfate	40000 2000 500	54	17
Aluminum sulfate	7000	40	21
5 minor elements, 200 lbs. of each, sulfate	1000	48	14
Control, no treatment	--	37	16
5 minor elements, 100 lbs. of each, sulfate with vermiculite	1000	51	8
Iron oxide	10000	41	12
Sulfuric acid, 95%	3000	40	12
Sequestrene, NaFe.	1000	39	7
Sulfur	2000	35	5
Manure, cow Sulfur Ferrous sulfate	40000 2000 1000	37	3

[1]Total of 4 replications, consisting of 36 plant bands, in which 2 seeds were planted to each band.

[2]The 5 minor elements were sulfates of manganese, zinc, iron, copper, and aluminum.

The Vegetable Situation

Austin E. Anson, *Executive Manager*
Texas Citrus and Vegetable Growers and Shippers, Harlingen

To cover the vegetable situation in the Rio Grande Valley in the space allotted is like putting a No. 12 foot in a No. 6 shoe, however I will try to bring you up to date with the figures that we are able to obtain from the varied sources throughout the area.

It is regrettable that in reporting to this group that we are deprived of the best facilities and the best information since the County Agents are not permitted to make these surveys; which we think is all wrong and we assure you some definite steps are being taken to see if it can be corrected.

Texas is miles behind Florida and California in having available correct and up-to-date data on our vegetable plantings, crop yields, distribution, etc. This worthwhile information could be assembled by our agricultural colleges, working in collaboration with United States Department of Agriculture and our State Department of Agriculture at a very nominal cost. We hope some day this will be accomplished.

The winter vegetable area from Del Rio to Brownsville comprises 200,000 acres of vegetables and while we have some of the best farming methods possible being pursued with the best type of seed that is obtainable and with water conditions the best we have had in the past three or four years this entire vegetable production hinges on: Will we have sufficient labor to finish all of these crops? This is the $64.00 question and will remain unsolved until our powers-that-be in Washington finally decide to take unilateral action on this all important matter.

Great worry has been indicated by many people in agriculture as to whether or not all of the surplus cotton land will go to vegetables. The fruit and vegetable industry has some surplus land of their own to consider first, as we still have 65,000 acres of the finest land in the Valley that was formerly in citrus and 10,000 acres of the top quality potato ground that undoubtedly will all go to vegetables on account of the cotton program, so this 75,000 acres is our own problem. We must agree, however, with the many agricultural experts that undoubtedly there will be a world of cotton ground going to vegetables, principally tomatoes, corn and cantaloupes.

Everything indicates that we will have an acreage equal or larger than 1946. In 1946 we had 64,000 acres of tomatoes; this year, even with the slight damage we have had from frost, 75,000 acres is indicated.

There were 32,000 acres of cabbage in 1946. Without question, we will equal this acreage and maybe more.

Sweet corn, both white and bantam type, was not a heavy factor in 1946. In fact the records are not very good on our past acreage of corn as it shows the heaviest acreage that we ever had as 10,500 acres. Many estimate there will be 20,000 acres this year owing to the fact that the new precooling and vacuum cooling systems lend themselves to the cooling of this very hot product and also the fact that both corn and tomatoes can and will send a very heavy volume to the canneries.

Corn is a new crop to our canneries but has proven a very satisfactory one up to date.

In 1946 cantaloupes showed an all-time high of 7200 acres. The only particular good that can be reported about that cantaloupe-year was that there were a goodly number of acres planted, otherwise the results were disappointing which was chargeable to improper seed, weather, lack of experience and many other contributing factors. This year, following two top-quality and high priced years, we think last year's 3000 acres will be easily doubled and some think the figure will go beyond the 6000 acres.

The cantaloupe acreage is in strong hands of experienced growers who realize it is an expensive crop to grow and all are shooting for that extra early thirty day market that our climate and soil condition makes possible for us to move into the terminal markets of the United States almost a month ahead of California and Arizona.

Potatoes will show a tremendous drop from 1946's 13,000 acres, as this year we will not exceed 3000 acres.

