JOURNAL

OF THE

RIO GRANDE VALLEY HORTICULTURAL SOCIETY

VOLUME 42, 1989

ISSN 0485-2044

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

PRINTED: JaMar Printing Company
506 E. Monroe
Harlingen, Texas 78550
(512) 423-2618

JOURNAL

OF THE

RIO GRANDE VALLEY HORTICULTURAL SOCIETY

VOLUME 42, 1989

Published by

RIO GRANDE VALLEY HORTICULTURAL SOCIETY
P.O. Box 107, Weslaco, Texas 78596

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A.V. 'Pete' PETERSON
1990 Recipient of
The Arthur T. Potts Award

Pete Peterson was born in 1915 and grew up on a small cotton farm outside Olivia, Texas. He attended Texas A&M University where he received his B.S. degree in Agricultural Education in 1939. After graduation, he accepted a position as a teacher on the faculty of Pharr High School in the Lower Rio Grande Valley of Texas. There he met a history teacher and a business teacher who profoundly influenced his life and career. The history teacher was the former Dorothy Rusk, who married Pete in 1940; and this year they will celebrate their 50th wedding anniversary. The business teacher was Edwin LaGrange, who together with Mr. Peterson laid the foundation for one of the most innovative and respected agribusinesses in the U.S. this business partnership began at the outbreak of World War II, when both Ed and Pete left Pharr High School to work as firefighters on Moore Air Base, near Mission, Texas. They worked opposite shifts and on their days off began growing tomatoes. Their efforts were temporarily interrupted toward the end of the War while Pete served in the Merchant Marines.

After his return in 1946, Pete and Ed obtained and cleared 200 acres near Rio Grande City, and successfully grew peppers that first year. As the enterprise grew, more partners and more land were acquired, and to date Starr Produce includes over 8,500 acres and is listed as one of the top 100 growers in the U.S. Mr. Peterson is currently Chairman Emeritus of Starr Produce Company headquartered in Rio Grande City, Texas. Dorothy and Pete had three sons who now work for Starr Produce. The eldest son, Bob, serves as President of the company while James manages the Starrco farm and David oversees the Special Projects Division. Also working with Starr Produce are two sons of Edwin and Francis LaGrange. Ross LaGrange manages the SunTex Farm, while Charles manages the Sales Division of Starr Produce.

In the 1950's the Progressive Farmer magazine honored the Petersons and LaGranges as "Progressive Farm Families." In 1980, Mr. Peterson received the Texas Vegetable Association's Award of merit and has been honored a number of times since. Pete is an active member of the Farm Bureau, the Chamber of Com-

merce, and is a Charter member of the Starr County Fair Association. Mr. Peterson has also served on the Tomato Marketing Order and helped promote the establishment of the South Texas Lettuce, Onion and Melon Committees, which help market Valley produce and provide research grants.

Mr. Peterson has always been an ardent supporter of agricultural research and extension activities throughout the region. He was a founding member of the Valley Agricultural Research and Development Corporation, which helped procure research land for both the Texas Agricultural Experiment Station and Agricultural Research Service of the USDA. He has served on the Vegetable Committee for the Starr County Extension Program, and for 23 years on the Vegetable Advisory Committee of the Texas A&M Experiment Station. He has been an active collaborator in the research programs of faculty members such as Ed Cox, Paul Leeper, Leonard Pike, Mayo Correa, and Ben Villalon. Most of the new and innovative technologies delivered to South Texas are often tested on Starr Produce Farms. Many of the new cultivars including onion, melons, lettuce, tomatoes and peppers are commonly tested at Starr Produce before public release. He has also provided strong support and encouragement to new researchers and extension personnel here in the Rio Grande Valley.

Besides the contribution to Texas Agriculture, Pete Peterson has contributed greatly to economic development of Starr County. Starr Produce is the single largest private employer in Starr County, and during the 1988 production season they employed 2,000 people.

