JOURNAL

OF THE

RIO GRANDE VALLEY HORTICULTURAL SOCIETY

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TABLE OF CONTENTS

RESEARCH REPORTS

Aims and Objectives of the Society

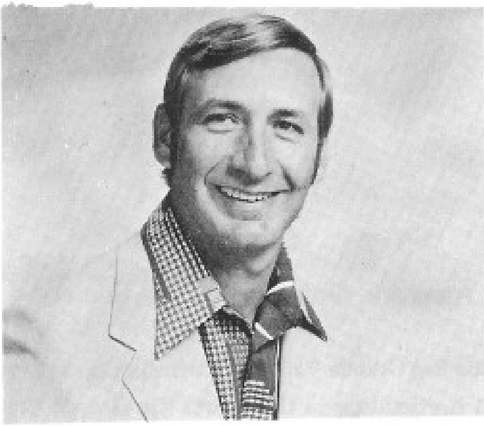
The purpose of the Rio Grande Valley Horticulture Society is the advancement and development of horticulture in the Lower Rio Grande Valley of Texas. It is the Society's aim to stimulate interest in research and its practical application to the Valley's problems with fruit, vegetables, and ornamentals.

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

The Society has sponsored 31 annual Institutes featuring outstanding speakers from all parts of the country who have presented new developments in the field of horticulture. Panel discussions, social get-togethers, and a barbecue complete the all-day program.

Talks given at the Institute and reports of Valley research are published in the *Journal of the Rio Grande Valley Horticultural Society*, providing a continuing record of horticultural progress in the Valley.

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



Fred Karle
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A. H. "Dutch" Karcher

Recipient of the Arthur T. Potts Award

Mr. A. H. "Dutch" Karcher is a native of Giddings, Texas. Lettering in baseball, he graduated from Texas A&M with a degree in Horticulture. A career Extension worker, Mr. Karcher retired in 1974 after 34 years of distinguished service.

Honors received during this time include the Texas Superior Service Award and Past President of the Texas County Agricultural Agents Association.

The contributions made by Mr. Karcher to Valley Horticulture during his 16 years as Hidalgo County Agent have been many. He has been executive director of the Hidalgo County Soil and Water Conservation District since its inception. He was instrumental in the adoption of tomato, carrot, lettuce, onion and citrus marketing orders by Valley producers.

His longtime support of the All-Valley Winter Vegetable Show at Pharr and the Texas Citrus Fiesta at Mission is well noted and deeply appreciated.

Mr. Karcher has disseminated information about Valley Horticulture by conducting tours for groups from France, Argentina, Japan and South Africa to name but a few.

The inscription on his plaque reads: "In recognition of his contributions to the Rio Grande Valley Horticultural Society, the Valley citrus and vegetable industries, the teaching and promotion of horticulture to the youth and adults of the Rio Grande Valley and his longtime devotion to helping people help themselves."

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Program of the Thirty-Second Annual Institute
Rio Grande Valley Horticultural Society
January 24, 1978

MORNING SESSION: John Fucik — Presiding

"Peaches: A Potential
Fruit Crop for the Valley" . . . . Andy Hill
Tex-Ag Co.,
Mission

"The Role of Citrus Rust Mite
in Pest Management of Citrus in Florida" . . . . Clayton McCoy
Entomologist,
IFAS, University of Florida,
Lake Alfred

"Avocado Marketing" . . . . Joe Ernst
Calavo Growers, Inc.,
San Antonio

Presentation of the
Arthur T. Potts Award . . . . Andy Scott
President

AFTERNOON SESSION: Marvin Miller — Presiding

"Plant Growth Regulators:
Current and Future Use in Horticulture . . . . Page Morgan
Professor,
Dept. of Plant Sciences,
Texas A&M University,
College Station

"Transplants: New Interest
In an Old Method" . . . . Jim Carson
Griffin and Brand, Inc.,
McAllen

"Breeding Cole Crops for Texas . . . . Bill D. Kingston
Assistant Professor,
Texas A&M University
Vegetable Research Station,
Munday

"Broccoli: Hybrid or
Open-Pollinated Varieties for the Valley . . . . Andy Scott
Director of Research,
Rio Farms, Inc.,
Monte Alto

EVENING SESSION: John Deaton — Presiding

"Houseplant Containers:
Picking the Perfect Pot" . . . . Frances Hash
Mission

"Rare and Endangered Native Plants
as Ornamentals for South Texas . . . . James H. Everitt
Range Scientist
S and WCR, SEA, USDA,
Weslaco

"Small Shrubs in Valley Landscapes" . . . . Phillip Buck
The Flower Pot,
Harlingen

SUMMARIES OF TALKS PRESENTED AT THE THIRTY-SECOND ANNUAL INSTITUTE OF THE RIO GRANDE VALLEY HORTICULTURAL SOCIETY

Peaches in the Lower Rio Grande Valley of Texas

Andrew L. Hill, Jr.
President, Tex-Ag Company
Mission, Texas

The peach is the leading deciduous fruit in Texas with approximately 12,000 acres grown, producing one million bushels annually. An effort was made to evaluate the potential commercial production of peaches in the Lower Rio Grande Valley of Texas.

Varietal Selection

The two varieties used were Florida Bell and Mac Red, both of which have been grown successfully in other sub-tropical regions of the United States. Their chilling requirements are approximately 150 hours. Chilling hours are the numbers of hours below 45 F. during the dormant period. Both varieties were grafted to nemogard rootstock, which is resistant to the root-knot nematode.

Cultural Practices

A 13-acre, well drained sandy loam soil was selected as the planting site. Peaches require a well drained soil and do poorly under constantly wet conditions. The planting arrangement yielded 140 trees per acre, which gave 1800 trees on the block. Trees were planted in February of 1976. Drip-irrigation was installed in order to accurately apply water as the trees progressed. Contact herbicides were applied in the tree row to control weeds and grasses. The middles of the rows were disked. Liquid Nitrogen fertilizer was periodically injected into the drip-irrigation system, giving each tree approximately ½ lb. N per year. During the early Spring, we injected Iron Chelate into the system, as some of the new growth appeared chlorotic. This application of iron corrected the minor chlorosis observed.

In late December and early January all trees are pruned by hand. The object of pruning peach trees is to create a "bowl" shaped appearance. Branches are removed from the center of the tree to allow light in and force the fruiting branches to grow out from the center.

After the trees leaf out in the Spring a spray program using 6-7 lb. wettable sulfur per acre is initiated. Sulfur is used to prevent rust on the leaves later in the year. If rust develops in July or August trees will prematurely defoliate, thus reducing next year's crop.

Fruit Handling Procedures

Young fruit should be thinned when it is about one-half inch in diameter. The object in thinning is to have one fruit for every 4-6" of branch. Fruit sizes better when thinned. Thinning also aids in harvesting. We thinned by hand as no chemical or mechanical means were available.

The Mac Reds were ready for harvesting in early May. Peaches grow rapidly as they approach maturity, gaining approximately one size every 2 - 3 days. The irrigating schedule was increased during this period to meet the needs of the rapidly growing fruit.

Peaches are difficult to handle after harvesting. They should be cooled to about 36 F. as quickly as possible after harvesting. Once cooled the carrying capabilities are greatly increased, and they can be kept in storage for as long as two weeks.

Our entire crop was marketed locally through a Valley grocery chain. With any new crop marketing becomes a problem because local produce people are not equipped to handle small quantities.

Avocado Marketing

Joe M. Ernst
Calavo Growers of California

Calavo is organized as a cooperative for the purpose of marketing fresh produce commodities throughout the United States and Canada with our principal item being avocados. Approximately 2,500 growers make up the Calavo organization in the states of California and Florida. Five principal marketing offices located in California, Texas, Florida, New York and Washington make up our nation-wide sales organization. At present Calavo is marketing fifty percent of the avocado production from the state of California, this year estimated at 160 to 170 million pounds. This market share proves to be of great value to the buyer in that he can depend on Calavo having avocados fifty-two weeks a year. Calavo considers itself to be the industry leader in the handling and marketing of avocados from the grower to the consumer.

Our principal function is to serve as marketing organization for achieving optimum return for grower production of avocados and other commodities. For this service we assess a commission of 10 to 15 percent depending on the amount of service and volume involved.

Harvesting - - A key ingredient in Calavo's success includes harvesting at the proper time to achieve optimum oil content, best possible size mix, favorable market conditions and to provide the most palatable fruit for the consumer. All of the above combine to achieve the best grower return possible.

Grading - Quality Control - - One of the most outstanding traits of Calavo is the quality control in their finished products. This is achieved by persistent work by our field representatives and technicians at each packing house operation.

Sizing - - A necessary part of effective marketing is achieving consistent sizes and weights of avocados within a container. Additionally, container minimum weights and sizes are necessary to establish and maintain buyer creditability.

Packing - - The packing house processing line and packing operation is the last major point where quality is consistently monitored and reviewed. At Calavo's four packing operations these processes of quality control are the primary concern of the packing house manager and his staff. Containers for avocados must have rigidity to protect fruit during transit, be of attractive appearance, identify product and producer, be readily available at minimum cost.

Storage - - An inherent part of each Calavo packing operation is a storage facility adequate to properly refrigerate the unshipped pack of the day's production. This feature helps tremendously to stabilize prices and adds shelf life to the product.

Distribution - - Calavo's Distribution Department has a staff totally responsible for providing dependable and efficient movement of our products. This is a very important and valued asset of our organization.

Marketing - Service - - After all the preparations previously mentioned have been achieved our marketing staff in five states is ready to work. They stay atop of market conditions in every region and provide on-the-ground service and inspection of deliveries. No other organization for the marketing of fresh produce has been able to achieve such effective market coverage.

Financial Management - - A computer billing operation is a necessity to maintain up to the minute knowledge of the thousands of customers throughout the United States. The finest product marketed at the highest price in the most expert fashion is of little value until the collection is made. The sales staff located in the field help greatly to minimize any losses due to business failures, and the like.

Consistency of Supply - - Another asset which is extremely important to the wholesale and retail buyers is a consistent and reliable supply of product. Calavo is in contact firty-two weeks a year with every major user of avocados in America. Without this constant contact, communications break down and are very difficult to reestablish.

Market Development - - Calavo spends significant amounts of money each year in an effort to expand the market for avocados. This program is administered by a staff of professionals. The California Avocado Advisory Board, representing the California Avocado Industry, spends several million dollars annually promoting avocados. These efforts have significantly increased per capita consumption in recent years.

Volume Projections - - In order to project prices and marketing objectives each year, a very thorough project is undertaken to project the next year's volume. This is further broken down by month - week - etc. As new producers in the broad commercial sense it is even more important for you to estimate to the best of your ability the projected volume during the marketing season. Recognizing the complexity of this task you, as grower/shippers, are in the best possible position to make such projections.

We are interested in your problems and successes in Texas. Any benefits that we can provide Texas Growers will also prove beneficial to our growers in California and Florida. We are hopeful this interest is mutual with you learning more about Calavo and its past performances in the marketing of fresh produce.

Breeding Cole Crops for Texas

Billy D. Kingston
Texas A&M Vegetable Research Station
Munday, Texas

Texas ranks first in cabbage production acreage in the United States with estimates of over 20,000 acres being produced in the state in 1977. Principal production areas include the Rio Grande Valley, San Antonio - Winter Garden and High Plains. Smaller acreages are grown in the Coastal Bend, Trans-Pecos, East Texas and North Texas areas. In addition approximately 800 acres of broccoli and 250 acres of cauliflower were grown in the Rio Grande Valley during 1977. Principal production problems include disease and insect control as well as non-uniformity of maturity. A breeding program has been initiated to develop inbred lines to be used in the production of hybrids which have resistance to the important diseases and insects and are adapted to principal production areas of the state.

Suitable sources of resistance to downy mildew, Alternaria and tip burn are being sought. High levels of resistance to Black Rot and Fusarium yellows are available and are being included in the breeding program. Resistance to cabbage insects primarily cabbage looper, imported cabbage-worm and diamondback moth are also being sought and will be incorporated into adapted lines.

Rare and Endangered Native Plants of Ornamental Value in Southern Texas

J. H. Everitt
Range Scientist
Southern Region, SEA, AR, USDA
Weslaco, TX 78596

An outstanding characteristic of southern Texas is its rich and variable flora. The South Texas Plains or Rio Grande Plain vegetational area consists of about 22-million acres located on a line projected from Del Rio on the Rio Grande River eastward to San Antonio and then to the mouth of the Guadalupe River (4). Over 2,300 native plant species grow in this area, including: 394 grasses, 281 shrubs, 1,615 forbs, and 32 cacti (5).

The Lower Rio Grande Valley is in this vegetational area. The Valley's flora is very complex because of a wide variation in climate, soils, and topography. Rainfall rapidly decreases from a 28-inch average at Brownsville on the coast to a 17-inch average inland at Rio Grande City which causes abrupt changes in our flora. The subtropical climate permits many plant species common to southern Mexico to grow in our area.

Land clearing for growing crops and grasses, draining ponds and resacas for agriculture, building of levees and dams to stop the overflow of water from the Rio Grande River, and wide-spread grazing and burning have caused the loss of several native plant species and the rapid destruction of other native plants. The Rare Plant Study Center at the University of Texas at Austin listed 69 plant species in the South Texas Plains vegetational area that are rare or endangered, and a large number of these grow in the Valley (6). We should make intensive efforts to maintain these rare and endangered species as members of our unique native flora. These efforts should include the establishment of plants from seedlings or cuttings of these species in protected areas, like the Santa Ana and Laguna Atascosa National Wildlife Refuges near Alamo and Harlingen, Texas, respectively, and Bentsen State Park near Mission, Texas. Another way to preserve these rare and endangered species is to use them as ornamentals.

Cenizo (*Leucophyllum frutescens* (Berl.) I. M. Johnst.), Mexican olive (*Cordia boissieri* A. DC.), Texas ebony (*Pithcellobium flexicaule* (Benth.) Coult.), and anacua (*Ehretia anacua* (Teran & Berl.) I. M. Johnst.) are native plants that are already highly prized as ornamentals. Twenty rare and endangered species of native plants that have potential as ornamentals in the Valley are described below:

AMARYLLIDACEAE - Amaryllis family

Agave lophantha Schiede. Thorn-crested Agave. A small agave reaching a height of 40 cm, characterized by sharp spines along the leaf margins. It grows on a few sandy loam soils in Starr and Zapata Counties.

BROMELIACEAE - Pineapple family

Hechtia glomerata Zucc. Guapilla. Desert-like plant similar in appearance to agave or yucca. Its leaves are arranged in a densely-spreading rosette with stout recurved spines along the leaf margins. It may grow to 60 cm in diameter. It grows on a few gravelly sites and sandstone formations in Starr and Zapata Counties.

CACTACEAE - Cactus family

Echinocactus asterias Zucc. Star cactus, sea-urchin cactus. A small spineless cactus reaching a diameter of 15 cm. It has beautiful yellow flowers, and unlike most cacti, this species flowers throughout the growing season. It is nearly extinct. A few populations grow in Starr County.

CAPPARIDACEAE - Caper family

Capparis incana H. B. K. Vara blanca. Rare evergreen spineless shrub with linear leaves and white flowers. It is represented by a single shrub in the United States on the Santa Ana National Wildlife Refuge in Hidalgo County that was discovered as a member of our native flora in 1970.

COMPOSITAE - Sunflower family

Gochnatia hypoleuca DC. Ocote. Evergreen, spineless shrub usually 1 to 2 m tall, with the twigs and bottom sides of leaves pale green colored and covered with densely-matted pubescence. The upper surfaces of the leaves are dark green and the flowers are white. This shrub is rare and grows on rocky hillsides or caliche ridges in Duval, Hidalgo, Jim Hogg, Starr, and Zapata Counties.

CUPRESSACEAE - Cypress family

Taxodium mucronatum Ten. Montezuma bald cypress, sabiño. A large tree with a straight trunk and enlarged base reaching a height of 30 m. The fruit is cone shaped. A few plants grow along the Rio Grande River in Cameron, Hidalgo, and Starr Counties.

EUPHORBIACEAE - Spurge family

Bernardia myricaefolia (Scheele) Wats. Southwest bernardia. Densely branched, evergeen, spineless shrub usually 1 to 1.5 m tall. The leaves are dark green and covered with pubescence. A few plants grow on rocky hillsides or caliche ridges in the western half of the South Texas Plains.

Euphorbia antisyphilitica Zuccarini. Candelilla, wax euphorbia. Small erect shrub reaching a height of 70 cm, with rodlike, leafless stems. It is primarily a Chihuahuan Desert species, but it was recently discovered in Starr and Webb Counties of south Texas (3).

FLACOURTIACEAE - Flacourtia family

Xylosma flexuosa (H. B. K.)). Ktze. Brush-holly; coronilla, Mexican xylosma. Slender, evergreen, thorny shrub usually 2 to 3 m tall, with white flowers followed by bright red berries. A few plants grow in the brushlands and palm groves of Cameron County.

LEGUMINOSAE - Legume family

Coursetia axillaris Coult. & Rose. Texas baby-bonnets. Densely branched, spineless shrub reaching a height of 1.5 m, producing colorful pale-pink flowers followed by small reddish-brown seed pods. A few plants grow in brushy vegetation on caliche ridges in Duval, Hidalgo, Jim Hogg, and San Patricio Counties.

Pithcellobium pallens (Benth.) Standl. Tenaza, huajillo. Spiny shrub or small tree reaching a height of 6 m. It produces colorful, white, mimosa-like flowers after heavy rains in summer. It grows on alluvial soils or on the edges of resacas in Cameron, Hidalgo, Starr, and Willacy Counties.

LYTHRACEAE - Loosestrife family

Heimia salicifolia (H. B. K.) Link & Otto. Hachinal, willow-leaf heimia. Much-branched, spineless, yellow-flowered shrub reaching a height of 3 m, but it is usually much shorter. A few plants grow on alluvial soils or along resacas or streams in Cameron, Hidalgo, and Willacy Counties.

MALVACEAE - Mallow family

Hibiscus cardiophyllus Gray. Tulipan del monte, mountain rose-mallow, scarlet hibiscus. Woody-based perennial subshrub reaching a height of 60 cm, with showy crimson to deep rose-red flowers. Some plants grow on gravelly hills, around boulders and breaks, and in chapparral in the western half of the South Texas Plains.

PALMAE - Palm family

Sabal texana (Cook) Becc. Texas palm, Texas palmetto, Rio Grande palmetto, palma de micharos. Tall tree reaching a height of 16 m, with large fan-like leaves forming a rounded crown. It is very similar to the cultivated Washington palm, but it has no prickles on the leaf petioles. It grows only on flatlands along the Rio Grande River, and along resaca edges in Cameron County.

ROSACEAE - Rose family

Prunus texana Dietr. Peach brush, durazno, durasnillo. Dwarf, spineless shrub with crooked branches and subevergreen leaves reaching a height of 1 m. It produces pink or white flowers followed by small peach-like fruits. A few plants grow on deep sandy soils in Brooks, Hidalgo, and Starr Counties.