Carrots in their new dress, namely the cello pack is the one agricultural vegetable product that is being revolutionized. Even though last year's acreage was tremendously heavy and the 1946 acreage showed 16,000 acres, most people look for at least 20,000 acres and a deal that will extend into May. This new pack in carrots, which was a product of misfortune and adversity, has gone over with a bang with the housewives who are now demanding cellos and are turning their backs on the carrots with tops that they have used over the many years.

Lettuce, a Johnny-come-lately in 1946, with new developments, better seed that is more nearly adapted to our climate, and better know-how in production, will give us easily 8000 acres for this winter crop in the Valley and the Winter Garden area.

Onions are the only product that is going to show an appreciable reduction in acreage. The Valley, including Raymondville, shows 10,500 acres, Laredo 2000 to 2500 acres, Winter Garden 1200 acres, Eagle Pass 600 to 1000 acres and Coastal Bend 20,000 acres. All of this acreage shows a drastic reduction of almost 50% over last year.

The onion crop is one production in the Valley that we can really brag about as it is our one and only vegetable that we exceed all other areas producing Bermuda or early onions in our yield. This all being brought about by the extensive research that has been going on the past two years.

What the vegetable industry needs is more research in order that we can produce heavier yields on less acres with better products, as that is

what it is going to take to compete with our competitive neighbors who are doing just exactly that and using the same type of labor that we do for the job.

Research is the answer and we sincerely hope it will be solved for our group in the immediate future, for as you know the answer to research is a simple procedure as research was analyzed by Vice-Chancellor Williams of A&M College as follows: "Research is trying to find out what to do when we find out we can't any more do what we are doing now."

It has been definitely proven we must have better yields and better quality to keep our place in the vegetable picture.

Screening Citrus Rootstock Seedlings For Tolerance To Calcareous Soils[1]

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Most citrus groves in the Rio Grande Valley of Texas are planted in Victoria, Hidalgo, Willacy and Brennan fine sandy loams. The topsoil and subsoil of the Victoria and Hidalgo soils are calcareous (containing lime or calcium carbonate) throughout the soil profile and have a pH of 7.5 to 8.5. These soils are underlain by a deep bed of calcareous clay loam. The topsoil and subsoil of the Willacy and Brennan soils are in most places noncalcareous and have a pH of 7 to 8. However, below a depth of 3 or more feet, a very calcareous clay is present in the Willacy series and a white calcium carbonate caliche lies beneath the Brennan soils.

Grapefruit and orange trees on sour orange rootstock grow well on all these soils unless there is a large accumulation of soluble salts in the soil. Iron chlorosis, or "lime-induced" chlorosis, rarely occurs on trees on sour orange rootstock. In contrast, young grapefruit trees on sweet orange, Cleopatra mandarin and certain other rootstocks show iron chlorosis when growing in a calcareous soil (Cooper and Olson, 1951). The symptoms of iron chlorosis are easily distinguished from those of other disorders. In mild chlorosis the veins of the leaves remain dark green while the area between the veins are yellow. In severe chlorosis the entire leaf including veins develop an ivory color. In badly affected trees on sweet orange rootstock, heavy defoliation results in dieback of many limbs. Severely affected trees die.

One difficulty in tests on orchard plantings is the natural heterogeniety of most soils. Although the soil may be generally calcareous, there may be lens-like areas of non-calcareous soil. Also, the clay stratum containing calcium carbonate may vary from 18 to 36 inches below the surface in various parts of the orchard. This difficulty may be minimized by using closely planted small seedlings grown in a small area. Screening tests with seedlings, however, have limitations, since the top or scion of each variety is genetically the same as the rootstock in unbudded seedlings whereas in commercial plantings the scion differs from the rootstock. The advantage of testing seedlings is that a large number of seedlings of varieties grown in a homogeneous substrate can be screened for lime tolerance in a short period. It is the purpose of the present paper to describe experiments with seedlings which give some insight into species of citrus in whch lime tolerance is likely to be found.