This society honors Mr. Peterson not only for his service and leadership role in Texas Agriculture, but for a philosophy of progressive and innovative thinking that benefits everyone. [*BTS, RMP, GEL;* 1989]

Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

Use of Pro-Shear (BA) to Improve Scion Heading in Citrus Nurseries

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Additional Index Words: Nursery practices, propagation, bud break.

ABSTRACT

Pro-Shear[1], a commercial formulation of the cytokinin 6-BA, was applied at 500 ppm to the terminal 15 cm of 'Rio Red' grapefruit (*Citrus paradisi* Macf.) budlings on sour orange (*C. aurantium* L.) rootstock in the nursery. Treatments were Pro-Shear in carrier solutions of water, methanol, 1.0% DMSO + 0.1% Tween 20, and a water control. All treatments were applied to single stem budlings that either had the terminal bud removed by tipping or to nontipped budlings. The greatest percentage of treated budlings were headed by treatment with Pro-Shear in DMSO + Tween 20 with methanol as a solvent being intermediate between DMSO and water. No heading occurred with the water control. Shoot length and bud break per plant were greatest when Pro-Shear was applied in DMSO + Tween 20. Tipping before treatment did not increase bud break. Heading was promoted in citrus by treating with Pro-Shear. Chemical names used: N-(phenylmethyl)-1H-purin-6-amine (BA).

Very little detailed information has been published on the practice of heading citrus nursery budlings, presumably because citrus nursery trees have been traditionally propagated in field nurseries and heading has been easily accomplished by tipping (Camp, 1938; Johnston et al., 1959; Opitz et al., 1968; Platt and Opitz, 1973; Tucker and Youtsey, 1984). The increased production of citrus nursery trees in containers has not been accomplished by increased research on heading, but has focused on forcing of the scion bud at the time of unwrapping the bud following budding. The goal of container nursery culture has been to produce a tree ready for field planting in 12 to 15 months. This reduced production time has shifted the scheduling of propagation practices. Rootstock seeds are planted during the winter, seedlings are budded during the late spring, and the budling headed during the fall of the same year when growing conditions of temperature and day length are not optimum for bud break and growth of lateral shoots.

[1]Mention of a trademark or a proprietary product does not constitute a guarantee or a warranty of the product by The Texas Agricultural Experiment Station and does not imply its approval to the exclusion of other products that also may be suitable.

Training of the scion shoot to grow as a single stem is a standard practice for the citrus nursery industry. The scion shoot is commonly tied to a stake so that the resulting tree will have a straight trunk. When the budling reaches 45 to 60 cm (18 to 24 inches), the shoot tip is removed (tipped) to promote lateral shoots in the top 10 to 15 cm (4 to 6 inches) to form what will be the framework of the finished tree. The practice of stimulating shoot growth from axillary buds near the tip of the budling and then selecting three to five well placed lateral shoots is referred to as "heading".

Development of techniques for continuing the growth of budlings and heading young trees during autumn are highly desirable. The cytokinin growth regulator BA reportedly promotes lateral shoot initiation in citrus (Nauer and Boswell, 1981). Therefore, a commercially available product containing BA was evaluated for its ability to stimulate bud break when heading citrus budlings.

MATERIALS AND METHODS

Budlings of 'Rio Red' grapefruit (*C. paradisi* Macf.) 41 to 51 cm (16 to 20 inch) tall on sour orange (*C. aurantium* L.) rootstock growing in 10.2 cm diam × 38.1 cm (4.0 × 15 inch) deep, 6 mil black polyethylene bag nursery containers filled with commercial soilless medium (Sunshine Mix + 1, Fison, Vancouver, B.C., Canada) were used to evaluate heading resulting from bud break on the top 10 to 15 cm (4 to 6 inches) of stems treated with Pro-Shear (Abbott Laboratories, North Chicago, IL). Pro-Shear is a commercial formulation of the cytokinin BA (N-[phenylmethyl]-1H-purine-6-amine). One-hundred-sixty citrus budlings were selected and divided into two groups of 80 plants. One group of 80 budlings were tipped to remove the terminal growing point and the other 80 seedlings were nontipped. The terminal 15 cm (6 inches) of 20 budlings in each group were then sprayed with 500 ppm BA as Pro-Shear dissolved in water, methanol, or 1.0% dimethyl sulfoxide (DMSO) + 0.1% Tween 20. Twenty plants in each group were maintained as a control and treated with water only.