RUBIACEAE - Madder family

Cephalanthus salicifolius H. & B. Mexican buttonbush. Spineless shrub or small tree reaching a height of 3 to 4 m, with showy white flowers and large, lanceolate, dark green leaves. A few plants grow in the wet soils in western Hidalgo County. This species was presumed to be extinct; however, it was rediscovered in 1974.

RUTACEAE - Citrus family

Amyris madrensis Wats. Mountain torchwood, Mexican Amyris. Slender, evergreen shrub or small tree usually 1 to 3 m tall, with all parts citrus-scented when bruised. This species produces small green or white flowers and a black one-seeded fruit. A few plants grow in brushy areas in Cameron, Hidalgo, and Willacy Counties.

Esenbeckia berlandieri Baill. Jopoy. Small tree reaching a height of 3 to 6 m, with glossy, dark-green, trifoliolate leaves. It has small cream-white flowers and a five-lobed fruit. It is an exceedingly rare species; formerly known from four trees at Los Fresnos, Cameron County, at a locality that has since been cleared of most of its vegetation. Presumably, it is no longer a member of our flora; although it is being grown as an ornamental at several locations in Cameron and Hidalgo Counties (1).

SOLANACEAE - Nightshade family

Solanum erianthum D. Don. Potato tree, salvadora. Shrub or small tree reaching a height of 3 m, with large leaves covered with fine pubescence. It has small white flowers followed by yellow many-seeded berries. A few plants grow along the resaca edges near Olmito in Cameron County. It has been established in Santa Ana National Wildlife Refuge and is being grown as an ornamental at several locations in Hidalgo County (2).

VERBENACEAE - Vervain family

Citharexylum berlandieri Robins. Berlandier fiddlewood, negrito, orcajuela. Shrub or small tree reaching a height of 6 m, with clusters of bright-red fruits. A few plants grow in thickets in coastal areas of Cameron and Willacy Counties.

Efforts are now underway to propagate many of these rare and endangered species from both seeds and cuttings under greenhouse conditions. Investigations need to be conducted as to the optimum field conditions for growing these plants as ornamentals. Hopefully, these plants will remain as species of our native flora and will become valuable and aesthetic ornamentals in our yards and gardens in the Lower Rio Grande Valley of Texas.

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RESEARCH REPORTS

Effect of Exocortis Infection on the Performance of Star Ruby Grapefruit on Sour Orange and Troyer Citrange Rootstocks

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ABSTRACT

Inoculation of Star Ruby grapefruit trees on sour orange (*Citrus aurantium* L.) rootstock with mild and severe strains of exocortis viroid did not affect trunk diameter, canopy volume, or yield when compared to non-inoculated control trees. Inoculation of Star Ruby grapefruit on Troyer citrange [*Poncirus trifoliata* (L.) Raf. x *C. sinensis* (L.) Osbeck] rootstock with a severe strain of exocortis reduced trunk diameter somewhat and reduced canopy volume by 50%. The mild strain did not affect growth of Star Ruby grapefruit trees on Troyer citrange rootstock. Production of dwarf citrus trees may be achieved by inoculating trees on Troyer citrange rootstock with severe exocortis strains.

Exocortis viroid causes severe stunting of trees grown on susceptible rootstocks such as trifoliate orange [*Poncirus trifoliate* (L.) Raf.] and its hybrids and Rangpur lime (*Citrus limonia* Osbeck) (2,3,4,5,9,10). The degree of stunting and bark scaling on the rootstock is dependent on the severity of the exocortis strain (2), the susceptibility of the rootstock (2,10), and on the climatic conditions (9). Dwarf citrus trees have been produced intentionally by inoculation of trees on susceptible rootstocks with exocortis (3,4,9). The disease reduces tree size substantially without affecting yield per unit volume of canopy, fruit size or quality (3,9).

Many commonly used rootstocks such as sour orange (*C. aurantium* L.), cleopatra mandarin (*C. reticulata* Blanco), and rough lemon (*C. jambhiri* Lush.) are considered tolerant to exocortis. However, exocortis infection reduced tree growth slightly on tolerant rootstocks when compared to virus-free control trees on the same rootstock (2,10).

Star Ruby grapefruit (*C. paradisi* Macf.) is a nucellar variety and consequently bears later and is more vigorous and thorny than the old-line Ruby Red grapefruit (6,8). The purpose of this study was to determine whether or not the early vigorous growth of Star Ruby grapefruit could be reduced by inoculation of trees on a tolerant and a susceptible rootstock with severe and mild strains of exocortis.

MATERIALS AND METHODS

Two exocortis strains were selected for the work: 1) a severe strain from an old-line Riddle Red Gold grapefruit which caused a severe leaf curl and bark splitting on Etrog citron (*C. medica* L. var. *ethrog* Engl.) indicator plants; 2) a mild strain from an old-line Marrs Early orange (*C. sinensis* L. Osbeck) which caused a slight leaf curl and petiole wrinkle in Etrog citron. To avoid inoculation of test trees with viruses other than exocortis, both isolates were mechanically transmitted from graft-inoculated indicator plants to healthy rooted citron cuttings by the knife slash technique (7). This procedure should free the exocortis isolates from viruses which are not mechanically transmissible such as xyloporosis.

In May 1972, 60 Star Ruby grapefruit trees on sour orange rootstock were planted in an orchard near Weslaco, Texas, on a 6 x 7.3 m spacing. At planting, budwood was collected from several trees and indexed on Etrog citron (1) to confirm that the Star Ruby budwood source used was exocortis-free. All indexed negative. In July 1972, 20 trees were graft-inoculated with the severe strain and 20 with the mild strain of exocortis. Control trees were grafted with two bark patches from a healthy citron. Treatments were arranged in a randomized complete block design.

In the spring of 1973, Troyer citrange seedlings were budded with Star Ruby grapefruit from an exocortis-free source. At budding, 12 of the trees were graft-inoculated with the severe strain, 12 with the mild strain, and 12 remained as non-inoculated controls. In the spring of 1974, the trees were planted in an orchard near Monte Alto, Texas in a randomized complete block design on a 4.6 x 7.6 m spacing.

Trunk diameter measurements were taken 15 cm above the budunion in early summer of each year. Canopy volumes were estimated by measuring the east-west and north-south diameters and the tree height and the volume calculated using the formula: $vol = 2.09\ r^2h$ where r = the average radius and h = height. In the block on sour orange rootstock, yields in kg/tree were determined at harvest in February and November, 1977. Yield data were not collected from the trees on Troyer citrange rootstock and the experiment was terminated early because salt problems developed at the orchard site.

RESULTS AND DISCUSSION

In the Star Ruby trees on sour orange rootstock there were no significant differences between treatments in trunk diameter, canopy volume, or yield (Table 1).

In other studies, growth of trees on tolerant rootstocks has been reduced by exodortis infection. Sinclair and Brown (10) found that trunk circumferences of navel orange trees on sweet orange and cleopatra mandarin rootstocks were

Table 1. Effect of severe and mild strains of exocortis on the growth and production of Star Ruby grapefruit trees on sour orange rootstock.

Exocortis strain	Trunk diam (cm)				Canopy volume (m^3)		Yield (kg/tree)	
	1972	1973	1974	1978	1975	1978	1976-77	1977-78
Severe	1.6	2.8	4.9	13.2	5.0	17.3	60	131
Mild	1.6	2.8	4.9	13.7	5.1	19.7	54	137
Control	1.7	2.8	5.1	13.2	5.6	19.1	68	141
	N.S.[1]	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

[1] Means not significantly different, $P \leq 0.05$.

reduced by inoculation with exocortis. The cross-sectional area of trunks of orange and Eureka lemon [*C. limon* (L.) Burm. f.] trees on sour orange rootstock was reduced by inoculation with exocortis (2). However, the growth, yield, and fruit quality of Marsh grapefruit trees on sour orange rootstock was not affected by exocortis (5). In the present study, even the severe strain did not reduce growth and there appears to be no advantage to inoculating grapefruit trees on tolerant rootstocks.

Growth of Star Ruby trees on Troyer citrange rootstock was affected by exocortis inoculation. Several of the smaller trees inoculated with the mild strain died shortly after transplanting, so that surviving trees in that treatment had a larger average trunk diameter at the beginning of the experiment (Table 2). In general, inoculation with the mild strain did not appear to affect tree performance. The severe strain reduced trunk diameters somewhat and reduced canopy volume by more than 50%. Only one of the trees inoculated with the severe strain showed bark scaling on the rootstock at 4 yr of age. Stunted trees had a healthy appearance despite their small size.

The use of exocortis for tree size control appears promising in California, Florida, and Australia where trifoliate orange can be used as a rootstock (3,4,5,9). Its use in Texas seemed less promising because trifoliate orange is poorly adapted to the fine-textured, calcareous soils in the Lower Rio Grande Valley. However, Troyer citrange is adapted to a wider range of Texas soils, and canopy size of trees on Troyer can be reduced substantially by inoculation with severe exocortis strains.

Table 2. Effect of severe and mild strains of exocortis on the growth of Star Ruby grapefruit trees on Troyer citrange rootstock.

Exocortis strain	Trunk diam (cm) 1974	1976	1977	1978	Canopy volume (m^3) 1978
Severe	1.1 b[1]	2.9 b	4.8 b	7.4	4.2 b
Mild	1.6 a	4.3 a	6.3 a	9.0	9.3 a
Control	1.3 b	3.8 a	6.1 ab	8.5	10.1 a
				N.S.[2]	

[1] Means in columns followed by the same letter are not significantly different according to Duncan's multiple range test, P = 0.05.

[2] Means not significantly different, $P \leq 0.05$.

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Identification of Lime Anthracnose in Texas

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ABSTRACT

Lime anthracnose was observed in the Lower Rio Valley of Texas for the first time. The causal organism, *Gloeosporium limetticolum* Clausen, was isolated from affected plants and symptoms of the disease were reproduced by inoculation of Mexican lime [*Citrus aurantifolia* (Christm.) Swingle] seedlings with the fungus.

Lime anthracnose, caused by *Gloeosporium limetticolum* Clausen, is a serious problem and a limiting factor in the production of Mexican lime [*Citrus aurantifolia* (Christm.) Swingle] in Florida and most of the Caribbean area (1,3). Anthracnose attacks the young leaves, shoots, blossoms and fruit of the small, acid limes. Young foliage and blossoms are blighted and distinct lesions form on leaves and fruit. Affected fruit frequently drop prematurely. The disease has been reported from many tropical areas (1), but was not noted in a disease survey of Texas citrus (2).

OBSERVATIONS AND METHODS

In the summer of 1976, a severe blight of new flushes of growth on Mexican limes growing at the Texas A&I University Citrus Center in Weslaco, Texas was noted. Young shoots were killed and affected flowers and young fruit dropped. Severe lesions typical of lime anthracnose formed on remaining leaves and fruit (Fig. 1). Symptoms were observed on the common thorny variety and on the Dominican Thornless lime.

To isolate the pathogen, affected leaf tissue was dipped briefly in 70% ethanol, rinsed in sterile distilled water and plated on corn meal agar (CMA). *Gloeosporium limetticolum* was isolated from nearly all leaf pieces plated.

For inoculation, *G. limetticolum* was grown on CMA for 2 weeks and the culture comminuted in a blender in sterile, distilled water. Spore concentration was determined by haemocytometer counts and adjusted to 10^6 spores/ml. Six 1-yr-old potted Mexican lime seedlings with new flushes of growth were sprayed to run-off with the spore suspension using a De Vilbiss sprayer (The De Vilbiss Co., Toledo, OH 43693). Six control plants were sprayed similarly with water. All plants were placed in a mist chamber for 48 hr and then moved to the greenhouse bench.

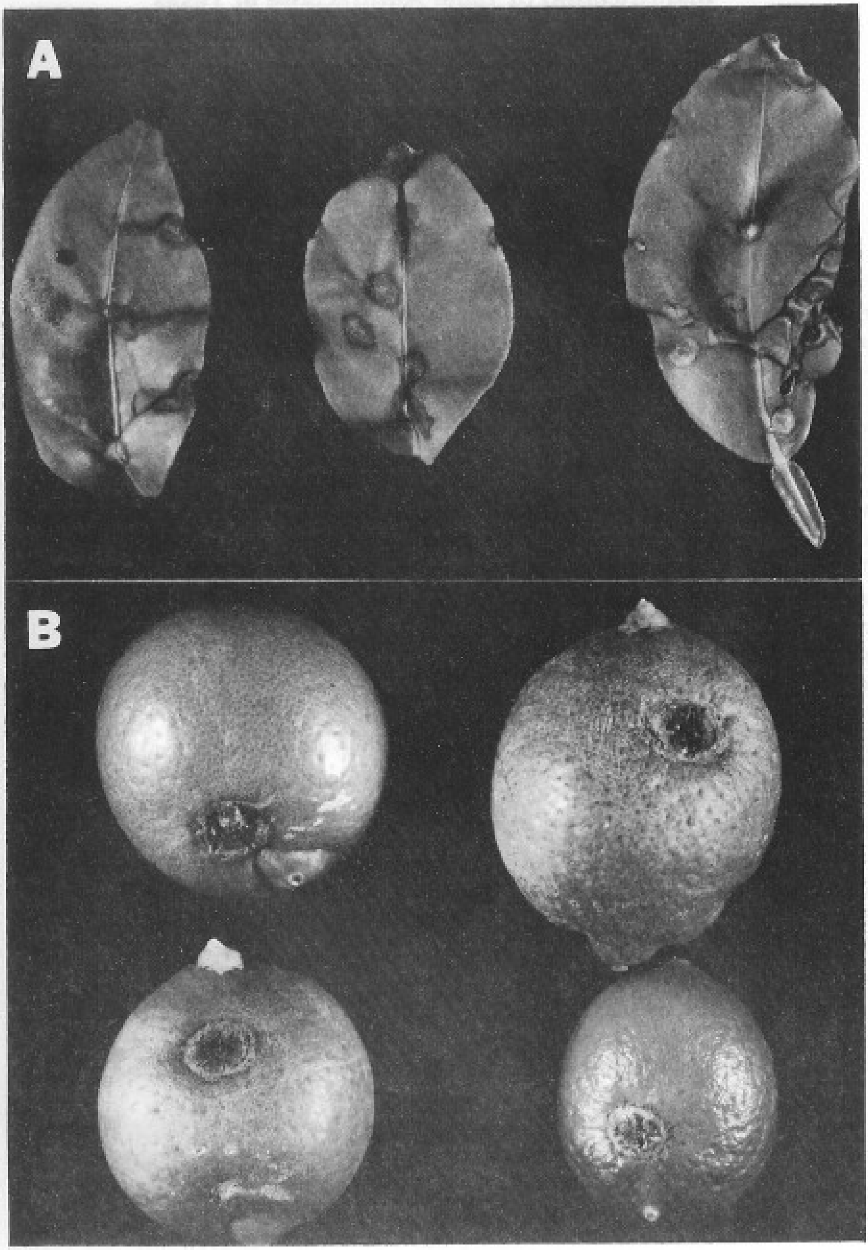

Fig. 1. Symptoms of anthracnose on Mexican lime. A) Lesions on partially expanded young leaves. B) Lesions on full-grown fruit.

RESULTS AND DISCUSSION

Four days after inoculation, typical anthracnose lesions began to form on the inoculated plants. Four of the six inoculated plants developed symptoms of the disease, whereas all control plants remained symptomless. Abundant conidia of *G. limetticolum* (Fig. 2) were produced on the lesions and the fungus was reisolated from all of the affected plants.

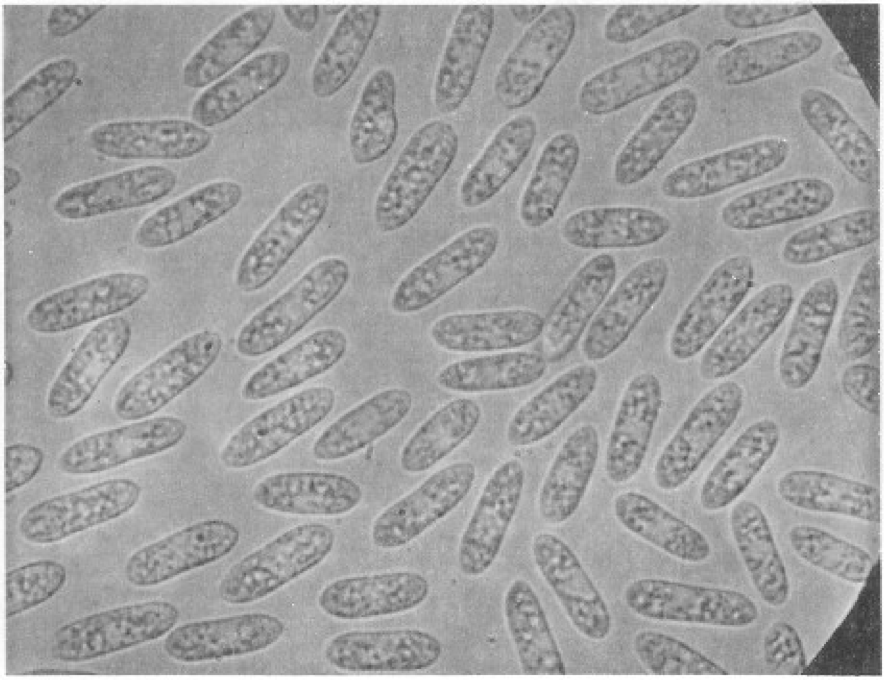

Fig. 2. Conidia of *Gloeosporium limetticolum* (1024X).

In Texas, Mexican lime is grown only for ornamental purposes and for home use. Observations over the last 2 years indicate that the disease is serious only when new flushes of growth coincide with extended periods of rainfall. Copper fungicides can be effective in controlling the disease, but they need to be applied frequently when conditions are favorable for anthracnose (1,3). Home owners can protect their trees by applying foliar fungicides during major flushes of growth. The large, seedless Persian or Tahiti lime (*C. aurantifolia* hybrid) is resistant to the disease and can be grown as a sutstitute for Mexican lime.

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'Ray Ruby' Grapefruit, A Mutant of 'Ruby Red', With Redder Flesh And Peel Color.

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ABSTRACT

'Ray Ruby' is a new red grapefruit (*Citrus paradisi Macf.*) with flesh and peel color intermediate between the 'Ruby Red' and 'Star Ruby' varieties, but with fruit quality and tree characteristics of 'Ruby Red'. It was discovered in 1970 by Mr. Robert Ray near Mission, Texas, as two trees in a 'Ruby Red' grapefruit orchard.

The 'Ray Ruby' was discovered in 1970 by Mr. Robert Ray in a 'Ruby Red' grapefruit (*Citrus paradisi Macf.*) orchard near Mission, Texas. Two five- to six-year-old trees bearing fruit with redder flesh and peel color were discovered growing with a number of 'Ruby Red' replacement trees in an older planting of 'Ruby Red' trees. There is no record of the nursery from which the trees were purchased. The two original 'Ray Ruby' discovery trees bear fruit only of the new variety type. All fruit produced on trees propagated from the original 'Ray Ruby' trees have had the characteristics of the new variety. The original bud mutation probably existed in a 'Ruby Red' tree that served as a budwood source for the nurseryman who budded and supplied the trees for the replacements. There are no differences in fruit or tree characteristics between the two originally discovered trees.