[1]These investigations are a part of the Cooperative Citrus Rootstock Investigations conducted by the Texas Agricultural Experiment Station and the U. S. Department of Agriculture, certain phases of which were carried on under the Agricultural Marketing Act (R M A Title II). The cooperation of Rio Farms, Inc., Monte Alto, is greatly appreciated.

Methods and Materials

The tests were conducted in the citrus nursery area of Rio Farms, Inc., Monte Alto, Texas. Two seedbeds were prepared by excavating the soil from two adjacent areas each being 12 feet long, 4 feet wide and 2 feet deep. The four sides of each excavation were lined with asphalt roofing paper to serve as a root barrier. One excavation was filled with a calcareous soil (Victoria fine sandy loam taken from the rootstock orchard planting showing iron chlorosis on grapefruit on sweet orange rootstock) and another with a non-calcareous soil (Willacy fine sandy loam). The pH of both soils was 8. The calcareous soil contained 2.15 percent calcium carbonate while the non-calcareous soil contained 0.20 percent calcium carbonate. The soil for each seedbed was thoroughly mixed to provide a homogeneous substrate. The entire seedbed area was shaded with palm leaves on three sides and on top.

Ten seed of each of 61 different citrus varieties (Table 1) were planted 1 inch apart in rows 4 inches apart in each quarter of each seedbed. The seed were planted on December 15, 1952. The seedbed was irrigated with water containing approximately 1000 p.p.m. of total soluble salts and having a pH of 8. Observations on iron chlorosis were made May 16, July 16, and October 2, 1953.

Results

In the non-calcareous soil the only seedlings showing noticeable leaf symptoms of iron chlorosis were those of the Mediterranean sweet orange, the Sangre Doble Fina sweet orange, and the trifoliate orange. In contrast, seedlings of 54 varieties in the calcareous soil showed leaf symptoms of iron chlorosis. More varieties showed symptoms and the symptoms were more severe in October than in May or July.

The chlorosis status in October of plants growing in calcareous soil is presented in table 1. The seedlings were classified according to severity of leaf symptoms and stunting of growth compared with similar seedlings in a non-calcareous soil. Within the sweet orange group, seedlings of all varieties showed moderate or severe chlorosis and those of most varieties showed stunted growth. In the mandarin group, the Suen Kat and Kunembo seedlings showed no chlorosis, the Cleopatra, Meune Shui Chang, Onece, LauChang, Sunki, Changsha and Tiawanica seedlings showed only mild chlorosis. Seedlings of the remaining 10 varieties showed moderate to severe chlorosis. A wide variation in iron chlorosis symptoms also occurred in the mandarin-hybrid group. The Shekwasha, calamondin, and Rangpur lime seedlings were free of chlorosis; the Temple, and Sampson and Orlando tangelo seedlings showed severe chlorosis. In the trifoliate orange hybrid group the Troyer, Savage, Mortan and Carrizo citrange seedlings showed only mild chlorosis. Chlorosis was severe on trifoliate orange, Thomasville citrangequat and Uvaldi, Norton and Rusk citrange seedlings.

Table 1. Record of chlorosis and stunted growth of citrus seedlings in calcareous soil, October 2, 1953.

Citrus group and variety	*Severity of iron-chlorosis leaf symptoms*	*Growth*
Mandarin:		
Cleopatra	mild (1)	
Suen Kat	none	
Kunembo	none	
Meune Shui Chang	mild	
Oneco	mild	stunted
Lau Chang	mild	
Sunki	mild	
Timkat	severe (3)	stunted
Clementine	moderate (2)	stunted
Changsha	mild	
Pong Koa	moderate	
Chu Koa	moderate	
Miray	moderate	
Tiamanica	mild	
Betangas	moderate	
Ponkan	moderate	
Kinokuni	severe	
Dancy	severe	stunted
Silverhill satsuma	moderate	stunted
Mandarin hybrids:		
Shekwasha	none	
Calamondin	none	
Kara	moderate	
King (orange)	mild	
Temple (orange)	severe	stunted
Williams tangelo	moderate	
Sampson tangelo	severe	stunted
Orlando tangelo	severe	stunted
Rangpur lime	none	