Treatments were applied with a one-liter, hand-held spray-bottle with an adjustable mist nozzle. The experiment was run during November when the mean daily high and low temperatures in were 29C (84F) and 16C (61F), respectively.

The experimental design was a randomized complete block with 20 replications. Each Pro-Shear treatment was applied to tipped and nontipped budlings with a control treatment in each group. The number of plants forced, the number of buds forced per plant, and the lengths of shoots growing from forced buds were recorded three weeks after treatment.

RESULTS AND DISCUSSION

The treatment using Pro-Shear in 1.0% DMSO + 0.1% Tween 20 as a solvent/penetrant resulted in the greatest percentage of plants headed (Table 1). The DMSO treated plants forced buds on 80% of tipped and 95% of nontipped plants. Only 55 to 70% of plants treated with methanol as a solvent were headed. It was not understood why more heading took place on nontipped plants, or whether this could be described as a trend. Plants receiving Pro-Shear in water as a solvent were least affected in stimulating bud break for heading. Plants treated with water solvent had swollen buds that appeared to extend, but limited shoot growth was initiated. None of the control plants treated with only water in either the tipped or the untipped group exhibited bud break.

Budlings treated with Pro-Shear in DMSO + Tween 20 had significantly greater

Table 1. Heading, bud break and shoot growth of citrus budlings either topped or non-topped and treated with 500 ppm BA in the commercial product Pro-Shear.

Treatment	Heading		Buds forced /plant	Length /shoot (cm)
	Total buds	Plants (%)		
TIPPED				
BA + DMSO[1]	126	80	8	4.0
BA + METHANOL	55	55	5	2.1
BA + WATER	31	35	4	1.5
CONTROL[2]	0	0	0	0
NONTIPPED				
BA + DMSO	169	95	9	6.0
BA + METHANOL	82	70	6	3.6
BA + WATER	32	50	3	0.6
CONTROL	0	0	0	0
LSD 5%		24	2	2.3

[1] DMSO applied as 1% DMSO + 0.1% Tween 20.

[2] Water without BA.

numbers of buds breaking per plant compared to other treatments. Eight and nine buds per plant were forced from tipped and nontipped plants treated with Pro-Shear in DMSO, respectively. Pro-Shear with methanol resulted in five and six lateral buds being forced from tipped and nontipped budlings, respectively. Pro-Shear in both DMSO and methanol treatments forced sufficient numbers of buds with adequate shoot growth to be commercially useful in citrus nursery production where it is desirable to head trees with three or four shoots per plant.

Mean shoot length was greatest for plants treated with Pro-Shear in DMSO + Tween 20. Shoot length of tipped plants treated with DMSO was almost double that of methanol, but the difference was not statistically significant. Shoot lengths of nontipped plants treated with Pro-Shear in DMSO were significantly longer than from methanol treatment.

The best combination of treatments in this experiment appeared to be Pro-Shear in 1.0% DMSO + 0.1% Tween 20 on nontipped trees. Use of DMSO as a solvent/penetrant to apply Pro-Shear to force citrus buds appears to be a better choice than methanol because of cost, performance success, product availability, and ease of use. The additional shoots stimulated when using DMSO should not be a problem since removal of extra and unwanted shoots is a routine nursery practice. Because of the success in forcing bud break with DMSO, treatment of fewer buds at the top of the budling should reduce the number of shoots.

Removal of the terminal bud (tipping) did not provide any additional stimulation to forcing lateral buds near the top of the budlings. Therefore, the practice of tipping could be eliminated when using Pro-Shear with DMSO in heading container-grown citrus budlings. Field-grown nursery trees may also benefit by using Pro-Shear in DMSO to force lateral bud break, especially when it is desirable to head trees during increasingly cooler night temperatures near the end of the growing season.