The Texas A&I University Citrus Center obtained budwood from the owner of the 'Ray Ruby' and subsequently planted the variety in field trials in November, 1971. Budwood of the 'Ray Ruby' was released by the Citrus Center to Texas citrus nuerserymen in May, 1977.

DESCRIPTION OF THE 'RAY RUBY'

Fruit of the 'Ray Ruby' is like the 'Ruby Red' in all respects except for its redder flesh and peel color. The red flesh color of 'Ray Ruby' is retained late in the season. The amount of red color, measured as mg of lycopene, in the juice of the 'Ray Ruby' was found to be intermediate throughout the season between that of the 'Ruby Red' and the 'Star Ruby' (Fig. 1).

The percent soluble solids in 'Ray Ruby' fruit from trees grown on sour orange rootstock was found to be approximately the same as in 'Ruby Red', but during most of the season both had lower soluble solids than 'Star Ruby' (Fig. 2). This could be expected to vary with different rootstocks and soil types.

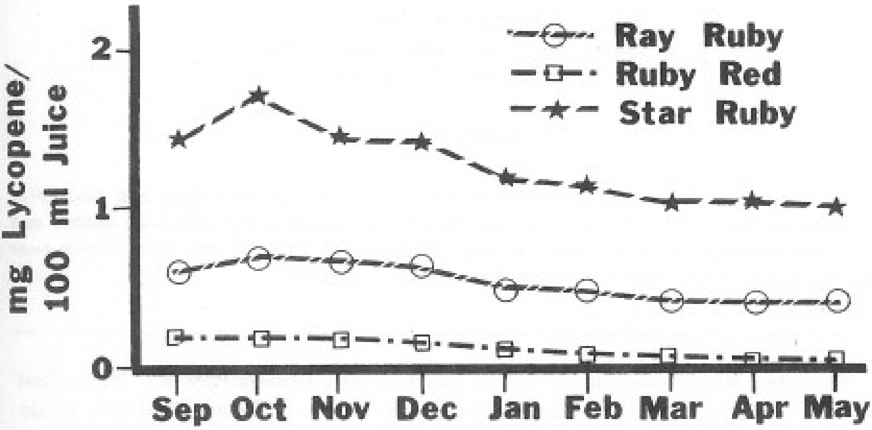

Fig. 1. The amount of red color in the juice of 'Ray Ruby', measured as mg lycopene/100 ml juice, is compared through the 1976-77 season with 'Ruby Red' and 'Star Ruby'.

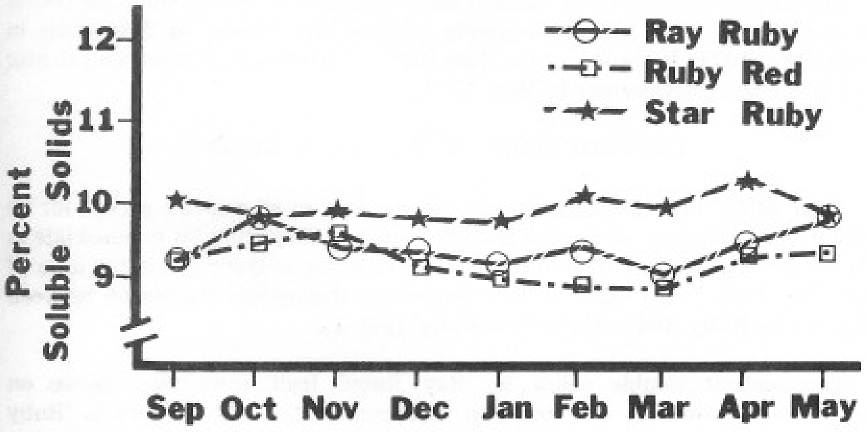

Fig. 2. The percent soluble solids in the juice of 'Ray Ruby' is compared through the 1976-77 season with 'Ruby Red' and 'Star Ruby'.

The peel of the 'Ray Ruby' has a redder blush and overall red color than the 'Ruby Red', although the difference is not noticed until mid December. After December the red peel blush of the 'Ray Ruby' approaches that of the 'Star Ruby', although never becoming quite as red.

The 'Ray Ruby' tree is indistinguishable from the 'Ruby Red' tree. Virus testing at the Texas A&I University Citrus Center indicates that the 'Ray Ruby' carries a mild strain of exocortis viroid.

Trees planted in November, 1971 in an 18 x 24 ft spacing (100 trees/acre) produced average yields of 240 lb/tree (12 tons/acre) when they were four years old and 330 lb/tree (16.5 tons/acre) when they were five years old. Fruit was 96% size 96 (3 9/16 inches in diameter) and larger in the fourth year and 70% size 96 and larger in the fifth year.

The juice of the 'Ray Ruby' should be a more attractive product when processed than that of 'Ruby Red'. The peel with its overall redder color and blush than that of the 'Ruby Red', should also make it a more attractive product for the fresh market.

The 'Ray Ruby' has sufficient advantages over the 'Ruby Red' that it will likely be considered for new plantings where 'Ruby Red' would have otherwise been planted. Other states and countries have shown an interest in obtaining propagating material of the new variety.

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Container Production of Citrus Nursery Stock and its Performance Compared to Field-Grown Stock

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ABSTRACT

Sour orange (*Citrus aurantium* L.) seedlings were grown in a 1:1 mixture of builder's sand and Hidalgo clay loam and in sand alone in nominal 1- and 2- gal containers (actual soil volumes of 2.3 and 5.6 liters, respectively) under various fertilizer treatments. Growth of the sour orange seedlings was the same for both container sizes for the first five months. After the seedlings grew large and were budded with grapefruit (*C. paradisi* Macf.), growth was more rapid in the 2-gal than in the 1-gal container. Split applications of fertilizer with a total of 340 mg N/liter as well as other nutrients provided the best growth of trees in the soil-sand mix. Trees in sand culture fertilized with complete nutrient solution weekly grew slowly at first, but were the largest by the end of the experiment.

Trees in 1- and 2-gal containers and in sand and the sand-soil mix were transplanted to the orchard where their performance was compared to that of field-grown nursery stock. After 2.5 yr in the orchard field-grown stock had greater trunk diameters, canopy volumes and more fruit per tree than container-grown stock. Field performance of container stock produced in sand and in the sand-soil mix was not significantly different. Trees grown in 1-gal containers were smaller initially, but eventually attained the same size as trees grown in 2-gal containers. Addition of fertilizer tablets to the planting holes did not affect growth. Container-grown trees performed better under basin than under drip irrigation, presumably because the coarse-textured soil in the root ball was not adequately moistened by a dripper placed on the fine-textured orchard soil. Method of irrigation did not affect performance of field-grown nursery stock.

Additional key words: fertilizer, container size, irrigation, potting medium, *Citrus aurantium* L., *Citrus paradisi* Macf.

Several Valley nurserymen tried container production of citrus nursery stock a few years ago following the example of a successful venture in Arizona (1). Many were disappointed with the results and none is engaged in large scale propagation of citrus in containers today. Growers who purchased container-grown trees have mixed feelings about the method. Most point out that the smaller container-grown trees require more care during the first year than do conventional field-grown trees. Platt and Opitz (5), in reviewing container production of citrus, list the smaller trees as the chief disadvantage. On the positive side, container production affords relatively simple control of many production factors: diseases, nematodes, mycorrhiza, fertility, irrigation, and weeds. Container stock can be held for long periods prior to planting, whereas field-grown, balled-and-burlaped trees cannot.

Typically, Valley nurserymen have continually moved to new sites where citrus had not been grown previously to avoid build-up of disease and nematode problems. As suitable locations become more difficult to find, container production may eventually be the alternative. The work reported here was undertaken to test the effect of container size, potting mix, and fertilizers on production of container-grown trees and then to compare the performance of these trees with field-grown nursery stock in the orchard.

MATERIALS AND METHODS

Two potting media were used for production of container-grown nursery stock: a potting mix prepared from equal parts of builder's sand and Hidalgo clay loam, and builder's sand alone. These materials were treated with dry heat at 83 C for 3 hr. The fertilizers indicated in the first column (April, 1974) of Table 1 were mixed with potting media in a cement mixer. Subsequent fertilizer applications were made to the soil surface and followed with an irrigation.

Commercially available plastic pots of nominal 1- and 2-gal size were used. The volume of potting media in these containers was 2.3 and 5.6 liters, respectively.

In late April 1974, sour orange (*Citrus aurantium* L.) seedlings were selected from flats grown in the greenhouse and potted. In the sand-soil mix, 240 seedlings were potted in 1-gal containers, 180 in 2-gal containers and in the sand receiving treatment G (Table 1), 40 seedlings were potted in 1-gal and 30 seedlings in 2-gal containers. These were arranged in a half-shade in a split plot design with container size as main plot, potting medium as the subplot, and fertilizer treatment as the sub-subplot. Plants were watered with a drip irrigation system using Rio Grande river water (700-1000 ppm salt). The seedlings were budded in August 1974 with old-line Webb Redblush grapefruit (*C. paradisi* Macf.).

Seedling height was measured from the pot rim, scion height from the budunion, and stem diameter was measured just below the budunion. Foliage color was rated on a scale of 0 (bleached) to 5 (deep green).

For the comparison of field-grown and container-grown trees, the largest of the container-grown trees were selected and planted on a Hidalgo clay loam soil with field-grown trees which had been raised from seed concurrently. The field-grown trees were budded in February 1975, 5 months after the container-grown trees. The orchard was planted in September 1975 in a split-plot design with irrigation method as the main plot, starter fertilizer tablets as the subplot,

Table 1. Fertilizer applications to container-grown nursery stock.

	Date of application										
	4/74			6/74	7/74	8/74	9/74			6/75	
Treatment[1]	N[2]	P	K	N	N	N	N	P	K	N	P
A	64[3]	14[3]	38[3]	-	-	-	-	-	-	-	-
B	132[3]	28[3]	76[3]	-	-	-	132[3]	28[3]	76[3]	250[8]	452[8]
C	264[3]	56[3]	152[3]	-	-	-	-	-	-	250[8]	452[8]
D	64[4]	-	-	21[7]	21[7]	-	132[3]	28[3]	76[3]	250[8]	452[8]
E	64[4]	25[6]	-	21[7]	-	21[7]	-	-	-	-	-
F	64[5]	-	-	21[7]	21[7]	-	-	-	-	-	-
G	complete nutrient solution weekly										

[1] Treatment A through F potted in a soil mix consisting of a 1:1 mixture of builder's sand and Hidalgo clay loam. Treatment G potted in sand only and received the nutrient solution, formula I, of Shive and Robbins (7) weekly.

[2] Amounts expressed as mg elemental N, P, and K/liter of soil mix.

[3] Applied as Osmocote (18-9-13), a slow release fertilizer from Sierra Chemical Co., Newark, CA 94560.

[4] Applied as sulfur-coated urea (40-0-0-4S), a slow release form of urea from Tennessee Valley Authority, National Fertilizer Development Center, Muscle Shoals, AL 35660.

[5] Applied as urea (45-0-0).

[6] Applied as triple superphosphate (0-46-0).

[7] Applied as ammonium nitrate (33-0-0).

[8] Applied as 14-59-0-4 Zn.

and origin of tree as the sub-subplot. Of the 96 trees planted, 32 were field-grown stock, 32 from 1-gal containers (16 from sand and 16 from sand-soil mix) and 32 from 2-gal containers (half from each potting medium). Trunk diameter 15 cm above the budunion was measured at planting and annually thereafter. The number of fruit a tree was counted in the summer of 1978. Canopy volume (V) was calculated from tree height and the average of the east-west and north-south diameters using the formula $V = 2.09\ r^2h$ where r = radius, h = height.

Fertilizer starter tablets (Agriform Orchard Starter Tablets, Agriform International Chemicals, Inc., Newark, CA) placed one per planting hole with half of the trees, weighed 9 gm and contained 2.5 g N, 0.31 g P, 0.36 g K, 0.18 g S, 0.09 g Fe, and 0.02 g Zn. Nitrogen was applied to all trees in the spring of each year at 57 g N/tree in 1976, 150 g N/tree in 1977 and 100 g/tree through June 1978. Half of the trees were drip irrigated using one Sysag dripper (Sistemas y Servicios Agrícolas, S. de R. L.) a tree. The amount of water added was calculated from pan evaporation and an estimate of tree size. Frequency of irrigation varied with weather conditions from daily to once a week. The other half of the orchard was basin irrigated. A ring of soil 10-15 cm high and 75-100 cm in diameter was hoed up around the tree. Water was supplied from a tank wagon at about 135 liters/basin. These trees were watered seven times during a drought period from planting in September 1975 through March 1976 which had only 87 mm (3.5 inches) of rainfall and four times during the following 6 months which had 762 mm (30 inches) of rainfall. Eighteen months after planting the entire orchard was converted to drip irrigation.

Results were subjected to analysis of variance and Duncan's multiple range test was used to separate means.

RESULTS

Shortly after planting, heights of sour orange seedlings with respect to fertilizer treatments were not significantly different (Table 2, column 1). By mid-June, plants receiving the highest rate of N-P-K (treatment C) were the tallest and those receiving the lowest rates of N (treatments A, D, E and F) were shorter and lacked deep green color (Table 2). According to stem diameter measurements in July, the high rate of N produced the largest seedlings. Percent of seedlings budded at the end of August, another reflection of stem diameter, was greatest for the highest rate of N and for the complete nutrient solution.

The highest rate of fertilizer and the complete nutrient solution favored growth through the seedling stage. The nature of the treatments did not permit a separation of the N and P effect. At equivalent rates of N there were no significant differences between slow release forms and ordinary urea.

At planting, the smaller container had larger seedlings (Table 2). By mid-June, seedlings in the larger container were greener, but differences in size were no longer significant. There were no other differences due to container size throughout the seedling stage.

Table 2. Growth of sour orange seedlings in two different container sizes under various fertilizer programs.

	5/74	6/74		7/74	8/74
Fertilizer treatment	Seedling height (cm)	Seedling height (cm)	Color rating[1]	Stem diameter (cm)	% of seedlings budded
A	22.6	28.0bc[2]	3.30d	0.48b	26b
B	22.1	29.8b	3.70c	0.49b	36b
C	23.5	33.9a	4.25a	0.53a	69a
D	23.0	26.8c	3.20de	0.47b	27b
E	22.4	26.6c	3.10e	0.47b	31b
F	24.4	28.0bc	3.05e	0.47b	27b
G	20.9	28.6bc	4.05b	0.48b	50ab
	N.S.				
Container size					
1-gal	23.3a	29.2	3.45b	0.48	32
2-gal	21.8b	28.4	3.60a	0.48	46
		N.S.		N.S.	N.S.

[1] Color of the foliage was rated on a scale of 0 (bleached) to 5 (deep green).

[2] Means in columns and groups separated by Duncan's multiple range test, P = 0.05.

Following budding of all seedlings of sufficient size in August and September, treatments B and D were brought to the same N and P level as treatment C. Treatments A, E, and F, with the fewest plants budded, were omitted from the second stage of the experiment which involved budded plants. Growth was slow during fall and winter. When scion heights were measured in February, plants in treatments B and D were largest, those in treatment C smallest, and those receiving complete nutrient solution intermediate (Table 3). Rate of growth increased in the spring. By the end of April, scion height was greatest with complete nutrient solution, followed by treatments B and D. Plants in treatment C, in which N deficiency was evident, were the shortest.

Table 3. Growth of grapefruit scions on sour orange rootstock with different fertilizer programs and container sizes.

Fertilizer treatment	Scion height (cm)			Trunk diam (cm)
	2/75	4/75	6/75	8/75
B	13.9a [1]	26.5b	36.5b	0.65b
C	8.4b	15.4c	30.2b	0.60b
D	12.8a	31.7b	34.9b	0.63b
G	11.6ab	39.1a	55.5a	0.79a
Container size				
1-gal	11.7	23.5b	31.4b	0.56b
2-gal	12.0	31.1a	45.5a	0.78a
	N.S.			

[1] Means in columns and groups separated by Duncan's multiple range test, P = 0.05.

In June, equal amounts of fertilizer were again added to treatments B, C, and D. Scion height measurements at the end of June showed that plants fertilized with complete nutrient solution were largest and those in treatment C had caught up with those in treatments B and D. This relationship continued with the mid-August trunk diameter measurements.

By April 1975, plants in 2-gal containers were significantly larger than those in 1-gal containers. These differences persisted with height measurements in June and trunk measurements in August.

Through the seedling stage, plants receiving complete nutrient solution improved continually in comparison to plants fertilized by other means. In the second year this treatment had the largest plants.

The largest trees from the various container treatments were selected for use in the field test. At planting there were no significant differences in trunk diameter due to potting medium or to starter fertilizer tablets (Table 4). The larger containers had significantly larger trees and by chance, larger trees were assigned to drip irrigation than to basin irrigation. However, the greatest difference was between field-grown and container-grown trees. Although field-grown trees were budded 5 months after container trees, at the time of planting field-grown trees had greater stem diameters.

There were no significant differences in growth or number of fruit/tree between the two potting media. The significant difference between container sizes persisted through the first year in the field, but by 1978 the trees that had originated in the smaller containers had attained the same size as those from larger containers (Table 4). Since there were no significant differences between those receiving fertilizer tablets and those receiving none in the first year, this was no longer considered a variable in the analysis.

The difference in trunk diameter between the two irrigation systems which existed at planting reversed itself in the first year. Trees which had been basin irrigated for the first 18 months had greater trunk diameters and canopy volumes in 1978. Differences between basin and drip-irrigated trees existed only with container-grown stock. In 1976, trunk diameters under drip and basin irrigation, respectively, were: field-grown, 2.35 and 2.37 cm; container-grown, 1.24 and 1.67 cm. In 1978, the diameters were: field-grown, 5.8 and 5.6 cm; container-grown, 3.8 and 4.7 cm.

Differences between field- and container-grown trees in trunk diameter, canopy volume, and number of fruit/tree existed through 1978 (Table 4, Fig. 1). The best of the container-grown trees, those from the soil-sand mix in 2-gal containers under basin irrigation, did not grow as well as the field-grown stock. Measurements of the various parameters for container stock, trees from 2-gal containers with the soil-sand mix, and field-grown stock, respectively, under basin irrigation were as follows: trunk diameter, 1975 - 0.78 cm, 1.05 cm; trunk diameter, 1976 - 1.93 cm, 2.37 cm; trunk diameter, 1978 - 5.0 cm, 5.8 cm; increase in trunk diameter, 1975-78 - 4.15 cm, 4.76 cm; canopy volumes, 1978 - 2.0 m^3, 2.9 m^3; number of fruit/tree, 1978 - 5, 26.

DISCUSSION

Growth through April 1975, one year after planting the seedlings, indicated that the split application of fertilizer was superior to the initial heavy application

Table 4. Comparison of field-grown and container-grown Webb Redblush grapefruit on sour orange rootstock for 2.5 yr after planting the orchard.