(Continued)

Table 1. (Continued)

Citrus group and variety	*Severity of iron-chlorosis leaf symptoms*	*Growth*
Sweet orange:		
Torregrossa	severe	
Ruby	moderate	
Indian River	moderate	
Lamb summer	severe	stunted
Parson Brown	severe	stunted
de Sangre	severe	stunted
de Nice	severe	stunted
Weldon	moderate	
Valencia	severe	stunted
Homosassa	moderate	stunted
Hamlin	moderate	stunted
Dillar	severe	stunted
Viciedo	severe	stunted
Ovale de Sangre	severe	stunted
Florida seedling	moderate	stunted
Mediterranean	severe	stunted
Maltese Oval	severe	stunted
Sangre Doble Fina	severe	stunted
Raymondville	severe	
Trifoliate orange and hybrids:		
Trifoliate orange	severe	stunted
Sacaton citrumelo	moderate	
Thomasville citrangequat	severe	stunted
Carrizo citrange	mild	
Uvaldi citrange	severe	stunted
Morton citrange	mild	
Norton citrange	severe	stunted
Rusk citrange	severe	stunted
Savage citrange	mild	
Cunningham citrange	moderate	
Troyer citrange	mild	
Miscellaneous:		
Sour orange	none	
Rough lemon	none	
Webb (Red Blush) grapefruit	severe	

(1) Mild chlorosis indicates yellow leaves with green veins on less than 30 percent of plants.

(2) Moderate chlorosis indicates yellow leaves with green veins on 30 to 70 percent of plants.

(3) Severe chlorosis indicates more than 70 percent of plants affected with symptoms ranging from yellow leaves with green veins to completely yellow or ivory-colored leaves.

Discussion

These results indicate that rootstocks showing lime tolerance are not likely to be found among varieties of sweet oranges. These data are in line with previous observations that seedlings of Pineapple, Parson Brown, and Florida sweet orange seedlings were intolerant to a calcareous soil in the Goodwin nursery at Mission, Texas (Cooper, 1948).

The present work indicates that lime tolerance may be found among the mandarin and mandarin hybrid varieties. The Suen Kat and Kunembo mandarins appear to have more lime tolerance than the Cleopatra mandarin. The apparent lime tolerance of the Suen Kat was observed previously in the Goodwin nursery (Cooper, 1948). The Shekwasha, likewise, showed lime tolerance in the present experiment. This confirms an observation by Swingle (1943) that the Shekwasha has lime tolerance. It grows vigorously in the porous limestone soils of extreme southeast Florida.

It is not possible at this time to evaluate properly the importance of the indicated lime tolerance of seedlings. As reported previously (Cooper and Olson, 1951), young grapefruit trees on lime-intolerant sweet orange rootstock showed severe iron chlorosis and stunting of growth when grown in a calcareous soil. Twenty-one trees of the original 24 showed severe chlorosis and died after 3 years in the orchard. The remaining 3, however, showed only slight chlorosis during the first 3 years in the orchard and very little chlorosis during the next 3 years. The growth of these trees was equal to that of trees on sour orange rootstock. Likewise, trees on Cleopatra mandarin rootstock showed mild chlorosis during the first 3 years but very little during the fourth to sixth years in the orchard. During 1952 it was generally observed in nurseries in calcareous soil that some young grapefruit trees on Cleopatra mandarin may recover from severe iron chlorosis and grow satisfactorily (Cooper and Peynado, 1952). Indications are that under Rio Grande Valley conditions young trees are more tolerant to calcareous soil than older trees. Observations for iron chlorosis in orchard plantings for a long period is needed to evaluate properly the relation of rootstock variety to lime-induced chlorosis.