It would be desirable to have supplemental experiments to determine optimum concentration rates, timing of treatment with respect to bud maturity and ambient temperature, and additional products and combinations of growth regulators. It is significant that in this experiment, Pro-Shear was highly effective in releasing axillary bud dormancy and initiating shoot growth under less than optimum conditions of cool night temperatures and decreasing day length and light intensity.

ACKNOWLEDGEMENT

The author thanks Mrs. Irene Eubanks for her cooperation and the use of plants provided by the Eubanks nursery in conducting this research.

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Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

Detection of Lettuce Infectious Yellows Virus (LIYV) in Greenhouse and Field Inoculated Plants Using an Indirect Enzyme-Linked Immunosorbent Assay (Indirect ELISA).

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Additional Index Words: diagnostic test, lettuce virus, melon virus, serology, whitefly transmitted virus

ABSTRACT

The lettuce infectious yellows virus (LIYV) is a recently recoginized plant virus that causes dramatic yellowing symptoms and a severe disease in a wide range of vegetable crops in Arizona, adjacent southwestern states and Mexico. Until now, the only available diagnostic method was a time-consuming bioassay which utilized the insect vector to transmit the virus, and subsequent manipulation of indicator plants. A rapid, sensitive diagnostic technique termed an indirect enzyme-linked immunoassay (indirect ELISA) system was developed for the detection of (LIYV) in infected plant material. A specific antibody was made to viral capsid protein which was purified by polyacrylamide gel electrophoresis. The indirect ELISA system was optimized and used to detect viral antigen in greenhouse inoculated melons. The system was subsequently adapted for the detection of LIYV in symptomatic and asymptomatic weed and cultivated plant species collected from infected fields in the vicinities of Yuma and Central Arizona. The indirect ELISA system described here allows for the detection of approximately 100ng of virus per well. The LIYV was detectable in symptomatic, but not in asymptomatic leaves of muskmelon plants infected with the virus. In contrast, the virus could be detected in both symptomatic and symptomless cheeseweed plants collected in the field. The optical density readings for infected weed species were generally lower than those for cultivated species such as melons, lettuce, and spinach, suggesting the possibility that there is less virus in the weed hosts tested than in infected, cultivated hosts.

INTRODUCTION

The lettuce infectious yellows virus (LIYV) is a recently recognized whitefly-transmitted plant virus which incites severe diseases in a variety of vegetable crop species within the Chenopodiaceae, Compositae, Cucurbitaceae, and Umbelliferae. (Brown & Nelson, 1984 and 1986; Duffus et al., 1986; Rosemeyer et al., 1986). The virus causes severe yellowing or reddening of leaves, stunting and dramatic yield losses in cultivated plants, including muskmelons and lettuce, as well as discoloration and stunting in many of its weed hosts (Brown & Nelson, 1986). The LIYV is transmitted by the sweet potato whitefly, *Bemisia tabaci* Genn., but not by mechanical means nor through seed (Brown & Nelson, 1986). In the past, reliable diagnosis of LIYV has necessitated the use of whitefly-transmission bioassays which require the availability of a virus-free whitefly colony and subsequent time-consuming manipulation of the whiteflies and virus specific indicator plants. In addition, a bioassay system such as this has an absolute requirement for succulent field samples to which whiteflies may be exposed for feeding and subsequent transmission.