Treatment	Trunk diameter (cm) 10/75	Trunk diameter (cm) 9/76	Trunk diameter (cm) 6/78	Increase in trunk diam (cm) 1975-78	Canopy volume (m^3) 6/78	Number of fruit/tree 6/78
Field-grown	1.1a[1]	2.4a	5.7a	4.6a	2.8a	27a
Container-grown	0.8b	1.5b	4.3b	3.5b	1.5b	4b
Sand	0.8	1.5	4.2	3.4	1.3	4
Sand:Soil	0.7	1.5	4.4	3.7	1.6	3
	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
1-gal container	0.7b	1.3b	4.2	3.5	1.4	3
2-gal container	0.9a	1.7a	4.4	3.5	1.5	4
			N.S.	N.S.	N.S.	N.S.
Fertilizer tablets	0.9	1.7				
No fertilizer tablets	0.8	1.6				
	N.S.	N.S.				
Basin	0.7b	1.8a	4.9a	4.2a	2.0a	9
Drip	0.9a	1.5b	4.2b	3.3b	1.4b	8
						N.S.

[1] Means in columns and groups separated by Duncan's multiple range test, P = 0.01.

Fig. 1. Webb Redblush grapefruit on sour orange rootstock 2.5 yr after planting in the orchard: left, container-grown tree; right, field-grown tree. Trees represent the average canopy volume for each treatment.

of Osmocote. Although Osmocote is a slow release material the high leaching regime exhausted the N supply in treatment C in about 6 months. Treatment B with the same total amount of the slow release material applied in split application showed no N shortage. Coleman, Mock and Furuta (3), using Osmocote at much higher rates with container-grown ornamentals, found that plant growth under drip irrigation was directly correlated with the rate of fertilizer applied. However, the largest plants were those from a treatment to which preplant fertilizer and weekly supplements were applied. The regular addition of a nutrient solution is easily accomplished with container-grown plants under a drip system.

The small container which held 2.3 liters of potting mix did not provide sufficient rooting volume after the plants were budded. The large size, which contained 5.6 liters was satisfactory. In another experiment, plants grew as well in a container with an effective volume of 4.9 liters as in the 5.6-liter container (Leyden and Timmer, unpublished). However, trees from the smaller containers had caught up with the larger ones 2 yr after planting in the orchard. In a California study, trees suitable for orchard planting were produced in 13 months in a container with a 3-liter volume (6). These trees were significantly smaller than those grown in larger containers, but 2.5 yr after planting in the orchard there were no significant differences in tree size (8).

Potting mixes have been investigated particularly with regard to the ornamental nursery industry. The U.C. system for the production of healthy container-grown plants was developed over a 25-yr period (2). Most of their mixes are rather complex. In a potting mix, as in a field soil, we would like to have adequate drainage, good water-holding capacity and reasonable nutrient storage. Mixes often include soil, sand and peat moss in an effort to meet these requirements. Fucik (4) tested four potting mixes, and while all could be used successfully, those containing some soil were the most desirable.

The fertilizer requirements of container-grown trees vary with the potting mix used. An extreme type such as builder's sand is best served by frequent application of complete nutrient solution. For a mix that includes a soil of good natural fertility such as the Hidalgo soils used in this study, a split application of a fertilizer providing N at about 340 mg N/liter and P at about 36 mg P/liter annually should provide maximum growth.

Transplants grow best when the soil texture at the planting site is similar to that in which the plants have been growing. Soil moisture relations are the controlling factor. Soil moisture moves from coarse-textured to fine-textured material under conditions of unsaturated flow which predominate in the field. The reverse will occur only under conditions of saturated flow such as during or immediately following heavy rains or irrigation.

The field-grown trees were raised in a nursery having nearly identical soil type as the planting site. These trees grew equally well under either irrigation system. Builder's sand represents an extreme change in texture from the clay loam of the planting site to a very coarse textured material. The potting mix consisting of equal parts of clay loam and builder's sand is also a more coarse textured material than the soil at the planting site.

We assumed that drip irrigation with frequent applications of small amounts of water would keep the coarse textured root balls adequately watered, particularly with the dripper placed at the trunk. However, when polyurethane tree wraps for cold protection were put around the trunks in November 1975, the drippers were moved 15-20 cm from the trunk to avoid a wicking action on the part of the polyurethane which would keep the trunk wet beneath the wrap. While the wraps were in place the container-grown trees were not being adequately watered. This was a drought period when effective irrigation was vital. In the 6 months following planting, there were only 87 mm of rainfall. Basin-irrigated trees were watered seven times during that fall and winter. The effect of that first 6 months is reflected in 1978 in significant differences in trunk diameter and canopy volume (Table 4).

With proper selection of container size and potting medium and attention to irrigation, fertilization, and disease control, citrus nursery stock can be grown to adequate size for transplanting to the orchard in a reasonable period of time. Unless grown under greenhouse conditions with heat in winter and cooling in summer, it is unlikely that container stock can be produced any more rapidly than field-grown stock. The 2-gal container size apparently restricts the root system sufficiently so that a tree of the size usually transplanted from field nurseries (1.25-1.5 cm in diameter at the budunion) cannot be attained in the same period of time as in a field nursery. Using larger containers is impractical because of increased costs of containers and potting media and greater space requirements. Smaller container-grown stock can be established in the orchard and performs reasonably well, but requires more care and attention than larger field-grown stock. If the results of this study are indicative, container-grown stock will, in the early years, be smaller and less productive than field-grown trees.

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Nitrogen and Phosphorus Fertilization of Red Grapefruit

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ABSTRACT

Nitrogen at four levels and phosphorus at three levels were used in a complete factorial experiment with red grapefruit (*Citrus paradisi* Macf.) growing on Hidalgo clay loam soil. For the six seasons from five to ten years of age a yield response was obtained from 1 lb N/tree/year over 0.5 lb N. No additional response resulted from higher rates of N. There was no response to P at rates up to 2 lb P/tree/year nor was there a significant interaction between N and P. Fruit size distribution was not influenced by fertilizer treatment but did vary with season.

A number of nutritional studies with citrus have been reported from Texas. Maxwell and Dacus (4) and Maxwell and Shull (5) found a response to nitrogen fertilizer in only one year out of six with red grapefruit growing on Willacy fine sandy loam. The site appears to have been one of high inherent fertility; the average yield over six seasons was 318 lb a tree without added nitrogen. Dacus and Shull (1) working with red grapefruit and Valencia oranges on Willacy fine sandy loam reported a response to nitrogen fertilizer two years out of four with red grapefruit but no response with Valencia oranges. The yield data presented for the oranges suggests that something other than nutrition was the limiting factor. Hipp and Shull (2) found that through nine years of age N at 0.75 lb a tree increased yields over no added N in three out of six years with red grapefruit on Willacy fine sandy loam. In several of the above studies phosphorus and potassium were used, usually at one rate. Where included, neither P nor K influenced yield. On Hidalgo clay loam soil one lb N/tree/year gave significantly greater yield of red grapefruit and Valencia orange than no N (3).

In each of the foregoing studies, an unfertilized check with no added N served as the reference. In some of the studies, one additional rate of N was used; in others, two additional rates. In three of the tests, P was included as part of one treatment. Since none of these fully examined the nitrogen response curve, nor considered any interaction between rates of N and P, the work reported herein was undertaken.

MATERIALS AND METHODS

Nucellar red grapefruit (*Citrus paradisi* Macf.) on sour orange (*C. aurantium* L.) rootstock were planted on an Hidalgo clay loam soil in June 1961. A complete factorial experiment involving four levels of N and three levels of P was laid out in a randomized complete block design with three replications. Individual plots were four rows wide with four trees a row giving 16 trees to a plot. The four center trees were test trees. Spacing was 16 x 22 ft within plots and 25 ft between plots. Rates of elemental N and P, applied in all combinations were:

Years	N, lb a tree	P, lb a tree
1962-64	0, 0.5, 1, 2	0, 0.5, 1
1965-67	0, 0.75, 1.5, 3	0, 0.5, 1
1968-74	0.5, 1, 2, 4	0, 1, 2

Nitrogen was supplied as ammonium sulfate or urea; phosphorus as triple superphosphate (0-46-0). Treatments were applied in January 1962 and annually thereafter.

The freeze of January 1962 caused variable damage across the orchard. Therefore all test trees were removed and replaced in January 1964.

Beginning at five years of age, the 1968 season, the crop was harvested, weighed and sized on an individual tree basis in December or January. The size divisions, based on fruit diameter, were: $<$3.56 inches, 3.56-4.13, $>$4.13 inches (equivalent U.S. sizes: $<$112, 96-80, $>$80).

Trees were hedged on two sides to about 7 ft from the trunk in the spring of 1970 and again in the spring of 1972.

Where appropriate, data were subjected to analysis of variance and means separated by Duncan's multiple range test.

RESULTS AND DISCUSSION

The average total pounds a tree for the 12 N P treatment combinations for the six seasons 1968 through 1973 are presented in Table 1. Highly significant differences attributable to N occurred in all seasons except 1972. There were no significant differences between the rates of 1, 2, and 4 lb of N, but each of these was significant over the 0.5 lb rate. This is in agreement with previously published Texas studies where response was obtained from rates down to 0.75 lb but no additional response from higher rates of N. As in all earlier studies of citrus nutrition in Texas, there were no significant differences due to P. In addition the interaction between N and P did not influence yield.

The general low yields and the lack of significance between treatments in the 1972 season is related to the hedging performed in February 1972. Yield reductions of as much as 85% from the previous year occurred.

Table 1. Yield of red grapefruit in pounds a tree as influenced by nitrogen and phosphorus fertilizer in twelve combinations, 1968 through 1973.

	$N_{1/2}$ [1]	N_1	N_2	N_4	Ave. P effect
			1968		
P_O [2]	89[3]	216	194	207	176
P_1	87	155	218	149	152
P_2	172	211	205	173	190
Ave. N effect	116	194	206	176	
			1969		
P_O	147	165	229	200	185
P_1	101	224	196	184	178
P_2	219	221	204	236	220
Ave. N effect	156	204	210	206	
			1970		
P_O	121	227	193	226	192
P_1	121	222	183	205	183
P_2	161	193	181	207	186
Ave. N effect	134	214	186	213	
			1971		
P_O	109	183	257	284	208
P_1	198	203	251	282	234
P_2	195	260	276	311	260
Ave. N effect	167	215	261	292	
			1972		
P_O	81	130	22	39	68
P_1	58	186	157	148	137
P_2	41	123	49	142	89
Ave. N effect	60	146	76	110	
			1973		
P_O	49	135	190	215	147
P_1	46	167	196	143	138
P_2	121	203	178	211	178
Ave. N effect	72	168	188	190	

[1] Nitrogen supplied as ammonium sulfate or urea. Subscripts indicate lb of N/tree/year.

[2] Phosphorus supplied as superphosphate (0-46-0). Subscripts indicate lb of P/tree/year.

[3] Yields for each treatment are the average of 12 trees.

Total yield data, when averaged over the six seasons and illustrated three dimensionally, reveals the N response (Fig. 1). The insufficiency of the 0.5 lb rate; the response to the next increment, one lb; and the lack of additional response to higher rates of N are readily apparent.

There were no significant differences in fruit size due to fertilizer treatment but there were highly significant differences between seasons. The percent of the crop falling into the less desirable size class varied greatly from year to year (Table 2). Such seasonal variation can be related to climatic factors. Norwine and Fucik (6), examining fruit size in relation to 50 climatological variables over a ten year period, found mean solar radiation during April to account for 50% of the variation in ultimate fruit size.

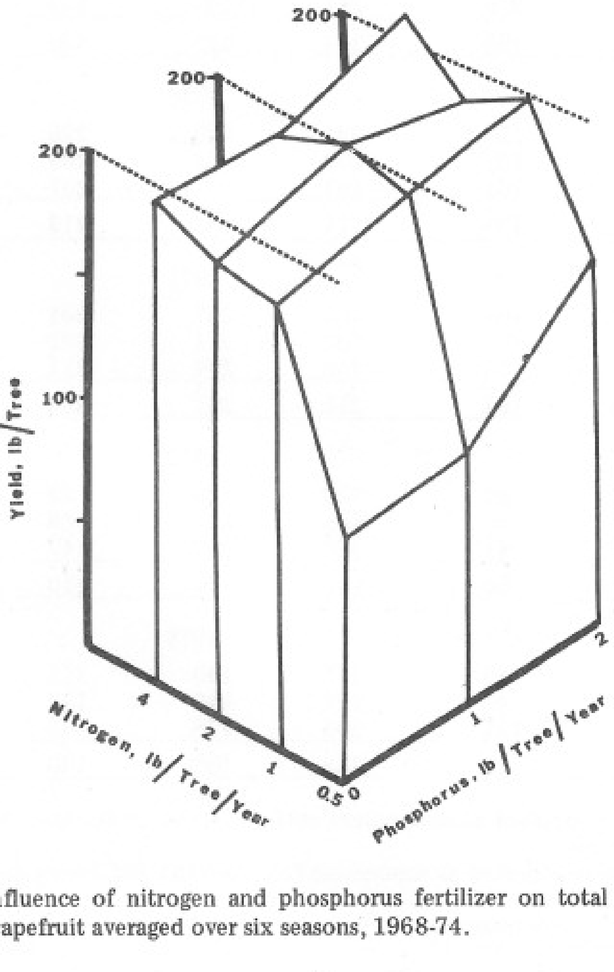

Fig. 1. Influence of nitrogen and phosphorus fertilizer on total yield of red grapefruit averaged over six seasons, 1968-74.

Table 2. Percent of the total weight represented by size 112 or smaller as influenced by season and nitrogen fertilizer.

Year	Nitrogen (lb/tree)				Ave. season effect
	0.5	1	2	4	
			Percent		
1968	27	27	31	24	27
69	8	8	11	6	8
70	12	3	3	3	5
71	33	36	42	42	38
73	19	26	34	35	25
Ave. N. effect	20	20	24	22	

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A Mathematical Model for Predicting Annual Minimum Temperatures for Texas Citrus

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ABSTRACT

A 101 year minimum temperature data record from Brownsville, Texas was analyzed by the spectral analysis technique to determine its cyclical nature. From this, a mathematical model was developed and used to predict "alarm years" for Texas citrus during the 1979-1988 period. Four alarm years are indicated. In addition, the mean length of time between annual lows ($\leq$ 26 F) was determined to be 3.63 years.

The existence of cyclical phenomena in weather is well documented (3). In the Lower Rio Grande Valley previous studies have predicted the cyclical pattern of freezes by analyzing low temperature data and calculating the average period between freezes. Predicted intervals have ranged from 5 to 20 years (2,4). A mathematical technique used by engineers and physicists to extract information about the cyclic components of data is known as spectral analysis (1). The purpose of this paper is to apply spectral analysis to the forecasting of annual low temperatures.

MATERIALS AND METHODS

Since weather patterns occur with cyclic tendencies, a sufficiently long record of past weather events, such as annual minimum temperatures, should contain reproducible patterns which can be used to forecast future low temperatures. A mathematical model was developed based on weather data for yearly minimum temperatures collected at Brownsville, Texas from 1878 to 1978. This model was then used to predict annual minimums in the Brownsville area for the years 1979 through 1988.

Spectral analysis applied to the 101 year data record of annual minimum temperatures in Brownsville, Texas developed a forecasting model of the form:

$$M(t) = M + \sum_{i=1}^{N} A_i \sin(\Pi t_i + \phi_i)$$

where:

- $M(t)$ = predicted annual minimum temperature for Brownsville
- M = the mean of the deviations of the actual temperature record from 26 F, a generally accepted critical temperature for citrus fruit
- A_i = the variation attributed to period i
- t_i = time period i
- ϕ_i = phase angle adjustment (ϕ is determined by a least squares fit of the time series).

Due to the complex nature of the weather data, 15 terms were required for a fit that explained 73% of the variance about the mean (Table 1).

Table 1. Mathematical model coefficients for predicting annual minimum temperatures at Brownsville, Texas.[1]

Term #	Cycle Length (yrs)	A_i	Πt_i	ϕ_i	% SS Explained
1	100.0	1.749	.063	3.393	9
2	15.9	1.357	.394	2.073	8
3	12.6	.957	.498	- 5.718	3
4	10.8	1.138	.581	5.969	2
5	6.3	1.506	.996	1.634	10
6	5.8	1.143	1.080	5.655	4
7	3.7	1.018	1.698	4.901	4
8	3.4	1.071	1.848	2.890	3
9	2.7	1.003	2.344	3.142	4
10	2.6	1.003	2.426	1.257	3
11	2.4	1.249	2.674	.440	6
12	2.3	1.229	2.805	- .691	7
13	2.2	1.304	2.882	4.838	3
14	2.1	1.198	2.964	4.273	3
15	2.0	.710	3.142	- .817	1

[1] Mean of temperature series = 29.88 F. Total sum of squares = 2517.

RESULTS AND CONCLUSIONS

Actual and predicted temperature readings for Brownsville from 1878 to 1978, plotted as deviations from 26 F, are shown in Figure 1. The model agrees

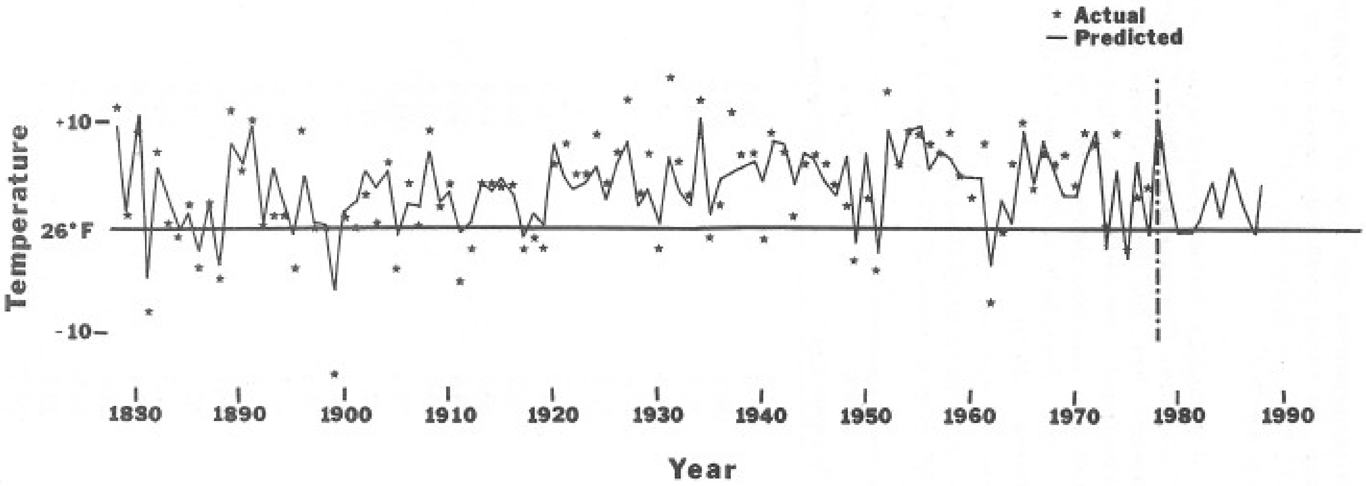

Fig. 1. Annual minimum recorded and predicted temperature for Brownsville, Texas 1878 through 1988.

well with moderate temperatures with most of the error occurring at the extremes. For example, the model predicted a temperature of 29.6 F in 1970, the actual low was 30 F; for the freeze year 1962 the model predicted 22.8 F, the actual temperature was 19 F.