Summary

Observations for iron chlorosis symptoms were made on young seedlings of 61 varieties of citrus growing in non-calcareous soil (0.20 percent calcium carbonate) and calcareous soil (2.15 percent calcium carbonate). Seedlings of only three varieties showed iron chlorosis symptoms when growing in the non-calcareous soil while those of 54 varieties showed iron chlorosis symptoms when growing on the calcareous soil. The varieties growing in calcareous soil were classified according to severity of leaf symptoms and stunting of growth. Seedlings of all sweet orange varieties tested showed moderate or severe iron chlorosis; some mandarin and mandarin hybrid varieties showed no chlorosis while others showed severe chlorosis; and seedlings of trifoliate hybrids showed mild to severe chlorosis. Those varieties that showed no chlorosis were

Suen Kat mandarin, Kunembo mandarin, Shekwasha, Rangpur lime, sour orange, and rough lemon.

It is not possible at this time to evaluate properly the importance of the indicated lime tolerance of seedlings. Indications are that under Rio Grande Valley conditions, young trees are more tolerant to calcareous soil than older trees.

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Correction of Iron Chlorosis of Young Grapefruit Trees on Cleopatra Mandarin Rootstock With Chelated Iron

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Introduction

Grapefruit scions on Cleopatra mandarin rootstock have shown iron chlorosis when the trees are grown in a calcareous soil (Cooper and Olson, 1951). Because iron chlorosis is occasionally severe on young trees some nurserymen and growers in the Rio Grande Valley are reluctant to use this rootstock. Iron sulfate applied to the soil has not given the greening of chlorotic foliage. When this material is applied as a foliage spray it has resulted in the formation of scattered green spots on chlorotic leaves. The green spots generally disappear and inadequate beneficial results are obtained. These results with iron sulfate are similar to those obtained by Guest and Chapman (1949) in California and by Leonard and Steward (1952) in Florida.

Recently, Stewart and Leonard (1952) reported that chelated iron applied to the soil corrected iron chlorosis of citrus in Florida. The results in Florida stimulated studies in Texas on the use of chelated iron as a possible corrective of lime-induced iron chlorosis of grapefruit trees on Cleopatra mandarin rootstock. The present paper is a progress report on these studies.

Methods and Materials

One- and two-year old Ruby red grapefruit on Cleopatra mandarin rootstock growing at three different locations (A, B, and C) were used for these experiments. The soil pH of A was 7.7; B, 8.0; C, 7.8. The calcium carbonate content of the soil at A was 1.0 percent; B, 2.3 percent; and C, 1.8 percent. The trees in all instances showed iron chlorosis. The veins of the leaves were dark green whereas the interveinal area ranged from light green to ivory. Many of the chlorotic leaves had necrotic spots.

Foliage sprays were made with solutions of each of the following materials: iron sulfate alone, iron chelate of ethylenediamine tetraacetic acid (EDTA)[1], and the iron chelate of diethylenetriamine pentaacetic acid (DTPA)[2]. A small quantity of Dreft was added to the spray solution as a wetting agent.

Four materials tested as soil amendments included iron sulfate alone, iron chelate of EDTA, iron chelate of DTPA and iron chelate of hydroxyethylethylenadiamine triacetic acid (EDTA-OH)[3]. Varying amounts of the materials (see table 1) were added to the soil at a single position 6 inches deep and 10 inches from the trunk of the tree where fine lateral roots occur. The treated area included approximately 36 square inches which was approximately one sixth of the area of the entire root zone of the trees.

Results

Chelated Iron Applied as a Foliage Spray. Foliage sprays of iron EDTA and iron DTPA were applied during the fall of 1952 and spring of 1953 to chlorotic trees at all three locations. The rates of application consisted of 1 percent, 2 percent and 4 percent solutions of the iron complex. The 2 and 4 percent solutions of both iron chelates caused leaf burning and splitting and gumming of the bark of the terminal twigs. The sprays induced green spots on some leaves, and complete greening of others, and had no effect on others. Since the results were erratic and the tests limited, the advisability of using sprays of iron chelates on trees needs further study.