To circumvent the problems associated with LIYV diagnosis, which relies solely on a functional bioassay, an immunodiagnostic test, termed the indirect enzyme-linked-immunosorbent assay (indirect ELISA) was developed for detection of LIYV in plant samples (Clark & Adams, 1977; Van Regenmortel, 1982; Voller et al., 1976). The indirect ELISA test utilizes a solid phase or polystyrene plastic to which virus particles extracted from plant material are bound. A specific primary antibody, which was made against the purified LIYV, is added to the well containing the absorbed virus particles and allowed to bind to the virus particles. A second antibody (made against the virus-specific antibody) to which a potentially reactive molecule such as an enzyme has been covalently bound, is added and allowed to bind to the primary or LIYV specific antibody. If the virus particles were present and bound the primary and, thus, the secondary or enzyme-labelled antibody, the addition of a chromogenic or color producing enzyme substrate will result in color development. The intensity of the color development is quantified by taking an optical density (O.D.) reading with a spectrophotometer equipped with a specific visible wavelength filter. The values obtained give a relative indication of the amount of virus which was absorbed to the plastic well.

To determine the optimum concentrations of antigen (virus) and antibodies required for use in the test, serial dilution assays must be conducted. Optimum conditions for release of virus particles from the plant sap and stabilization of the particles must also be determined empirically. One of the predominant problems associated with detection of plant viruses in plant sap is the non-specific binding of antibodies to plant constituents. Thus, conditions must be identified and optimized which result in the reliable detection of low concentrations of virus particles, which simultaneously minimizing the interference caused by non-viral constitutents in the plant sap. In this report, the development of a relatively sensitive diagnostic indirect ELISA test (Clark & Adams, 1977; Voller et al., 1976) is described for the detection of LIYV.

MATERIALS AND METHODS

Antiserum Production. The LIYV was purified from virus infected casaba (*Cucumis melo* L.) cv. "Golden Beauty" inoculated 3 wk previously with LIYV using the whitefly vector as described previously (Brown and Nelson, 1986). The virus capsid (coat protein) polypeptide was further purified by polyacrylamide gel electrophoresis. A band of approximately 27,000 da. molecular weight which corresponded to the expected size of the capsid protein was excised from the gel and emulsified in Freund's complete adjuvant. This was injected into a rabbit (intramuscularly) for production of the antiserum. Subsequent antigen boosts were made in similar manner and serum was collected at regular intervals following the boosts. The IgG fraction was purified from the pooled sera by precipitation with saturated ammonium sulfate followed by passage through a DEAE anion-exchange column. The column fractions containing the IgG were pooled and concentrated using an Amicon ultrafiltration device fitted with a PM30 membrane. The concentrated antibody fractions were dialyzed against a low salt buffer (0.016M potassium phosphate, 0.05M sodium chloride, pH 7.2) and frozen at -20C (Kurstak et al., 1986). The final volume of IgG was 1/10 the starting volume of whole serum.

Indirect ELISA Protocol. Purified antigen in buffer (Table 1) and greenhouse-inoculated or field collected leaves (Table 2), were homogenized in extraction buffer by grinding with a mortar and pestle, diluted in 0.5M carbonate buffer, pH 9.6,added (100 ul) to the wells of a polystyrene microtiter plate (Nunc Immuno 2 plates, Irvine Scientific, CA) then incubated overnight at 4C. The plates were washed three times with buffer

Table 1. Results of the ELISA test using a serial dilution of purified LIYV (antigen) and appropriate controls to optimize the assay. Values represent optical density readings at 410 nm and are considered positive when optical density is at least two times greater than healthy control.

Antigen	1° Antiserum Dilution[1] 1:500	1:000	No 1° Antiserum
Purified LIYV (O.D. A_{260} = 0.40)			
1:25	.746	.593	.150
1:50	.438	.350	.007
1:100	.271	.216	.001
1:250	.119	.099	.015
1:500	.076	.055	.008
1:1000	.057	.042	.007
Primary Antiserum Control (1:25)	0.72	0.26	-
Purified Healthy Control muskmelon (undil.)	.273	.109	-
Purified Healthy Control lettuce (undil.)	.096	.076	.047

[1] Values represent the average of two replicates.