Alarm years are determined by the model based upon a critical temperature of 26 F ± 1 F for Texas citrus. Crop seasons in which 27 F or less are predicted are then considered alarm years. For the 28 crop years that 26 F or less was recorded, the model predicted correctly 20 times, incorrectly 8 times (Table 2). In addition there were only two false alarms, 1964 and 1977, when 26 F was predicted but not reached. This criteria is used to evaluate the model forecasts for the 1979-1988 period (Table 3).

Table 2. Comparison of model predictions and actual temperatures recorded for the 28 years in which 26 F or less was reached at Brownsville, Texas.

Crop Season	Model Temperature	Actual Temperature	Criteria Check
1881	21.0	18.0	Correct
1883	28.5	26.0	Incorrect
1884	26.0	25.0	Correct
1886	24.0	22.0	Correct
1888	22.0	21.0	Correct
1892	25.8	26.0	Correct
1895	26.2	22.0	Correct
1897	26.5	26.0	Correct
1898	26.2	26.0	Correct
1899	20.0	12.0	Correct
1901	28.5	26.0	Incorrect
1903	30.0	26.0	Incorrect
1905	25.5	22.0	Correct
1907	28.0	26.0	Incorrect
1911	25.8	21.0	Correct
1912	26.5	24.0	Correct
1917	25.1	24.0	Correct
1918	27.5	25.0	Incorrect
1919	26.4	24.0	Correct
1930	26.3	24.0	Correct
1935	27.5	25.0	Incorrect
1940	30.3	25.0	Incorrect
1949	25.0	22.0	Correct
1951	24.0	21.0	Correct
1962	23.0	19.0	Correct
1963	29.0	26.0	Incorrect
1973	24.0	26.0	Correct
1975	24.0	24.0	Correct

Table 3. Predicted minimum temperatures at Brownsville, Texas for the years 1979 through 1988 based on a spectral analysis model of past minimum temperatures.

Crop Season	Predicted Temperatures, F
1979	30.50
1980	A[1] 25.98
1981	A 26.91
1982	A 26.99
1983	30.30
1984	27.30
1985	31.50
1986	28.60
1987	A 25.30
1988	30.40

[1] A = Alarm years; crop years in which a temperature of 26 F or less may be reached.

The years prefixed with an A are alarm years. That is years, based on past weather patterns, in which 26 F or less could occur in Brownsville. Only 1982, using the criteria, would be considered doubtful. Other valley areas, which are generally colder than Brownsville, would likely have lower temperatures in these years.

Another interesting conclusion is apparent from Table 2. If we construct a histogram of the frequency of occurence of 26 F or less, the most frequent period is 2 years (Fig. 2). In addition, 67% of these Brownsville cold nights were followed by another 26 F or less night within 3 years. In Table 2, note that periods of less than 3 years contribute 26% of the variance about the mean. According to the spectral density function the mean length of time between lows ($\leq$ 26 F) is 3.63 years.

This study has tried to analyze the cyclical low temperature patterns of Brownsville and project this pattern ahead for the next 10 years. This is just one component of the freeze risk in Texas citrus. The extent of tree cold hardiness and expected duration of the freeze are also required to ascertain the impact of a freeze.

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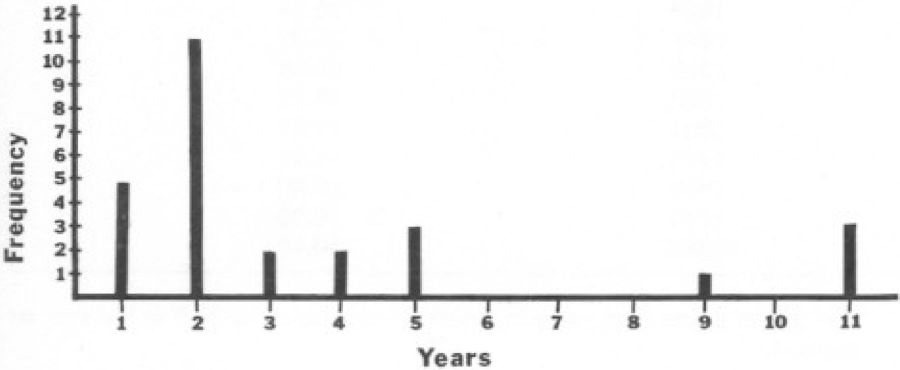

Fig. 2. Frequency of reoccurrence of 26 F or less at Brownsville, Texas 1878 through 1978.

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Relationship of Vines to Management of Other Pests on Texas Citrus

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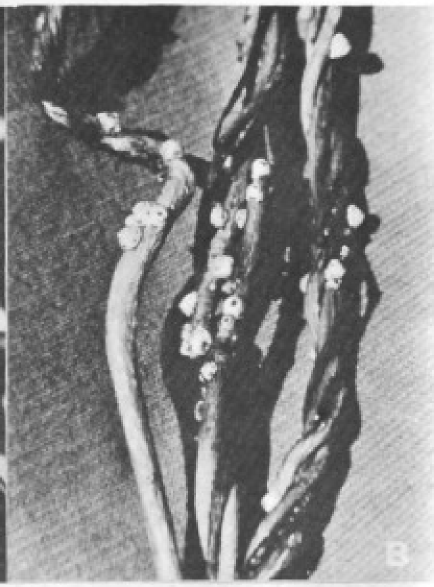
ABSTRACT

Vines are hosts for several insect species attacking citrus in the Lower Rio Grande Valley. The milk vine, *Cynanchum unifarium* (Scheele), growing within the citrus tree canopy, frequently supported infestations of citrus mealybug, *Planococcus citri* (Risso), or barnacle scale, *Ceroplastes cirripediformis* Comst. Vine control is an important consideration in the development of an integrated pest management program for Texas citrus.

In our investigations on citrus mealybug, *Planococcus citri* (Risso), we observed an association between this pest and certain vines. Often grapefruit trees with heaviest mealybug infestations were shrouded by the milk vine, *Cynanchum unifarium* (Scheele). This vine, a member of the milk weed family - Asclepiadaceae, is commonly found growing on citrus throughout the Lower Rio Grande Valley. Citrus mealybug frequently inhabited the woody stems of the milk vine which were entwined within the citrus tree canopy. The more succulent and leafy exposed portions of the vine covering the tree seldom harbored mealybug. Infestation levels usually paralleled those on the citrus tree, with occasional late stage immatures and adult mealybug found on milk vine in mid to late May and gradually building to highest numbers in late summer. It was not uncommon in early August to find woody vines heavily encrusted with mealybug extending from the soil surface to a height of 10 ft into the tree (Fig. 1-A). All life stages of citrus mealybug were usually represented, i.e., egg and motile stages.

Ivy treebine, *Cissus incisa* Desmoul (family Vitaceae), was also an occasional host of citrus mealybug, but never observed to support large numbers. Treebine (possum grape) is mostly herbaceous but semiwoody near its base and is less common than milk vine on Valley citrus. The leaves emit a characteristic pungent odor when crushed.

Mealybugs were not found on vines during the winter months (Dec. - March) although only limited sampling was conducted and severe vine dieback occurs during this period.



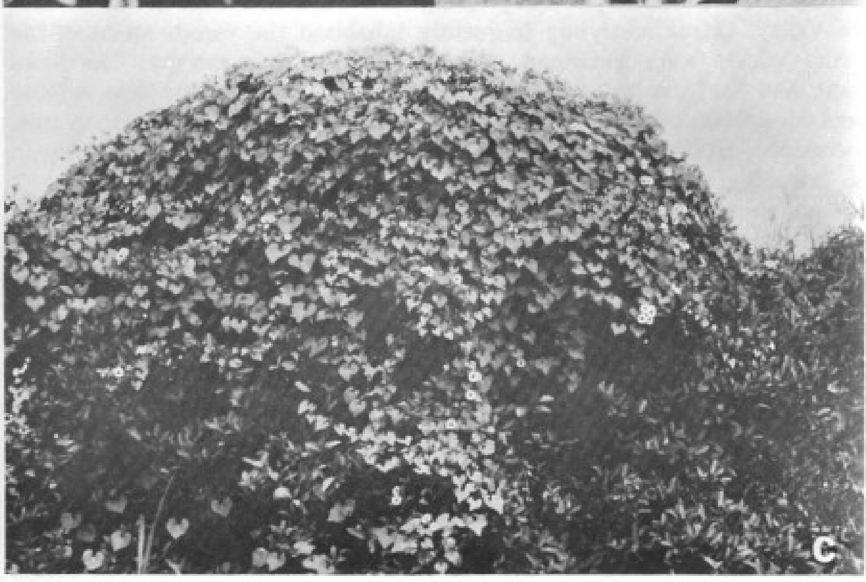


Fig. 1. (A) Citrus mealybug on milk vine, *Cynanchum unifarium* (Scheele). (B) Barnacle scale on milk vine. (C) Citrus tree shrouded by *Ipomoea amnicola* Morong. (Convolvulaceae).

Colonies of the fire ant, *Solenopsis geminata* (Fabr.) were frequently found tending mealybugs on vines. Ants seek honeydew secreted by mealybugs and in turn provide protection by killing or driving off attacking insect parasites and predators. Fire ants readily sting and can inflict severe pain and discomfort to orchard workers.

Barnacle scale, *Ceroplastes cirripediformis* Comst., has at times been a problem on citrus in some Valley locations. This pest was also observed on milk vine, again preferring the woody parts of the plant for colonization (Fig. 1-B). Female barnacle scale with eggs massed beneath their bodies were frequently found on vines and newly emerged scale crawlers would rapidly disperse using this host as an avenue to invade different areas of the citrus tree. At times the barnacle scale which inhabited vines appeared larger and more robust than their counterparts on surrounding citrus foliage. This was noted especially with large gravid females. Since the possibility exists of increased egg production or even enhanced growth and development of barnacle scale on the vine host, this aspect warrants further investigation.

We have also observed cottony-cushion scale, *Icerya purchasi* Maskell, and several unidentified aphid species on vines in citrus. Scales chiefly inhabited woody stems, while aphids congregated on succulent actively growing portions of the vine and seldom moved onto surrounding citrus foliage.

Vines thus far identified on Valley citrus are a diverse group, with some 15 species in 13 genera and 9 families represented. The majority are in 5 families: Asclepiadaceae (milk weed); Convolvulaceae (morning glory); Polygonaceae (buckwheat); Sapindaceae (soapberry) and Vitaceae (grape). Both annual and perennial vine species are represented.

Aside from the fact that vines harbor destructive pests and compete with the citrus tree for water, nutrients and sunlight - they are important in the general management of other pests in the orchard ecosystem. For example, when trees are heavily shrouded with vines (Fig. 1-C), it is difficult for pesticide sprays to penetrate the tree canopy -- even when high volume, high velocity, air blast sprayers are used. Control of pests like citrus rust mite, *Phyllocoptruta oleivora* (Ashmead), and chaff scale, *Parlatoria pergandii* Comstock, which require thorough spray coverage, is severely limited. Moreover, the microclimate within the vine-shrouded-tree is undoubtedly altered and variations in temperature, humidity, light and wind conditions can affect insect and mite growth and development. Rust mite thrive in Valley citrus orchards when relative humidity is high and temperatures are not excessive, i.e., $<$90F. Filtering of sunlight and wind by heavy vine foliage moderates temperatures, slows drying and evaporation from soil and tree surfaces, and thus, perpetuates conditions which are ideal for buildup of rust mite or other citrus pests.

Integrated pest management (IPM) is a system, compatible with the environment, that utilizes all available techniques and methods to maintain pest populations on a given crop below those levels causing economic injury. While biological, chemical, mechanical, legal and cultural controls comprise an IPM system, greatest emphasis is usually on development and integrated use of the first two methods. Since the most dramatic and often the quickest results are obtained with chemical and biological methods there is justification for stressing these. However, a functional and effective IPM program must also take maximum advantage of less obvious and more subtle control measures. Vine control is an important cultural practice which serves a dual purpose in an IPM system - the vine, a pest itself, is eliminated, and the management of often more serious insect and mite pests in the citrus orchard is made easier.

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Ornamental Use of Citrus and Related Plants

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ABSTRACT

Most of the common citrus varieties and several related species are well adapted and can make attractive additions to Valley landscape plantings. Brief descriptions of these plants and how they might be used in various designs and situations are provided.

A fundamental in selecting plants for yard and garden is that they have a purpose in the overall landscape plan. The two most common purposes are functional and aesthetic. The plant provides shade, food, a windbreak, a visual screen or the owner simply likes its shape, flower color, or whatever. In any case, the purpose can best be fulfilled by being thoroughly familiar with each plant's characteristics and requirements. Most disappointments in landscaping result from failure to account for the mature size and shape, adaptability to the site, maintenance needs or some other basic feature of the plant. Around the home most citrus is probably planted for its fruit. However, a full assessment of all the characteristics of citrus and related species confirms their ornamental value as well.

CITRUS TYPES AND THEIR CHARACTERISTICS

Before looking at individual plants, a review of citrus and its plant family might be helpful. The *Rutaceae* (Rue family) with well over 1500 species is divided into seven sub-families (8). Three of these have members of ornamental interest. The orange sub-family, *Aurantioideae*, has two tribes, the *Clauseneae* which has several species used as ornamentals and the *Citreae* whose 13 genera contain all the citrus, kumquat and trifoliate orange species plus several others of interest. The Rutoid and Toddaloid sub-families have several species including five native Texas plants which have landscaping value (3, 10). Generally these species all have fragrant flowers and waxy, usually smooth, dark green, aromatic leaves in single, triple or compound arrangement (1). The considerable variation in other characteristics will be noted in relation to their landscaping possibilities.

When used as ornamentals, citrus and its relatives should meet the same criteria as other landscape plants. If adapted to the site, reasonably free from insect, disease and other problems, fairly cold hardy, not over-exacting in

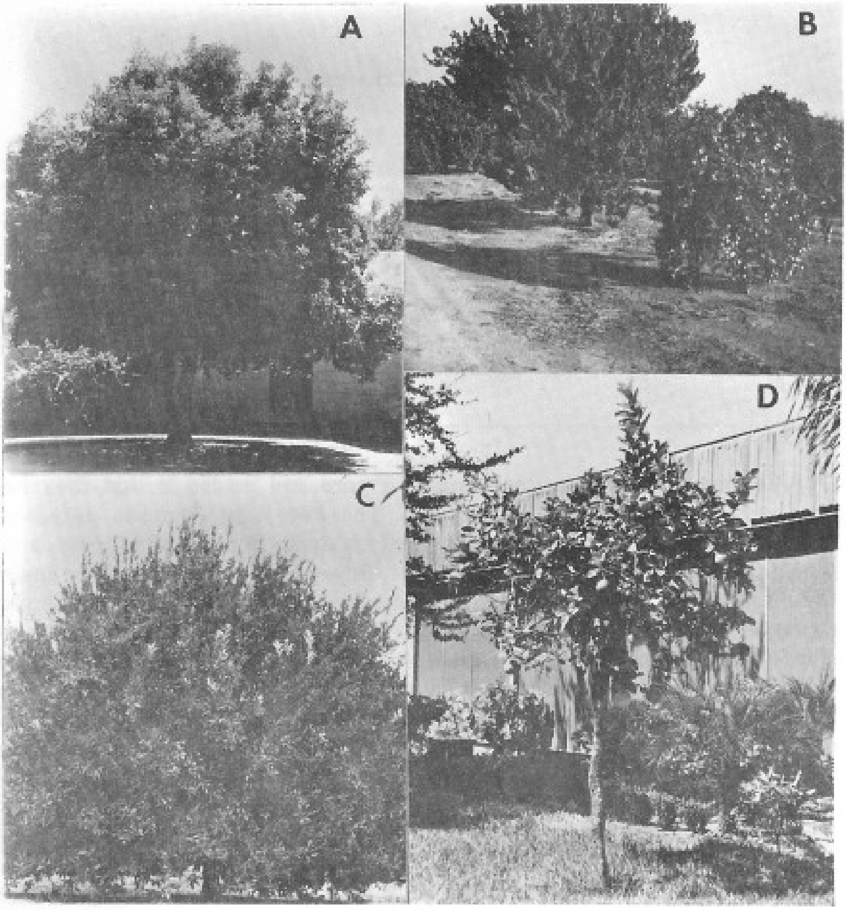

Fig. 1. (A) Pruned up high grapefruit makes a tall, round-topped shade tree. Bonuses are fragrant spring blooms and, when well tended, crops of high quality, delicious fruit. (B) The Chinotto sour orange (foreground), with myrtle-like leaves, irregular branching and colorful fruit has a decided oriental flavor. The Jaboticaba sour orange (background), with dense, dark green foliage borne on strongly upright branches creates an attractive vase shaped specimen for the more open landscape featuring strong design elements. (C) Tangerine trees may assume many forms, but their generally smaller leaves and upright branches produce a finer textured, more compact tree than other citrus. As a group tangerines are quite hardy and offer a wide variety of fruit types. (D) With severe pruning the Ponderosa lemon can add interest and proper scale to an oriental or courtyard landscape. The large fruit, produced almost year round, yield a cup or more of juice.

nutritional or water requirements, and properly placed regarding its ultimate size and shape any plant should prove a satisfactory and enjoyable ornamental. Because many citrus and related species meet these criteria as well as providing edible fruit, wildlife sanctuary, good hedges and screens or colorful flowers, they should be welcome additions to any landscape planting. The trees and shrubs cited below are no exception and the tips on how, where and why these Rue family members might be used in landscaping are offered for the edification of both plant and property.

MEDIUM TO LARGE TREES

Orange, tangelo and grapefruit *(Citrus sinensis, C. reticulata X paradisi* and *C. paradisi,* respectively*)*. Most of the familiar orange, tangelo and grapefruit varieties will make 20 to 30 ft. shade trees if trained to a single trunk. For under-the-tree accessibility, the main scaffold branches should emerge well over head height since the ends of the branches may droop 3 to 4 ft. under a heavy fruit load. The width of the tree's canopy will usually run 5 to 10 ft. less than the tree's height. Citrus trees create quite dense shade which discourages the growth of grass. Shade loving ground covers like English ivy *(Hedera helix)*, Asiatic jasmine *(Trachelospermum asiaticum)*, dwarf lily turf *(Ophiopogon japonicus)* or wood violets *(Viola odorata)* should do quite well under citrus. If not harvested, fallen fruit is unsightly and messy.

Tangerines *(Citrus reticulata)*. Most tangerine trees grow more upright with finer leaves and denser canopies than grapefruit and oranges. Mature heights and widths will be around 20 and 25 ft., respectively. Except for a specimen tree, they may better serve as screening or background trees where their canopies can touch the ground. The Willowleaf variety provides an interesting texture and color contrast behind darker green broad-leaved plants. Being quite cold hardy, tangerines can be planted in exposed, freeze prone locations.

Mexican lime *(Citrus aurantifolia)*. The Mexican or Key lime is an upright growing tree of 14 to 16 ft. height and the same width. The small, light green leaves are borne on very thorny branches. Though most of the crop matures in late summer, usually some fruit can be harvested the year round. Limes, the most freeze-sensitive of the common citrus varieties, require a well-drained, sheltered site. Their best use is as specimen trees, with a citrus collection, or as patio container plants.