Chelated Iron Applied as a Soil Amendment. On the basis of work done to date, iron chelates applied as soil amendments are more satisfactory than the same materials applied as foliage sprays. When iron EDTA, iron EDTA-OH, or iron DTPA was applied to the soil about chlorotic trees, marked improvement in the trees occurred within 8 weeks after application (table 1). Some leaves on treated trees showed only three-fourths or more of the leaf area turning green, while others showed complete greening (figure 1). On some trees only part of the leaves greened while on others all greened. Where the chlorotic leaves before treatment had necrotic spots the chlorotic area greened leaving necrotic spots on green leaves (figure 1). New growth flushes of green leaves usually accompanied the greening of chlorotic old leaves. The treated trees presented a distinct contrast to control trees receiving only $FeSO_4.7H_2O$. The control trees remained chlorotic and did not produce a new flush of growth during the 8-week period.

The most effective treatment at location A was iron EDTA-OH, which caused greening of chlorotic trees when 4 grams of chelated iron per tree was used. Twenty-seven and 68 grams of chelated iron were required to green chlorotic leaves when EDTA and DTPA, respectively were used. The tests made at locations B and C were not as extensive as

[1]These investigations are a part of the Cooperative Citrus Rootstock Investigations conducted by the Texas Agricultural Experiment Station and the U. S. Department of Agriculture, certain phases of which were carried on under the Agricultural Marketing Act (RMA Title II). The helpful suggestions of Ivan Stewart and Chester Leonard of the University of Florida, Citrus Experiment Station at Lake Alfred, Florida, are greatly appreciated.

[1]Versene iron chelate or ferrogrene manufactured by the Bersworth Chemical Co.
[2]Crystalling acid form of Chel 330 manufactured by Alrose Chemical Co.
[3]Liquid Chel 153 manufactured by Geigy Agricultural Chemicals.

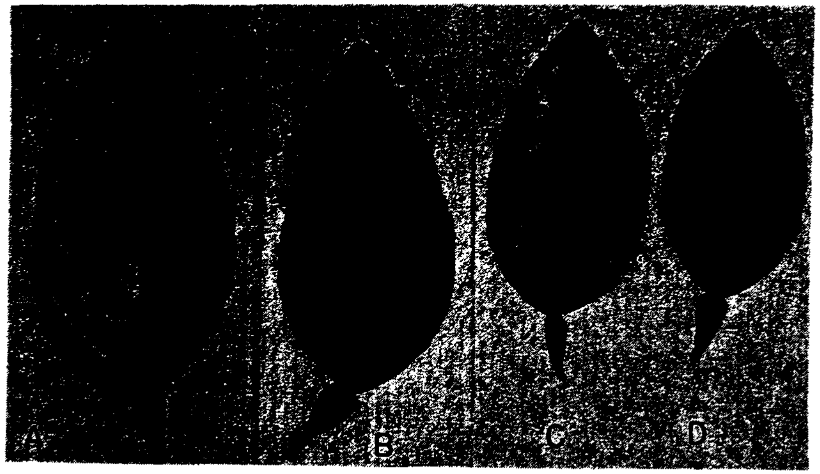

Fig. 1. Leaves of Ruby red grapefruit on Cleopatra mandarin rootstock 8 weeks after treatment. A—Chlorotic leaf from tree receiving $FeSO_4.7H_2O$ only. B—Completely green leaf from tree treated with 4 grams of iron chelate of EDTA-OH. C—A completely greened leaf except for the necrotic spots which were in the leaf before treatment with 4 grams of iron chelate of EDTA-OH. D—A practically greened leaf on tree treated with 4 grams of iron chelate of EDTA-OH.

Table 1. Effect of soil application of iron chelates on greening of chlorotic foliage of small grapefruit trees on Cleopatra mandarin rootstock. (Three trees given each treatment Oct. 1, 1953 at location A.)

Chelating agent	*Chelated iron per tree*	*Trees with leaves in indicated condition 8 weeks after treatment.*		
		All chlorotic	*Some green*	*All green*
	grams	*number*	*number*	*number*
None[1]	—	3	0	0
EDTA	14	2	1	0
	27	1	1	1
	54	0	2	1
EDTA-OH	4	0	2	1
	13	0	1	2
DTPA	17	3	0	0
	34	2	1	0
	68	0	3	0

[1]Used 1 pound of $FeSO_4.7H_2O$ per tree.

those made at location A but the results were substantially the same as at A.