(phosphate buffered saline, pH 8.2, containing 0.1% Tween-20), and blocking buffer (100 ul) containing 1% bovine serum and 20% non-fat dry milk. Plates were incubated for 1 hr at 37C. The plates were washed once, the anti-LIYV IgG diluted in blocking buffer was added (100 ul), and the plates were incubated for 1 hr at room temperature. Plates were washed three times to remove unbound antibody and enzyme-labelled anti-rabbit antibody (horseradish peroxidase labelled goat anti-rabbit IgG Fc; (American Qualex, La Mirada, CA) was diluted in blocking buffer and added (100 ul). Plates were incubated for an additional 1 hr at room temperature, washed four times with wash buffer, and the enzyme substrate was added. The enzyme substrate used was hydrogen peroxide, mixed with a solution of 0.1mM ABTS (2', 2' azino-bis-3-ethylbenzthiazoline-6- sulfonic acid, Sigma, St. Louis, MO) in citrate buffer, pH 4.2. Substrate was added to each well and incubated for 15 min at room temperature. The reaction was stopped by the addition of 5% sodium dodecyl sulfate and the intensity of the color reactions were read at 410 nm using a MicroELISA plate reader.

Table 2. Results of the ELISA test for detection of LIYV in plant sap extracted from greenhouse or field-inoculated plant sources. Values represent optical density readings at 410 nm after addition of chromogenic substrate, and are considered positive for infection when optical density is at least two times greater than healthy control

Sample Tested	1° Antiserum Dilution 1:500	1:000
Greenhouse Inoculated		
LIYV muskmelon-a (S)[1] 'Hales Best'	1.146	0.500
LIYV muskmelon-b (S) 'Hales Best'	1.138	0.533
Healthy muskmelon 'Hales Best'	0.240	0.111
LIYV casaba (S) 'Golden Beauty'	0.471	0.361
LIYV casaba (NS)[2] 'Golden Beauty'	0.186	0.094
LIYV muskmelon (S) 'Topmark'	0.407	0.329
LIYV muskmelon (NS) 'Topmark'	0.046	0.000
Purified Antigen Control (1:50)	0.511	0.293
No Ag	0.115	0.026
Field Samples - Coolidge, Arizona		
muskmelon (S)	0.728	0.530
muskmelon (NS)	0.077	0.071
lettuce-red leaf (S)	0.560	0.427
lettuce-romaine (S)	0.651	0.456
lettuce-greenleaf (S)	0.335	-
lettuce-iceberg (S)	0.368	-
spinach (S)	0.860	-
spinach (NS)	0.153	-
cheeseweed (S)	0.113	0.068
cheeseweed (NS)	0.122	0.076
healthy cheeseweed	0.074	0.030
healthy lettuce-greenleaf	0.096	0.076
healthy muskmelon	0.200	0.155

TABLE 2. CONTD.

Field Samples - Yuma, Arizona		
lettuce-iceberg (S)	0.565	0.333
lettuce-iceberg (NS)	0.292	0.163
lettuce 'Merit' (S) 'Merritt'	0.428	0.284
lettuce 'Merit' (NS) 'Merritt'	0.304	0.194
lettuce 'Butler' (S)	0.353	0.238
lettuce 'Butler' (NS)	0.149	0.097
cheeseweed (S)	0.224	0.096
cheeseweed (NS)	0.155	0.087
healthy lettuce	0.096	0.076
healthy cheeseweed	0.102	0.082