Calamondin *(Citrus X Fortunella* hybrid ?*)*. This small leaved, densely foliated, rather upright growing tree is generally covered with small orange fruit for most of the year. Canopy height is around 15 ft. and diameter 10 to 12 ft. Providing the dropped fruit is not objectionable, calamondins are effective in groupings or in open rows along lot lines or as a colorful specimen amongst lower growing shrubs or ground covers. They also do well in containers and are hardy to 22 F. Calamondins add a distinctive, tangy flavor to marmalades and drinks.

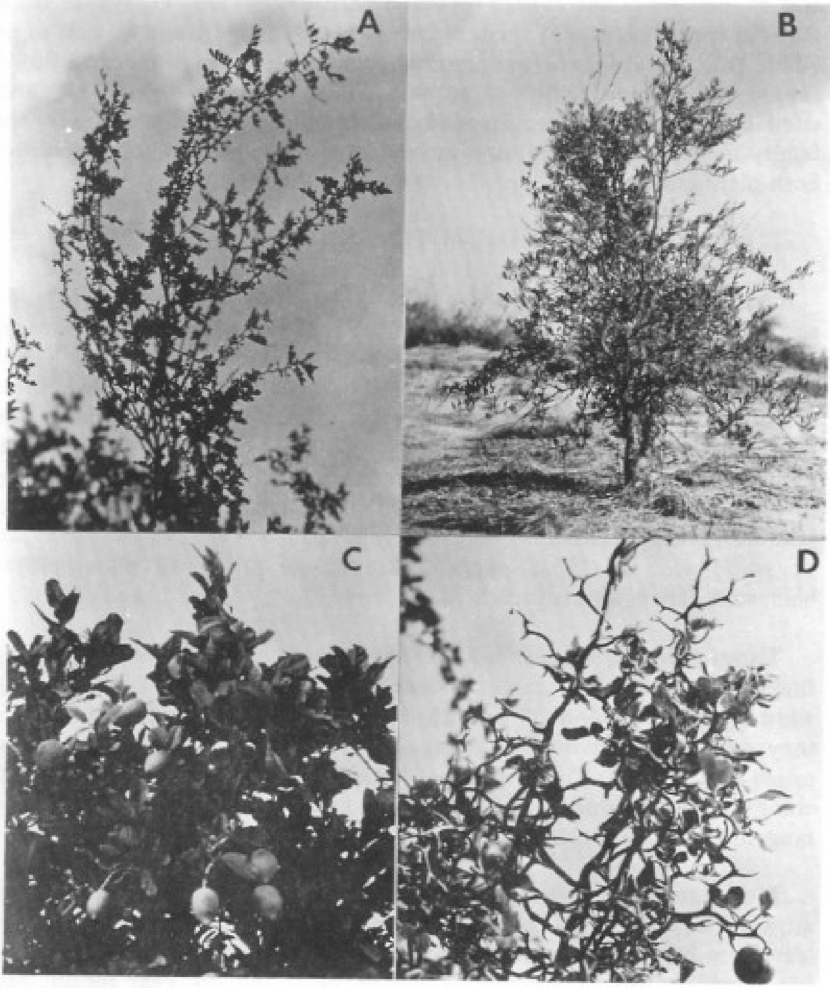

Fig. 2. (A) The lime prickly ash, *Zanthoxylum fagara*, a native citrus relative, has fine textured foliage and tiny, dark red fruit. A well-adapted small tree that is useful for a shady spot with limited space. (B) The willow-like appearance of *Eremocitrus glauca*, the Australian desert lime, offers a fine textured tree and filtered shade for a dry site and desert-type landscape. (C) The Citron makes a dense, heavy textured, round shrub or small tree. The fruit, referred to in Old Testament literature, has a pleasant fragrance. The thick peel is candied to make the citron used in confections and baking. (D) The twisted, thorny branches of the Flying Dragon trifoliate orange make an arresting pattern against the sky or in floral arrangements. Trifoliate orange is deciduous, very cold hardy and bears yellow-orange inedible fruit.

Ponderosa lemon *(C. limon X C. medica hybrid ?).* Grown primarily for its unusually large, lemon-flavored fruit, the Ponderosa tree has useful specimen qualities. It has large leaves and an open canopy which achieves heights of 15 ft. and equal widths. However, with severe training it looks much at home as a curiosity or conversation piece in a formal or oriental setting. Ponderosa is adaptable to small scale plantings by pruning heavily. The fruit makes a good lemon substitute and is available more or less the year round.

Sour orange *(Citrus aurantium).* The standard sour orange, principal rootstock for Valley citrus orchards, is frequently used as a boulevard or hedgerow tree. Mature heights may reach 25 ft. with widths to 20 ft. The fruit, favored by marmalade connoisseurs, also makes a spritely flavoring for pies and drinks. The variety Bouquet de Fleur with its slightly cupped, dark green leaves and short internodes offers an interesting shape and texture where a dense, compact, medium-sized tree is desired. Another sour orange variant, Chinotto *(C. aurantium* var. *myrtifolia)*, has small, myrtle-like, closely spaced leaves which in full sun tend to make a fine-textured, dense canopy. Under shady conditions the randomly oriented branches create a more open, irregular appearance. The distinctly oriental look of Chinotto makes it an excellent choice for the Japanese and Chinese garden or a very contemporary, modern setting. While these sour oranges are all quite cold hardy, they do require spraying for best appearance. The foliage of both Bouquet de Fleur and Chinotto, with or without fruit, makes handsome arrangements and evergreen wreaths.

Lime-prickly ash, colima *(Zanthoxylum fagara).* This pinnately compound, aromatic-leaved citrus relative is native to the Valley. The canopy, to 25 ft. high and as wide, tends to be quite open in the shady understory of its natural habitat. Its catclaw thorns and adaptability to trimming make it good hedging material. Likewise in an informal border or woodland setting, lime-prickly ash would be most appropriate. The dark red berries borne in axillary clusters are quite ornamental. Locally, the powdered leaves are used as a condiment and an extract of the leaves or bark is said to be a good soporific and nerve tonic.

Mountain torchwood *(Amyris madrensis).* This open canopied, usually multiple trunked tree has small, pinnately compound leaves very similar to the lime-prickly ash. The fragrant, white spring blooms are followed by dark purple fruit in the fall. Mountain torchwood grows to 20 ft. and is quite shade tolerant. Its delicate leaf and branch structure fits well in patio or courtyard plantings or as an underplanting in a shady, woodland landscape. The common name was derived from its easy kindling quality which made it useful for torches and starting fires. A related species, chapotillo, *(A. texana)*, grows to only 10-12 ft., but does not have as interesting a form and leaf structure as *A. madrensis.*

Wafer ash *(Ptelea trifoliata).* This Rue family member and the related *P. baldwinii* form a fairly compact, narrow crown to 20-25 ft. The fruit, a samara which resembles elm, has been used as a hops substitute in home brew. The trifoliate leaves are deciduous. A root extract which contains the alkaloid, berberine, has been used to treat dyspepsia. The wafer ash being rather coarse textured and upright in growth could be used as an informal screen or plant wall where space is restricted or as a background planting for low-growing shrubs and perennials.

Australian desert lime *(Eremocitrus glauca).* One of few truly desert species of the *Rutaceae*, this medium sized tree of 25 ft. height is native to the dry areas of Queensland and New South Wales. In extremely arid situations the gray-green leaves are very narrow and elongated giving the tree a definite willow-like appearance. Under more humid conditions, however, the leaves may be ½ in. wide and 3 in. long. The roots will tolerate high salt and boron concentrations and when dormant the tree can withstand temperatures down to -5 F. On dry sites, and especially for the desert-type landscape, *E. glauca* would be a fitting choice as a shade or specimen tree.

TALL SHRUBS OR SMALL TREES

Meyer lemon *(C. limon* hybrid*).* Although the Meyer, often called Valley lemon, can attain 15-20 ft. heights, it is more likely to form a low, sprawling shrubby tree less than 8 ft. high. This does not make a particularly attractive specimen, which relegates the Meyer to planting strictly for the fruit or perhaps in a shrubby border collection.

Etrog citron *(Citrus medica).* The citron tree form resembles the Meyer lemon but has somewhat more upright growth and greater height. Its large leaves and open canopy suggest specimen use in an oriental or contemporary setting. The elongated fruit, used ceremonially by the ancient Hebrews, exudes a very pleasant fragrance which can perfume a whole room for many days.

Kumquat *(Fortunella* spp.*).* Kumquats attain heights of 6 to 8 ft. and generally take the shape of large, globe shaped shrubs. The fragrant blooms and orange fruit occur nearly year round. Meiwa, the round fruited variety, tends to be more compact and denser than the oval-fruited Nagami or Marumi varieties. Where a colorful screening hedge, specimen or scaled-down citrus representative for an oriental effect is desired, the cold hardy kumquats are excellent choices. The whole fruit can be eaten fresh or preserved. Several lime, lemon, and orange-kumquat hybrids are also useful as ornamentals.

Flying Dragon trifoliate orange *(Poncirus trifoliata).* This deciduous member of the orange family has extremely tortuous, large-thorned branches which give the tree an arrestingly grotesque appearance. With limited pruning, the Flying Dragon can provide a unique conversation piece for the formal, oriental or very modern landscape. Like the standard but less spectacular trifoliate orange, Flying Dragon is very cold-hardy and attains heights of 12-16 ft. The small, wrinkled yellow-orange fruit clustered on the twisted, greenish branches introduce a truly exotic dimension to floral arrangements. There are several citrus-trifoliate orange hybrids which are also cold hardy and useful as ornamentals in situations like those described above.

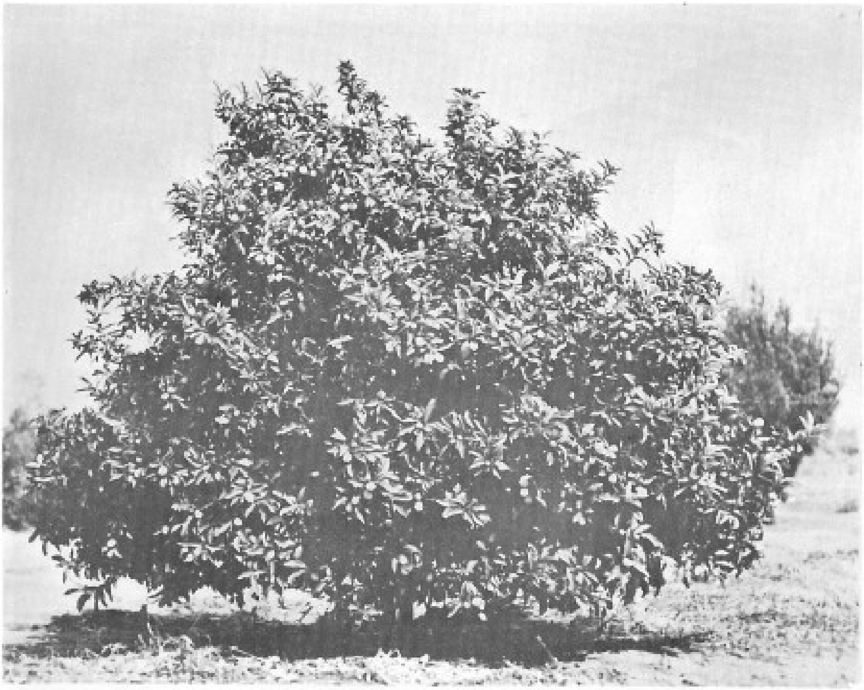

Fig. 3. As a specimen, the kumquat makes a dense, rounded shrub bearing bright orange fruit almost continuously. Both the round and oval fruited varieties are quite cold hardy.

Chalcas, orange jessamine *(Murraya paniculata).* This bright green, compound-leaved upright shrub withstands severe trimming but will develop into a narrow, vase-shaped 15 ft. tree. Chalcas prefers a semi-shady location, is quite tender to cold, and has very sweet smelling blooms in late spring followed by dark red berries. Even without trimming, chalcas seldom exceeds 6 ft. width which makes it a good choice for a narrow screening hedge in a protected spot along lot lines or alleyways.

Chinese box-orange *(Severinia buxifolia).* No doubt the dark green, oval leaves, compact shape, and compatibility with shearing of this citrus relative make it a good substitute for boxwood. Its thorniness and purple fruit also provide a nearly impenetrable hedge for wildlife cover and food. *Severinia* is cold hardy to 14 F. and is reported to be very tolerant of boron, accumulating 2 to 3 times the concentration of this element as other citrus without apparent injury. There are several other less common species of *Severinia* of differing sizes, leaf and flower variations including a spineless, denser-leaved form of *S. buxifolia* bearing a most striking resemblance to true boxwood (8).

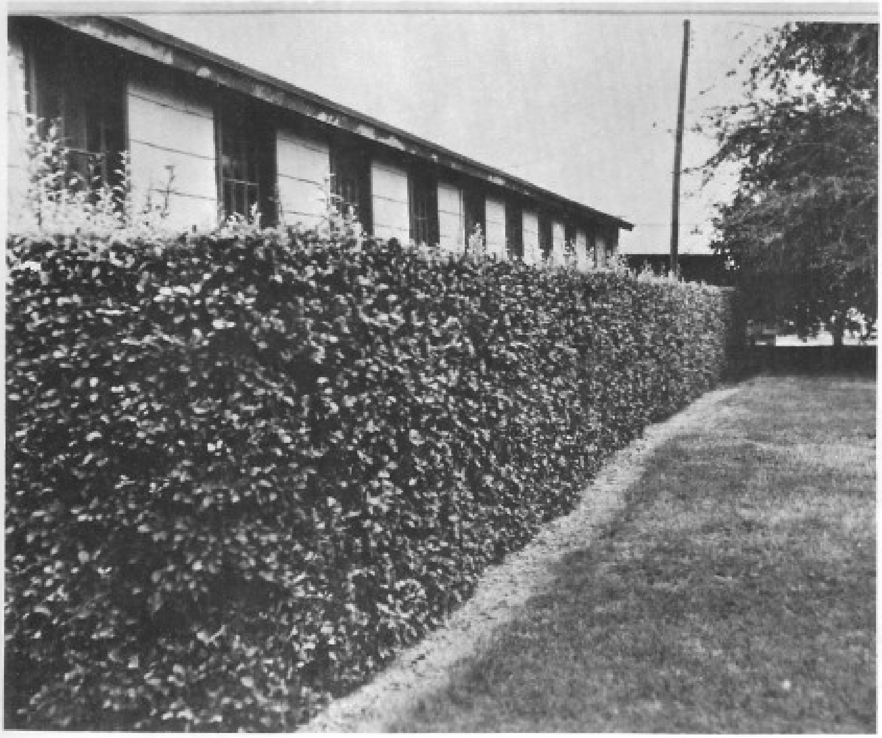

Fig. 4. Trifoliate orange, *Poncirus trifoliata*, with sharp, sturdy thorns and the ability to withstand severe trimming makes a nearly impenetrable hedge or screen for the landscape.

Limeberry *(Triphasia trifolia).* A 3 to 5 ft. shrub with shiny, trifoliate leaves, fragrant solitary flowers and dark red fruit, this thorny member of the citrus tribe is quite salt tolerant and recommended for sea-side plantings. Since it takes severe trimming well, limeberry can be used in the landscape as a low hedge or espaliered in the manner of pyracantha or pear (6).

Australian fuchsia *(Correa* spp.*).* This small to medium-sized shrub, a native of western Australia, needs a well-drained, partially shaded site but can tolerate poor, rocky, saline soils. The inch-long, tubular flowers which, as its common name implies, resemble fuchsias, may vary from white through pink to deep red depending on the variety (4). Bloom usually occurs continuously from November to April. The small leaves and compact habit of *Correa* fit well into miniature landscapes like courtyards or bedroom patios. *C. pulchella* growing to 2½ ft. high and spreading to 8 ft. is used as a ground-cover for dry locations in N. California (7). *Correa's* are hardy to 20 F.

Baretta *(Helietta parvifolia).* A small to medium tree (25 ft.), native to the hillsides of western Hidalgo and Starr counties and Mexico, baretta has aromatic, trifoliate leaves and fragrant flowers which are borne in axillary panicles in March and April. The open, irregular crown of *Helietta* would permit underplanting with lower shrubs and plants favoring a semi-shaded site. For the woodland and desert setting or in a collection of native plants, baretta would certainly provide authenticity and adaptability.

Rue, Herb of Grace *(Ruta graveolens).* The finely cut, gray-green leaves of this perennial herb have a long history associated with their use in folk medicine and lore. The plant grows to 2-3 ft. and favors a slightly alkaline, well-drained soil in a partly sunny location. Concoctions of the aromatic foliage were deemed effective antidotes to the poisons of toadstools, snake and insect bites, and against infection by the plague (2). Its common name derives from its reputed use as an additive to Holy Water. In the landscape, rue's color and texture would fit into a perennial border, woodland setting, and certainly in the herb garden. The branches and dried seed clusters are often used in wreaths and floral arrangements.

Information on insect control, fertilization, watering and general care of citrus is contained in publications available from Texas A&I University Citrus Center and Texas A&M University Agricultural Research and Extension Center or county extension agents (5, 9). Transplanting of native plants from the wild is more likely to succeed when done in late fall or very early spring. Selecting young plants, including a good-sized ball of soil containing intact roots and removing 1/2 to 2/3 of the foliage will further aid survival. Law and courtesy require obtaining the landowner's permission before removing plants. To improve the germination of seeds from many native plants, a scarifying, chilling and sometimes drying pre-planting treatment may be necessary, although this is less true of the *Rutaceae* than other plant families. Whether the choice be native or exotic, these plants properly planted, placed and cared for can be delightful and valuable additions to many Valley landscapes.

ACKNOWLEDGEMENTS

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Effect of Lead on Reflectance of Mexican Squash Plant Leaves

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ABSTRACT

A study was conducted to ascertain if lead (Pb) affected Mexican squash plant's *(Cucurbita pepo* L., 'Tatume') leaf reflectance enough for possible use in spectrally detecting Pb contaminated plants. Plants were grown hydroponically with no added Pb (control) and three Pb levels (100, 500, and 1,500 ppm), and their reflectances were measured spectrophotometrically. The 500-and 1,500-ppm Pb treatments stunted plant growth as compared with the 100 ppm and control treatments. (Leaves of the 1,500-ppm Pb treatment were too small for spectral measurements.) Data in the visible region at the 0.55-µm wavelength showed that the 100-and 500-ppm Pb treatments had significantly higher reflectances (low chlorophyll) than did the control treatment (higher chlorophyll). Lead treatments did not affect leaf reflectance in the near-infrared region (0.75-to 1.35 µm waveband). In the water absorption region (1.35 to 2.5 µm), reflectances of control leaves were significantly higher than were Pb-treated leaves at the 1.45-, 1.65-, and 2.2-µm wavelenths. Visible light reflectance spectra might have the potential to detect Pb-contaminated plants, but techniques are needed to distinguish Pb-stressed plant spectra from that for other plant stresses that also affect leaf pigment concentrations.

The pollution problem threatening man's environment must be alleviated. One component of this polluted biosphere is lead (Pb). High Pb concentrations in certain environments may be a health hazard to their fauna. Therefore, research on the plant uptake of Pb and other heavy metals is presently very active.