Discussion

Chelated iron corrects iron chlorosis on grapefruit trees in the nursery in calcareous soils in the Rio Grande Valley. However, the quantities required of the materials tested were relatively large and treatment may be impractical for general nursery use at present because of the expense of chelates. Yet, the use of these iron chelates provides a new approach to the iron chlorosis problem in the Rio Grande Valley, and subsequent developments may reduce the cost per tree. Of the three materials tested, EDTA-OH was the most effective and appears to have the most promise. The results of the trials on calcareous soils in Texas confirm the earlier findings (Leonard and Stewart, 1953) that EDTA-OH is a more efficient supplier of iron than EDTA when the two compounds were compared on calcareous soils in Florida. It is hoped that tests now in progress will disclose more efficient methods of applying the materials to the nursery row. Other tests are being conducted on soils with more calcium carbonate than those described in the present work.

Summary

Chelates of iron with ethylenediamine tetraacetic acid (EDTA), hydroxyethylethylenediamine triacetic acid (EDTA-OH) and diethylenetriamine pentaacetic acid (DTPA) corrected iron chlorosis on small Ruby red grapefruit trees on Cleopatra mandarin rootstock growing in a nursery on slightly calcareous soils. Leaves on some chlorotic trees became green within 8 weeks when trees were supplied with a single soil application of 4 grams of iron chelated with EDTA-OH, 27 grams of iron chelated with EDTA and 68 grams of iron chelated with DTPA. At this time foliage spray of iron chelates are not as promising correctives of iron chlorosis as soil applications. Further study is required to develop a practical method of applying these materials to calcareous nursery soils.

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Notes on the Processing Characteristics of Limes

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Limes have been grown successfully in the Lower Rio Grande Valley, but because of a limited market there has been little interest in commercial production until the recently popularity of frozen limeade base has offered prospects of a profitable outlet.

During the spring and summer of 1953, several citrus processors expressed interest in the possibilities of manufacturing commercial products from limes. Their interest was prompted by the possibilities for Valley grown fruit; availability of idle plant facilities for processing citrus, and the fact that since the Valley is only 250 miles from the northern lime producing area in Mexico, an immediate source of raw material was readily available.

Since Valley lime orchards were destroyed in the freezes of 1949 and 1951, and since production would be started on Mexican-grown fruit, samples of these limes were supplied to the Weslaco laboratory for preliminary studies. These Mexican limes are of the same type as those grown heretofore in the Lower Rio Grande Valley, being variously known as West Indian, Key, or Mexican limes. The following information was obtained during the processing of these samples.

The acid content, as citric, varied from 6.7 to 8.0 percent, as is shown in table 1. Jacobs (1951) reports the acidity of Persian limes as varying from 5.58 to 6.26 percent, depending on maturity. Bissett et al (1954) report the citric acid content of a sample of Persian limes grown in Florida as 5.75 percent. This indicates the acid content of juice from Mexican limes averages 1.5 percent higher than Persian limes. Limes grown on the Florida Keys are similar to Mexican-grown limes in composition. Stahl (1935) reports 8 percent acid in Florida Key limes.

Lime juice may have both bitterness and high oil content that can cause the juice to be unacceptable. Peel oil pressed into the juice causes it to have a sharp or burning taste. More oil is obtained from green limes than from mature fruit. Taste tests indicate the upper limit of oil content to be about 0.10 – 0.15 ml. of recoverable oil per 100 ml. of fresh, unsweetened juice. Dilution with sugar and 5 volumes of water will result in a limeade oil content of approximately one-eleventh of this amount. Processors prefer an oil content in the reconstituted drink of .004 ml. per 100 ml. Excess peel oil can be largely removed by running the juice through a deoiler (vacuum flashing) but bitterness is not affected by this procedure. Seshadro (1943) has shown the bitterness of limes to be due to limonin rather than naringin. Emerson (1949) discusses the de-

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Table 1. Composition and taste of fresh and reconstituted sweetened lime juice obtained by different extraction methods.