[1] S = Symptomatic leaf

[2] NS = Asymptomatic leaf

RESULTS AND DISCUSSION

The results of the ELISA tests using a dilution series of purified virus antigen are shown in Table 1. The relatively high optical density readings (relative to controls) for antigen dilutions in the range of 1:25 to 1:250 at both 1:500 and 1:1000 dilutions of the virus-specific (primary) antiserum, indicates the feasibility of the system for detection of LIYV. Purified muskmelon and lettuce controls were not diluted in this experiment, thus, the seemingly high optical density readings. When these preparations were adjusted to standard concentrations equivalent to those used for purified virus antigen (at O.D. = 260), the subsequent values for controls dropped off rapidly with the dilution, as expected (data not shown). In all cases, the healthy muskmelon control gave higher readings than healthy lettuce or watermelon (data not shown) and could be indicative of the presence of exogenous peroxidases in the muskmelon tissue, and/or the presence of antibodies to healthy muskmelon antigen. The substitution of alternate enzyme systems (such as alkaline phosphatase [AP]) and/or cross-absorption of the primary antiserum will likely reduce these values. Preliminary results in which values were dramatically decreased when AP was used, suggested that exogenous peroxidases present in cucurbits were the interfering factor. Using the original HP system, the indirect ELISA allows for the detection of about 100 ng and 300 ng of virus at 1:500 and 1:1000 dilutions of primary antibody, respectively.

Virus-inoculated greenhouse plants, and field samples thought to be infected with LIYV (based upon symptoms) were analyzed in the indirect ELISA system and the results are summarized in Table 2. In greenhouse inoculated muskmelon, the LIYV was easily detectable in leaves showing definite LIYV symptoms, despite the high values obtained from healthy muskmelon. In asymptomatic leaves taken from known infected plants, however, the virus could not be reliably detected. This prompted a concern for the status of field material with respect to symptoms, on which assays were

performed. A similar result was observed when field material (muskmelon, lettuce, spinach) was analyzed (Table 2). The virus could be reliably detected only when distinct symptoms were observed on the leaf, or when a symptomatic portion of the leaf was used in the assay. However, when weeds such as cheeseweed (*Malva parviflora* L.) were assayed, both those expressing and lacking discrete symptoms gave positive results in many cases. When representative cheeseweed samples were bioassayed using a virus-free colony of *B. tabaci*, virus could be recovered to muskmelon indicator plants, in all cases regardless of the symptom severity associated with the source plant. This observation suggests that the virus may be present in weed sources which are not expressing obvious symptoms. In addition, the optical density readings which resulted from assays with symptomatic cheeseweed leaves are lower than those for melons, lettuce, or spinach. These data suggest that the level (titer) of virus particles in infected cheeseweed may be less than in infected cultivated plants. Further investigations of these phenomena are currently underway in the laboratory. In addition, the potential for achieving greater levels of virus detection with lower background readings (non-specific binding) is being investigated using a double antibody sandwich ELISA, which is a modification of the indirect system described here.

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Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

Virus Diseases of Muskmelons in the Lower Rio Grande Valley[1]

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Additional Index Words: virus diseases, muskmelon, *Cucumis melo*

ABSTRACT

Three hundred forty-five muskmelon leaves were assayed with an enzyme-linked immunosorbent assay (ELISA) in the spring of 1988 to determine the incidence and temporal distribution of 6 cantaloupe viruses in south Texas. Tobacco ringspot virus was detected on 7 April and had the highest incidence, 23.2% of samples. Squash mosaic virus was detected on 20 April. Papaya ringspot virus type W, watermelon mosaic virus, zucchini yellow mosaic virus, and cucumber mosaic virus were not detected until 27 May. Two or more viruses were found in many samples. Eighty samples had negative ELISA readings although zucchini squash exhibited virus-like symptoms when inoculated with sap from the samples, indicating additional viruses are present in south Texas muskmelon populations.

Virus diseases are limiting factors in muskmelon production in south Texas. Within a short period of time, a virus can seriously reduce the yield and quality of melons. (McLean and et al., 1961, 1962) conducted a survey in the 1960s to determine the viruses infecting cucurbit populations in the Lower Rio Grande Valley (LRGV). Based on host range studies, they determined that tobacco ringspot virus (TbRSV), watermelon mosaic virus 1 (WMV1) = papaya ringspot virus type W (PRSV-W), watermelon mosaic virus 2 (WMV2) = watermelon mosaic virus (WMV), cucumber mosaic virus (CMV), and squash mosaic virus (SqMV) were infecting cucurbits, however, they did not indicate the incidence of each of the viruses nor their relative importance.