Warren and Delavault (17), Cannon and Bowles (3), and Singer and Hansor (14) reported that automobile exhaust fumes were responsible for high Pt concentrations in soil and in vegetation near heavily traveled highways. Page Granje, and Joshi (12) demonstrated that Pb accumulations in and on plants o 27 varieties of crops grown close to heavily traveled highways in souther California were caused principally by its aerial deposition on leaves and not b plant root absorption from Pb-contaminated soils.

Keaton (10) applied Pb compounds to soil and found they had no detriment effects on barley growth; and actually, in small amounts they stimulated barle growth. Baumhardt and Welch (2) also showed that corn plants, grown in tl field with added Pb, did not show any morphological, color, maturity, or growth differences, even though plant Pb concentration increased as soil Pb was increased.

Heavy metal stress in vegetation causes chlorosis (13). Differences in pigment caused by heavy metal concentrations were used by Yost and Wenderoth (16) to measure spectral differences between balsam fir and red spruce.

We conducted this study to ascertain if leaf reflectances of Mexican squash plants grown with varied Pb concentrations differed enough for their possible use in spectrally detecting Pb-contaminated vegetation. Mexican squash was chosen because it promptly develops large leaves since leaves must be larger than 2 cm in diameter to cover the spectrophotometer's reflectance measuring port.

MATERIALS AND METHODS

Mexican squash *(Cucurbita pepo* L., 'Tatume') seeds were planted and germinated in sterilized, chloride-free sand in 23-cm diameter glazed crocks with a 7.6-liter capacity; 200 ml of glass-distilled water was added daily.

Plants were grown in a growth chamber. The growth chamber's parameter ranges were: day temperature, 30.0 to 31.0 C; night temperature, 20.0 to 21.0 C; day relative humidity, 56.0 to 66.0%; night relative humidity, 90.0 to 92.0%. A 12-hr light-dark cycle was used; light intensity approximated 800 ft-c (8.60×10^{-1} lumen cm^{-2}) at the plants' apexes.

Four uniform plants, with macroscopically visible true leaves, were transplanted into each of 16 plastic containers with a 1.9-liter capacity containing continuously aerated, full-strength nutrient solutions. (Turtox's Water Culture Outfit, No. 2108171, Chicago, Illinois) (Mention of company or trademark is included for the readers' benefit and does not constitute endorsement of a particular product listed by the U. S. Department of Agriculture over others that may be commercially available.) Four Pb treatments (0, 100-, 500- , and 1,500-ppm Pb), obtained by adding Pb acetate to the complete solution, were replicated four times and used in a randomized complete block experimental design.

From the four plants (tagged A, B, C, or D) in each container, the first true leaves from plants tagged A were collected for spectral reflectance measurements, when leaves were large enough to cover the spectrophotometer's 2-cm diameter port. (Leaves were 11 days old when collected for spectral measurements.) The first true leaves from plants tagged B were composited for each treatment, and then two samples of each (one for the 1,500-ppm treatment) were used for chlorophyll analyses (8). The intact plants (excluding roots) C and D, and the remains of plants A and B (after reflectance measurements and chlorophyll samples were completed) were composited for Pb analyses by atomic absorption, conducted by Pan American Laboratories, Brownsville, TX.

Water content of leaves and plants collected for spectral measurements and Pb analyses, respectively, were determined on a dry-weight basis; leaves and plants were oven dried at 68°C for 72 hr and cooled in a desiccator before weighing. Leaf thickness was determined with a linear displacement transducer and digital voltmeter (7). Leaf areas were measured with a planimeter.

Tissue pieces from near the center of leaves were fixed in formalin-acetic acid-alcohol, dehydrated with a tertiary butanol series, embedded in paraffin, stained with the safranin-fast green combination, and transversally microtomed at 12-μm thickness (9). Photomicrographs were obtained with a Zeiss Standard Universal Photomicroscope.

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

Seven wavelengths, selected from the 41 wavelengths measured over the 0.5- to 2.5-μm waveband, were 0.55 μm (green reflectance peak), 0.65 μm (chlorophyll absorption band), 0.85 μm (a wavelength on the near-infrared plateau), 1.45 μm (water absorption band), 1.65 μm (reflectance peak following water absorption band at 1.45 μm), 1.95 μm (water absorption band), and 2.20 μm (reflectance peak following water absorption band at 1.95 μm). Reflectance data for these wavelengths were analyzed for variance (15), using Duncan's multiple range test to test differences among means ($p = .05$).

RESULTS AND DISCISSION

Plant Growth

The 500-and 1,500-ppm Pb treatments stunted the squash plants (Fig. 1) and caused them to be lighter green (less chlorophyll as will be shown later) than were the control plants. The 1,500-ppm Pb-treated plants did not have enough leaves for statistical comparisons with the other treatments. The average area per leaf for the 500 ppm Pb treatment was significantly smaller (10.2 cm^2) than that of the control and the 100-ppm Pb treatments (28.8 and 24.4 cm^2, respectively) which were not statistically different. Leaf thicknesses of 0.111, 0.110, and 0.112 mm, and water contents of 91.2, 92.0, and 91.0% for the control, 100-, and 500-ppm Pb treatments respectively, did not differ statistically.

Histology

Transections of 100-and 500-ppm Pb-treated leaves were compared with those for control leaves by examining them with light microscopy. Lead treatment did not induce cell abnormalities or mesophyll structure differences.

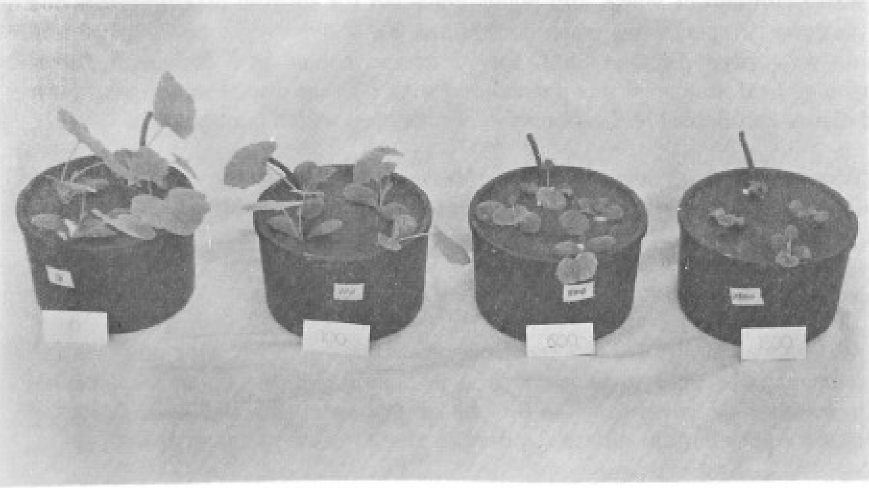

Fig. 1. Mexican squash plants grown with four different lead levels (from left to right) zero, 100-, 500-, and 1,500-ppm Pb treatment.

Lead Assays

Plant Pb concentrations were 30, 87, 84, and 77 ppm for the control and 100-, 500-, and 1,500-ppm Pb treatments, respectively. The lower values for the 500-and 1,500-ppm Pb treatments, as compared with the 100 ppm Pb treatment, may have been caused by effects on Pb absorption because we observed root growth reduction. This is supported by plant growth reduction in sand culture (11) and seed germination inhibition (4) with high Pb concentrations. The high Pb concentration of the control plants (30 ppm) may have been caused by atmospheric Pb pollution (5) because we conducted the experiment only 100 m from a heavily traveled highway.

Reflectance Spectra

Reflectance spectra for the control and Pb-treated plant leaves over the 0.50- to 2.50-μm waveband are charted in Fig. 2. Reflectance for the 1,500-ppm Pb treatment was affected by leaf size. The leaves were very small (average leaf area was 2.4 cm^2) with closely netted veination and interveinal "pimpling." Some leaves were so small that the spectrophotometer's light beam impinged on veins, rather than on an interveinal area, which resulted in an increased near-infrared reflectance (0.75 to 1.35 μm) as compared with interveinal reflectance (D. E. Escobar and H. W. Gausman, Unpublished data, Weslaco, Texas). Therefore, we will not discuss leaf spectral characteristics for the 1,500 ppm Pb treatment.

At the 0.55- and 0.65-μm visible light wavelengths Pb-treated leaves had higher reflectance than did control leaves because they had less chlorophyll (7.8 and 8.3 mg/g for 100-and 500-ppm Pb treatments, respectively) than did control leaves (10.5 mg/g). Leaves with a low chlorophyll concentration had less light absorptance and, consequently, more reflectance than leaves with a high chlorophyll concentration. Mean reflectances were significantly different at the 0.55-μm wavelength: 12.8, 17.3, and 15.2% for the control, 100, and 500 ppm treatments, respectively. Reflectance of the control leaves (6.2%) at the 0.65-μm wavelength was significantly lower than that of the 100-(7.7%) and 500-ppm (7.2%) Pb treatments which were alike. Lead treatments did not significantly affect near-infrared reflectance over the 0.75- to 1.35-μm waveband (Fig. 2).

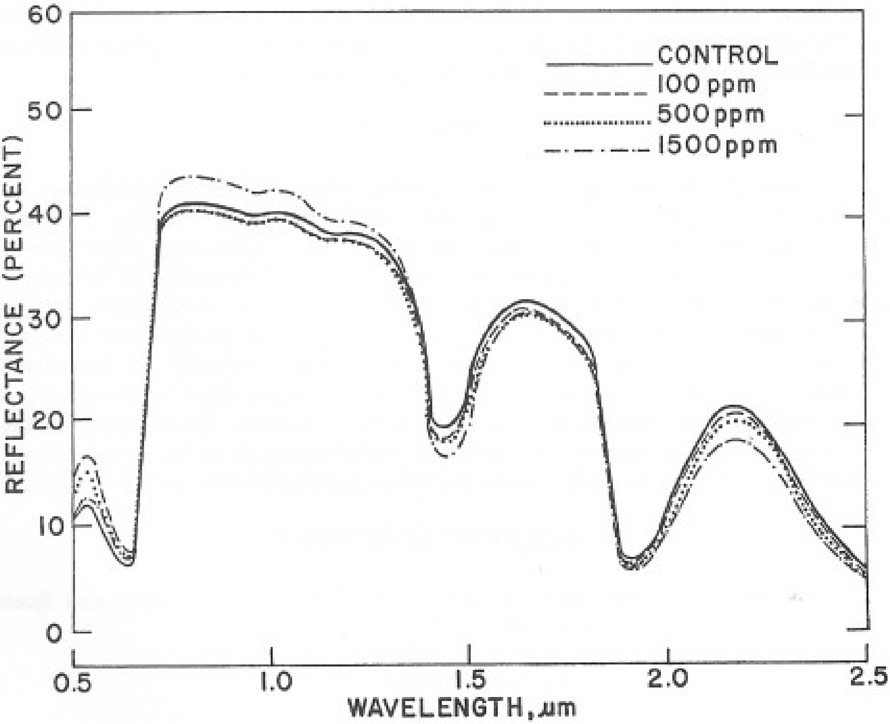

Fig. 2. Reflectance spectra over the 0.5- to 2.5-μm waveband for the zero, 100-, 500-, and 1,500-ppm Pb-treated leaves.

In the near-infrared water absorption waveband (1.35 to 2.5 μm), reflectances of the control leaves at the 1.45-, 1.65-, and 2.2-μm wavelengths were significantly higher than that of the 100-and 500-ppm Pb-treated leaves which were alike. The lower reflectance of Pb-treated leaves at these wavelengths may not have been caused by water absorption of radiation, because among treatments the leaf water contents were essentially alike. In addition, the mean reflectances for the 1.95-μm water absorption band for all treatments were statistically alike.

Unfortunately, the effects of Pb on squash leaf reflectance in the visible region were essentially the same as those caused by nutrient deficiencies (6). Press (13) also recognized that heavy metal-stressed plants would be difficult to distinguish from plants with other stresses. He concluded that a variety of integrating imaging sensors might be helpful to detect metal-stressed plants by simultaneously monitoring variable factors like soil type, climate, and the ratio of total leaf area to exposed background. We feel that the use of narrower multispectral scanner bands deserve *a priori* consideration to facilitate detecting metal-stressed plants from among plants with other stresses.

CONCLUSION

Leaves of Mexican squash plants grown with high Pb concentrations had higher visible light reflectance than did leaves from control plants. Therefore, detecting Pb-polluted crops may be feasible by measuring plant canopy reflectance if further research is conducted to distinguish the reflectance spectrum of Pb-stressed plants from that caused by other plant stresses, particularly nutrient deficiencies. Possibly, this could be achieved by using multispectral scanners with narrower wavebands, ratioing of wavebands, conducting multispectral photography with appropriate filter combinations, or by employing a variety of integrating imaging sensors. In addition, further research should be conducted with heavy metals other than Pb, to determine if their possible stress to plants causes any anomalous leaf reflectance patterns.

ACKNOWLEDGEMENT

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Chemical Control of Dryland Willow in the Lower Rio Grande Valley of Texas

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ABSTRACT

Dryland willow, a troublesome woody plant species in the Lower Rio Grande Valley, can be effectively controlled by treating its trunk base with diesel fuel or a combination of dicamba herbicide and water. Basally applied herbicides can be used in intensive agricultural areas with little drift hazard to surrounding agricultural crops.

Dryland willow or willow baccharis *(Baccharis neglecta* Britt.*)* is a native woody plant of south Texas. This plant is a shrub 5- to 10-ft tall and is found on a variety of soil types, but it is most common in disturbed habitats, like abandoned fields, improved pastures, rangelands, roadsides, and sides of drainage ditches and irrigation canal banks. Farmers and ranchers are concerned about controlling this plant. If not controlled, this plant quickly develops thickets and renders these areas impenetrable (Figure 1).

Various mechanical and chemical methods have been used to control dryland willow. Mechanical methods include shredding, disking, dozing, rootplowing, and grubbing (2, 4). Hoffman and Ragsdale (2) killed dryland willow plants by treating the base of their trunks with 2, 4, 5-T (2, 4, 5-trichlorophenoxyacetic acid) at 8 lb/100 gal of kerosene or diesel fuel. Hoffman (3) controlled dryland willow by either ground broadcasting or aerial spraying 2, 4-D (2, 4-dichlorophenoxyacetic acid) at rates ranging from 1½ to 2 lb/acre.

Everitt and Gerbermann (1) described the problem of drift hazard to surrounding agricultural crops when using either aerial application or ground-broadcast spraying of herbicides in the Lower Rio Grande Valley of Texas. Consequently, they used the basal method to apply herbicides on huisache *(Acacia farnesiana* (L.) Willd.*)*. Like huisache, dryland willow usually occupies only small acreages in the valley. Thus, the most common method for controlling this plant is by grubbing or shredding, which usually does not kill the plant and must be repeated every 2 to 3 years. In this paper, we compared the effectiveness of various herbicides in water solution with diesel fuel, as a means of controlling dryland willow by the basal application method.

Fig. 1. A) Dryland willow infestations prior to treatment; B) dead dryland willows 1 year after applying dicamba (4-lb A.E./gal) + water.

MATERIALS AND METHODS

This study was conducted 3 miles north of Mission, in Hidalgo County, Texas, on a 10-acre coastal bermudagrass *(Cynodon dactylon* (L.) Pers.*)* pasture that had been invaded by dryland willow. The dryland willows ranged from 3- to 10-ft tall usually with less than 3-inch trunk diameters. The soil type was a Pharr (Typic Argiostolls) sandy loam.

We used a randomized complete block design with three replications of six herbicide treatments and 25 trees per plot. The treatments used were: diesel fuel; dicamba (3, 6-dichloro-o-anisic acid) (4-lb acid equivalent/gal) + water; dicamba (3-lb acid equivalent/gal) + water; 2, 4, 5-T (2, 4, 5-trichlorophenoxyacetic acid) (4-lb acid equivalent/gal) + water; 2, 4, 5-T (3-lb acid equivalent/gal) + water; and a control. (Names are included for the reader's benefit and do not imply an endorsement of or a preference for the product listed by the U. S. Department of Agriculture.) The herbicides were mixed according to the manufacturer's recommendations. The higher concentration treatments (4-lb acid equivalent/gal) consisted of 16-oz herbicide/ 12.5 gal of water, while the lower concentration treatments (3-lb acid equivalent/ gal) consisted of 12-oz herbicide/12.5 gal of water. All chemical mixtures were equivalent to either 4-lb herbicide/100 gal of solution or 3-lb herbicide/100 gal of solution. About 1 pt of each specific treatment mixture was applied to the base of the trunk of each dryland willow in June 1974. The soil surface was dry, and soil moisture in the upper 6 inches of the soil averaged 10% at application. There was little wind at the time of application, thus drift hazards were minimal.

Plant kill was determined in June 1975, 1 year after application of treatment. Plants were counted as dead if we could see no evidence of basal sprouts or live tissue.

RESULTS AND DISCUSSION

Percentage kill of dryland willow with diesel fuel, and both dicamba formulations + water did not differ significantly (Table 1). Dicamba + water at either concentration was as effective as diesel alone, and the lower concentration of dicamba + water was as effective as the higher concentration. The combination of 2, 4, 5-T and water at either concentration did not effectively control dryland willow.

The effect of the higher concentration of dicamba + water on dryland willow at 1 year after application is shown in Figure 1. There was no observable evidence of live tissue on these plants treated with dicamba and water.

Diesel fuel killed grass in the immediate area of the trunks; combinations of dicamba or 2, 4, 5-T with water did not kill grass.

We found that either diesel fuel alone or combinations of dicamba and water most effectively controlled dryland willow, using the basal application method.

The use of diesel fuel provided no drift hazard to surrounding agricultural crops, but dicamba should be applied only when there is little or no wind. The average cost for killing dryland willow with dicamba and water was 2 cents/tree, while diesel cost was 5 cents/tree (Table 1).

Table 1. Control of dryland willow obtained by basal application of diesel and herbicide-water combinations and cost of treatment at Mission, Texas.

Herbicide Treatment	Percent Dead Plants	Cost
	%	cents/tree
Diesel	81 a[2]	5
Dicamba (4-lb A.E.[1]/gal) + water	75 a	2
Dicamba (3-lb A.E./gal) + water	69 a	2
2, 4, 5-T (4-lb A.E./gal) + water	5 b	2
2, 4, 5-T (3-lb A.E./gal) + water	4 b	2
Control	0 b	-

[1] A.E. -- Acid Equivalent

[2] Numbers followed by the same letter do not differ significantly at the 1% level using Duncan's multiple range test.

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Germination of Texas Ebony Seeds

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ABSTRACT

Texas ebony *(Pithcellobium flexicaule* (Benth.) Coult.*)* is a native ornamental tree grown extensively in south Texas. Its hard seed coats that restrict imbibition of water can be scarified to promote germination by soaking the seeds in concentrated sulfuric acid from 30 to 150 minutes. Germination was $\geq$ 84% at five different temperature regimes (15, 20, 25, 30, and 35 C). Seedling growth was best at 30 C. Salt levels in the aqueous substrate had little effect on seed germination; however, stage of development of seedlings was inhibited by 3,000 ppm NaCl. Emergence of Texas ebony seeds in soil in the greenhouse was optimum at a planting depth of 1 cm.