Method of Extraction	FRESH JUICE				RECONSTITUTED JUICE			
	Percent Yield	*Acid as Citric Gm/100 ml*	*Degrees Brix*	*Oil: ml per 100 ml*	*Acid as Citric Gm/100 ml*	*Degrees Brix*	*Oil: ml per 100 ml*	*Bitterness—Taste*
1. Hand press	31	8.0	9.1	.11	.74	13.0	.03	No bitterness
2. Model F press	49	7.4	9.0	.92	.76	13.2	.18	Bitter
3. Chisholm-Ryder Model C	45	7.2	9.0	.60	.74	13.4	.12	Very bitter
4. Commercial Press	—	7.5	9.0	(Deoiled) .02	.78	13.0	—	Slightly bitter
Treatments to Lower Oil Content								
Hand peeled, Hand pressed	56	7.0	8.4	.025	.72	13.2	—	Slightly bitter
Lye peeled, Hand pressed	53	6.7	8.4	.083	.64	13.8	.01	Slightly bitter
Chisholm-Ryder Model C	45	7.2	9.0	.60 .15*	.75	13.4	—	Very bitter

*Deoiled in Mojonnier Evaporator.

velopment of bitterness due to limonin in navel oranges. He states that bitterness develops from a water-soluble, non-bitter precursor which is converted to limonin under the influence of the acidity of the juice. Limonin disappears from navel oranges as the fruit matures. This is apparently also true with limes, as less difficulty with bitterness was experienced when more mature fruit was processed. To insure minimum bitterness it is best to process mature fruit and it is very important that rag and pulp be separated from the juice immediately following pressing. More work on the components causing bitterness of limes is planned.

Several methods of extraction, and three treatments to reduce oil content were tried with the limes submitted to this laboratory. Cutting the limes in half and pressing each half with a squeezer as is frequently done when serving fresh limeade gave a juice yield of 31 percent of the weight of limes; acid content of the juice was 8.0, Brix 9.1, and the oil content (0.11 ml. per 100 ml. juice) close to what is considered the upper limit. The juice was not bitter and the limeade was judged very acceptable. Limes which were cut and pressed in a Chisholm-Ryder* Model F juice extractor produced juice which was too high in oil and too bitter for use as a limeade base. Commercial juice (No. 4 in table 1) produced by pressing limes between two perforated stainless steel plates and deoiling, gave a product which, when reconstituted had only a slight bitterness. One lot of limes which was processed in a Chisholm-Ryder Model C press*, and then run through a Mojonnier flash evaporator to remove excess oil was extremely bitter. Before deoiling this juice contained 0.6 ml. of oil per 100 ml.; after deoiling, 0.15 ml. When limes were peeled and then hand-pressed the juice contained .025 ml. of oil per 100 ml.

Juice from limes pressed in a rotary juice press lacked pronounced bitterness, but required deoiling to produce an acceptable limeade base.

It was found that by careful extraction, using equipment which did not tear or macerate the fruit, immediate filtration of the pressed juice, removal of excess oil if necessary, and adjustment of the sugar-acid ratio to 15 or 16 to 1 by bringing the Brix to 60-65° with added sugar, an excellent limeade base can be produced from Mexican limes. Reconstitution using five volumes of water to one of sweetened juice gives a beverage having an acidity of approximately 0.7-0.8 gms. acid per 100 ml. of beverage and a sugar content of 12-14 percent. Data on the yield and analysis of several lots of lime juice is contained in the attached table.

Conclusions

An excellent limeade can be made from Mexican limes if careful extraction procedures are used. Due to high acidity, Brix of the limeade base should be adjusted to 60-65°. For reconstitution five volumes of water to one of base should be used to bring the limeade to an acidity of approximately 0.7 to 0.8 gms. per 100 ml. and a sugar content of 12 to 14 percent.

*Mention of a commercial product does not constitute an endorsement of one manufacturer or product over another, and is made for convenience.

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