Texas ebony is an evergreen native tree that grows in the southern half of the South Texas Plains to as far north as Sinton in San Patricio County, Texas (2).

Texas ebony reaches a height of 15 m and has a rounded, very dense, dark crown (Fig. 1). Its leaves are dark green, bi-pinnately compound, alternate, and 3 to 5 cm long with 1 to 3 pairs of pinnae. Plants flower from April to July (rarely to November) following rains. The flowers are cream colored and are followed by dark-brown seed pods (6).

Although Texas ebony is highly prized as an ornamental and shade tree and has long been considered one of the most valuable native trees in the Lower Rio Grande Valley of Texas (3,6), little research has been conducted on it. This experiment was designed to conduct laboratory investigations on effects of environment on germination of Texas ebony seeds.

MATERIALS AND METHODS

Seeds were randomly collected from several populations of Texas ebony trees in Hidalgo County, Texas, during the summer and fall of 1977 and the winter of 1978. All seeds were stored at room temperature in 1-qt jars with moth balls. Fully developed, undamaged seeds were used for the germination experiments.

The experiments were conducted in small growth chambers with automatic temperature and light controls. All experiments had 12 hour photoperiods provided by fluorescent light. An experimental unit consisted of 10 seeds in a

Fig. 1. A mature Texas ebony *(Pithcellobium flexicaule* (Benth.) Coult.*)* tree.

15-cm petri dish containing two filter papers wetted with 20 ml of distilled water or appropriate test solution. Experiments were designed as randomized complete blocks unless otherwise stated. Treatments were replicated five times, and each experiment was conducted twice. Data were pooled for presentation.

Exploratory experiments on the germination of Texas ebony seeds revealed their germination was very low because of a hard seed coat. Seeds were soaked in concentrated H_2SO_4 (scarification) for various periods of time and tested for germination at 30 C (4). The seeds were soaked for 0, 15, 30, 60, 90, 120, and 150 minutes. The scarified seeds were washed with tap water for 5 minutes and scrubbed to remove any residue. Only percent germination was recorded in this study. Subsequent studies were conducted using seeds scarified for 90 minutes in H_2SO_4.

Seeds were considered germinated if the radicle had extruded to 2 mm. Number of seeds germinated, radicle lengths, and stage of seedling development were recorded 7 days after wetting. The stages of development described by Scifres (4) were used: seeds not germinated "0"; seedlings with radicles extruded "1"; seedlings with cotyledons expanded "2"; seedlings with the first true leaf emerged "3"; seedlings with the true leaf fully expanded "4"; seedlings with the second leaf emerged "5". Temperature regimes evaluated for germination of acid-scarified Texas ebony seeds were 10, 15, 20, 25, 30, 35, and 40 C. The petri dishes were randomized at each tempeature regime and the data were analyzed by one-way analysis of variance.

Tolerance of Texas ebony seeds during germination to various concentrations of NaCl was studied at a constant temperature of 30 C. Salt concentrations of 0, 150, 400, 700, 1,000, 1350, and 3,000 ppm (wt/vol) were formulated in distilled water.

The influence of planting depth was studied in the greenhouse. Ten H_2SO_4-scarified seeds were planted in large pots (16 cm diameter x 16 cm height) at depths of: 1, 2, 4, 6, and 8 to 10 cm. The five depths were treatments, and each was replicated five times in a randomized complete block design. The potting mixture was three parts sandy loam soil:one part perlite:one part peat moss. Seedling emergence and height were recorded at the end of 60 days.

Germination and emergence data were transformed (arcsin $\sqrt{\%}$) prior to analyzing for variance. Analysis of variance were also conducted on radicle length, stage of development, and seedling height. Differences among means were compared with Duncan's multiple range test (5).

RESULTS AND DISCUSSION

Approximately 20% of the nontreated seeds had insect punctures or other natural imperfections, which might enhance imbibition and allow subsequent germination in nature. Only 11% of the seeds not soaked in H_2SO_4 germinated after 7 days. Soaking seeds in H_2SO_4 for 15 minutes significantly increased percent germination as compared with nonsoaked seeds. Soaking the seeds in H_2SO_4 for 30, 60, 90, 120, and 150 minutes resulted in significantly higher germination percentages than those soaked for 15 minutes; however, germination percentages did not differ significantly among the five soaking periods (Table 1). Although radicle length and stage of development of seeds

Table 1. Percentage germination of Texas ebony seeds soaked in sulfuric acid and germinated at 30 C for 7 days.

Soaking time (min)	0	15	30	60	90	120	150
Germination [1] (%)	11c	59b	77a	86a	84a	84a	77a

[1] Means followed by the same letter are not significantly different at the 1% probability level, according to Duncan's multiple range test.

and seedlings were not recorded, soaking the seeds for the increased periods of time in H_2SO_4 did not seem to retard subsequent growth or morphological development of the seedlings.

Table 2 presents the percent germination, radicle lengths, and stage of development for Texas ebony seeds subjected to seven different temperatures for 7 days. Germination percentages were significantly higher at 15, 20, 25, 30, and 35 C than at 10 or 40 C. More seeds germinated and seedlings were better developed at 40 C than at 10 C. Although there was no significant difference in the germination percentages for the five temperature regimes from 15 to 35 C, there were significant differences among the radicle lengths and stages of development for these temperatures. Evidently, 30 C is the optimum temperature for morphological growth of seedlings.

Table 2. Percentage germination, seedling radicle lengths, and stage of seedling development after 7 days at seven different temperatures.

Temp. (C)	Germination (%)	Radicle length (mm)	Stage of development
10	1 c [1]	0.02 e	0.10 e
15	88 a	8.02 d	1.00 d
20	86 a	23.00 c	1.78 c
25	94 a	37.58 b	2.71 b
30	91 a	49.96 a	3.87 a
35	84 a	25.96 c	3.56 a
40	54 b	10.84 d	1.09 d

[1] Means within a column followed by the same letter are not significantly different at the 1% probability level, according to Duncan's multiple range test.

Percent germination and radicle length of seedlings were not adversely affected by NaCl in the aqueous substrate, although stage of development of seedings was inhibited the most by 3,000 ppm of NaCl (Table 3). Ayers (1), indicated that salinity may reduce germination due to toxic levels of certain ions and restricted water entry into the seed; however, data from this study indicate that salts have little effect on Texas ebony seed germination and seedling growth.

Table 3. Influence of NaCl on the germination and seedling growth of Texas ebony after 7 days at 30 C.

NaCl Conc. (ppm)	Germination (%)	Radicle length (mm)	Stage of development
0	88 ab [1]	41.3 c	4.03 ab
150	90 a	46.0 abc	4.11 a
400	83 abc	43.5 bc	3.71 bc
700	80 bc	51.2 a	3.57 c
1,000	73 c	41.8 c	3.77 bc
1,350	77 c	50.2 ab	3.64 c
3,000	76 c	41.3 c	3.11 d

[1] Means within a column followed by the same letter are not significantly different at the 5% probability level, according to Duncan's multiple range test.

Emergence was optimum when Texas ebony seeds were planted 1 cm deep in soil (Table 4). Very few seedlings emerged when seeds were planted deeper than 4 cm. Seedlings emerging from 2- to 4-cm planting depths were less vigorous and less well developed than those from the 1-cm planting depth. Germination was high at the lower depths, but evidently the seeds were planted too deep for the seedlings to emerge.

Table 4. Percentage seedling emergence and seedling height 60 days after planting Texas ebony seeds at various depths in soil in the greenhouse.

Planting depth (cm)	Emergence (%)	Height (mm)
1	84 a[1]	58.86 a
2	60 ab	33.22 b
4	44 b	19.22 b
6	8 c	2.60 c
8-10	2 c	0.02 c

[1] Means within a column followed by the same letter are not significantly different at the 1% probability level, according to Duncan's multiple range test.

Information derived from this study may be beneficial to horticulturists concerned with the propagation of Texas ebony as an ornamental.

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Five Years Observations on Pecan Variety Adaptation To the Lower Rio Grande Valley

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ABSTRACT

A testing program for pecans, *Carya illinoensis*, in the Lower Rio Grande Valley was established in February, 1974 to study the performance of 44 different varieties and selections from the U.S.D.A. pecan breeding program. Of the oldest trees in the planting 'Chickasaw', 'Cherokee' and 'GraBohls' came into production earlier and have had the heaviest crops of nuts while 'Cheyenne', 'Mohawk', 'Choctaw', and 'Wichita' have produced lesser amounts. Cultural practices for pecan production in the Valley are described.

Pecans, *Carya illinoensis*, are adapted to a wide range of soils and climate, ranging from the arid West to the humid Southeast. However, pecans in general have not been considered adapted to the subtropics or areas with long growing seasons and mild winters. The USDA pecan selection and variety testing program has become quite extensive since 1964. There are presently 279 test sites in 18 states in the U.S. (Fig. 1). This is the best known method to determine variety adaptability for an area.

While growing up in the subtropical Lower Rio Grande Valley, the senior author noticed large trees of many varieties of pecans that matured nuts regularly. Pecan varieties are now known to vary in chilling requirement, time of budbreak in the spring and nut maturity in the fall. In recent years, pecans have been planted in areas with mild climates such as the San Joaquin Valley of California, from Fresno to Bakersfield, and the northwest coast of Mexico near Hermosillo, Sonora. Some varieties such as 'Wichita', 'Cheyenne', 'Choctaw', 'Apache', 'GraBohls', 'Mohawk', 'Sioux' and a few others are performing well in these areas, whereas varieties with higher chilling requirements are having difficulties because of insufficient chilling and resulting delayed foliation.

To determine the adaptability of pecans to the Lower Rio Grande Valley of Texas, the USDA-SEA and the Texas A&I University Citrus Center at Weslaco initiated a cooperative test to study the performance of 44 different varieties and selections from the USDA pecan breeding program. In February, 1974, nursery-budded trees, 3-year-old 'Riverside' rootstocks with one-year-old budded tops, of the varieties 'Chickasaw', 56-10-6 ('Shoshoni' X 'Cherokee'), 'Caddo',

Fig. 1. Testing sites for USDA pecan selection and variety testing program.

'Cherokee', 'Desirable', 'GraTex', 'Cheyenne', 'GraBohls', 'Mohawk', 'Choctaw', and 'Wichita' were planted at Weslaco on a spacing of 30 ft X 30 ft in 3-tree plots in 2 rows. Five additional rows of 3-year-old 'Riverside' seedling rootstocks were planted at the same spacing. In April, 1977, 3 years after transplanting, the seedlings were grafted using the inlay bark graft technique. These seedlings were grafted in 2-tree plots to 'GraKing', 53-9-1 ('Mahan' X 'Odom'), 49-23-16 ('Brake' X 'Sioux'), 'Cape Fear', 'Shoshoni', 56-6-148 ('Mahan' X 'Stuart'), 53-11-139 ('Moore' X 'Stuart'), 61-6-67 ('Mohawk' X 'Starking'), 47-4-10 ('Oklahoma' X 'Ideal'), N-2-43 ('Nugget' X 'Western'), 'Kiowa', 48-15-3 ('Major' X 'Evers'), 'Kernodle', 45-10-38 ('Moore' X 'Mahan'), 55-11-11 ('Major' X 'Shoshoni'), 56-15-11 ('Odom' X 44-12-259), 62-11-26 (44-12-86 X 'Starking'), 'Shawnee', 55-17-3 ('Oklahoma' X 44-12-86), 49-20-112 ('Brake' X 'Candy'), 56-15-13 ('Odom' X 44-12-259), 'Forkert', 41-19-20 ('San Saba Improved' X 'Mahan'), 'GraCross', 48-13-311 ('Moore' X 'Schley'), 'Sioux', 52-1-9 ('Candy' X 'Curtis'), 'Apache', 'Tejas', 53-9-203 ('Mahan X 'Odom'), 64-11-17 ('Chickasaw' X 'Starking'), 48-3-33 ('Brooks' X 'Moore'), and 53-9-340 ('Mahan' X 'Odom'). These varieties and selections vary greatly as to chilling requirement, budbreak in the spring, and nut maturity in the fall.

Observations on variety and selection adaptability to the Lower Rio Grande Valley, 1974-1978 varieties. Only the transplanted nursery budded trees have produced any significant quantities of nuts to date since the seedling rootstocks were grafted in 1977. As of August, 1978 the 'Chickasaw', 'Cherokee', and

'GraBohls' have produced a heavy crop of nuts and 'Cheyenne', 'Mohawk', 'Choctaw', and 'Wichita' have produced lesser amounts. Each of these varieties produced nuts at an early age.

Spacing and tree growth: Because of the longer growing season, similar to the Winter-Garden area, pecan trees make profuse vegetative growth and should not be spaced closer than 30 ft X 30 ft. For some varieties 35 ft X 35 ft or 40 ft X 40 ft may be more desirable.

Fertilization: Nitrogen and zinc are the main nutrient requirements for pecan trees. The trees at Weslaco, beginning in 1975, have received 0.5 lb N per tree a year through 1977 and 2.5 lb N in 1978 in the form of urea. Since this high N rate resulted in the great amount of vegetative growth, the amount will be reduced to 1 lb N/tree in 1979. Zinc sulfate, at the rate of 2 lb per 100 gal of water, has been applied 2 or 3 times in early spring at 2-3-week intervals for control of pecan rosette. No nitrogen or zinc deficiency symptoms have been observed on these trees.

Irrigation and drainage requirements: After transplanting, pecan trees require adequate soil moisture to re-establish a new root system. This is critical the first 2 years, and the top 3 ft of soil should not be allowed to dry completely. Tank watering in basins the first 2 years at 2-week intervals is desirable in times of no rainfall. Once the trees are established, irrigation water may be applied at 21-30-day cycles, depending on rainfall and soil type. Pecans prefer a well-drained soil and inundation for 3 to 4 weeks may be harmful. Many Valley soils have a high water table, however, pecan trees grow on 3-4 ft of soil in Georgia, the leading state in pecan production. Poor drainage in a high pH soil may result in some leaf burn. This type leaf burn, which resembles chloride burn, was noted on 'Desirable', 55-11-11 ('Major' X 'Shoshoni') and 45-10-38 ('Moore' X 'Mahan') in the Texas A&I plots in August, 1978.

Tree training and pruning: The trees should be trained to a central leader during the first 5 years to develop strong scaffold branches (1). As a result of the profuse vegetative growth tip-pruning in February and once in the summer may be necessary to check growth and increase nut production (2). Growers in the San Joaquin Valley are tip-pruning twice during the summer and once in the winter.

Diseases and insects: Pecan scab, caused by the fungus *Fusicladium effusum*, was noted on 'Cherokee' and 'GraBohls' and to a lesser extent on 'Wichita' and 'Mohawk' in August, 1978. The trees had received two early spring applications of Du-Ter (triphanythin hydroxide) fungicide. Growers in the Southeast apply 5 to 12 applications of a fungicide to control scab on susceptible varieties. In a new area it may be desirable to use non-scabbing varieties. Fall webworm, *Hyphantria cunea* (Drury) and yellow aphids, *Monellia spp.* have been noted on a few trees in this test block but are easily controlled. Black aphids, *Tinocallis caryae foliae* have been reported on pecan trees in other parts of the Valley.

Preharvest nut sprouting may be a problem with some varieties due to the long growing season and vegetative growth of the tree or wet weather at the time of nut maturity. This problem has been encountered in the Winter-Garden area of Texas.

Periodic progress reports will be published on this variety test and much more will be known about variety adaptability in the Rio Grande Valley within the next 3 to 5 years.

Anyone interested in establishing a small planting in the Lower Rio Grande Valley area might consider planting 3-year-old seedling rootstocks and grafting to the desired varieties in 2 or 3 years. Three-year-old seedling rootstocks, 5 to 6 ft with 30-36-inch root system can be purchased from a number of pecan nurserymen for $2.00 - $3.00 per tree.

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By-Laws of the

Rio Grande Valley Horticultural Society

ARTICLE I. NAME

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

ARTICLE II. PURPOSE

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

ARTICLE III. YEAR

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

ARTICLE IV. MEMBERSHIP AND DUES

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

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

3. *Dues.* Annual dues shall be:

Individual	$ 7.50
Sustaining	25.00
Patron	50.00
Special Contributor	100.00

Dues are payable at the time of application for membership and become due and payable in January each year.

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

5. *Termination of Membership.* The membership of any member may be terminated for cause by a two-thirds vote of the members of the Board of

Directors, and the accused shall be given an opportunity to appear before the Board of Directors to give reasons why his membership should not be terminated, prior to final action by the Board.

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

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

ARTICLE V. SECTIONS

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

Citrus
Vegetables
Special Fruits
Ornamentals

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

ARTICLE VI. MEETINGS

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

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

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

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

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

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

ARTICLE VII. DIRECTORS AND OFFICERS

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

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

3. *Election.* The President-elect and the Directors shall be elected by a majority vote of the members present at the Annual Institute and shall assume duties following termination of the Institute.

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

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

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

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

8. *Succession.* The Board of Directors shall apoint a line of succession of Vice-Presidents.

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

ARTICLE VIII. DUTIES OF THE OFFICERS

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

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

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

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

ARTICLE IX. COMMITTEES

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

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

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

as the Citrus Committee, the Vegetable Committee, Special Fruits Committee, and the Ornamentals Committee, etc.

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

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

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

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

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

ARTICLE X. AMENDMENTS

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

The above revised by-laws were approved 13 April 1978 by the Horticultural Society.

Editorial Guidlines for Manuscripts

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

Subjects: Previously unpublished scientific research and observations, review and technique articles, reports of new problems or pests, market evaluations, varieties releases, etc., are acceptable for publication. Popularized or new versions of previously published information are unacceptable. Papers should pertain to the Lower Rio Grande Valley's horticulture, but pertinent research which has been conducted elsewhere may also be included. Manuscripts dealing with non-horticultural crops are acceptable, if they have some application to horticultural science.

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

Byline: The author's name follows the title. This is followed by the author's affiliation (title and institution) and institutional address with zip code. ACKNOWLEDGEMENTS should directly precede LITERATURE CITED. Use no footnotes—supplementary information should be included in the text, and it may be parenthesized.

Abstract: An author-written abstract follows the institutional address, separated with space. The abstract should be brief, concise, and informative. Key words and phrases should be used to facilitate information retrieval. Separate the abstract from the text with a solid line, use two to four spaces above and below the line.

Text: An "Introduction" heading is not used. Introductory statements should give the background and objectives of the research work reported, or purpose of the article.

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

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

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

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

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

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

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

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

When in doubt as to manuscript preparation or literature citation style, please consult the STYLE MANUAL FOR BIOLOGICAL JOURNALS, American Institute of Biological Sciences.

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

Authors are responsible for the accuracy and quality of papers published in the *Journal.* Well-written papers, which contain new information or ideas, will reflect credit on both the authors and the institution represented.

Manuscripts for publication in the *Journal,* if mailed, should be sent to:

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ON THE COVER

Trifoliate orange, *Poncirus trifoliata*, with its network of thorny branches, yellow-orange fruit and extreme cold-hardiness offers considerable potential as a landscape plant. See page 76.