Muskmelons and other cultivated cucurbits are grown in the spring and fall in the LRGV and therefore do not serve as primary overwintering hosts for the viruses. Abundant overwintering hosts and insect vectors must be present for virus diseases to become epidemic in the spring. McLean (1962) found 19 weeds, including such common weeds as sunflowers and nightshade, that served as hosts for TbRSV and probably other viruses. Viruses, insects, and weeds are endemic to the area and the possibility of an epidemic of virus diseases is always present.

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[1] Presented at the 43rd Annual Institute of the Rio Grande Valley Horticultural Society, January 17, 1989.

Viruses are spread from plant-to-plant by insects. Aphids, including *Aphis gossyppi* and *Myzus persicae*, transmit PRSV-W, WMV, ZYMV, and CMV; the chrysomelid and coccinellid beetles trasmit SqMV (Sherf and McNab, 1986); and thrips, tobacco flea beetles, spider mites, and nematodes transmit TbRSV (Schuster, 1983; Stace-Smith, 1970; Thomas, 1969). Many growers have observed that even though aphids are not found on the melon vines, epidemics of virus diseases still occur in the fields. This is because the winged form of the aphid is the most important in spreading viruses. Chemical control of the insect vector has been of little success in stopping the spread of viruses. A contaminated aphid can fly into a field, land on a cantaloupe plant, feed and transmit the virus. It doesn't matter that the aphid may be killed 5 minutes later by an insecticide, the virus has already been transmitted.

Identifying viruses which are present in a field can be difficult. Symptoms of many of the cucurbit viruses are similar and there are more than 50 viruses that can infect one or more species of cucurbits (Lovisolo, 1980). Identification can be accomplished by determining the range of plants that can be infected by the unknown virus and comparing it to the host range of known viruses; however, this requires several weeks and is expensive because of the labor involved. New biotechnology tools such as the enzyme-linked immunosorbent assay (ELISA) are much faster and less expensive to use. The ELISA was used in the spring of 1988 to conduct a survey of viruses in muskmelons in the LRGV to determine 1) if additional viruses are present in muskmelon populations since the survey by McLean (1961, 1962) and 2) the time of occurrence of each virus.

Beginning on 30 March leaf samples were taken from fields south of Donna and near Rio Grande City. Later the survey was concentrated in fields in the mid-valley because more virus symptoms were appearing in this area. The survey continued through 31 May. The number of samples ranged from 11 during the first week to a high of 56 on 18 May. A total of 345 samples were processed during the survey.

Samples were randomly taken from leaves near the vine terminal on plants showing virus-like symptoms. The samples were taken to the Plant Pathology lab in Weslaco and assayed the next day with the ELISA. ELISA kits for WMV, PRSV-W, zucchini yellow mosaic virus (ZYMV), cucumber mosaic virus croton strain (CMVcr), cucumber mosaic virus vinca strain (CMVvi), and TbRSV were purchased from AgDia Inc., 1901 N. Cedar Street, Mishawaka, IN 46545. The ELISA for SqMV was obtained from Dr. Ben Villalon, Texas Agricultural Experiment Station, Weslaco, TX. Leaves that tested positive with ELISA were discarded and the virus recorded. Leaves from plants showing virus-like symptoms that tested negative with ELISA were ground in a 0.05M phosphate buffer at pH 7.5 and plant sap used to inoculate zucchini squash plants. The squash plants were placed in the greenhouse and observed for the development of virus-like symptoms. Leaves from squash plants that developed virus-like symptoms were freeze-dried to preserve the unknown viruses.

Viruses were not detected in many of the leaf samples exhibiting symptoms of leaf crinkling and distortion taken in late March and early April. The distortion was probably caused by environmental conditions. TbRSV and SqMV which are transmitted by insects with chewing and rasping mouthparts, thrips, beetles, and spider mites, were the first viruses found in muskmelons (Table 1). TbRSV was detected on 7 April and had the highest incidence, 23.2%, throughout the growing season. SqMV was detected on 20 April. The aphid transmitted viruses, PRSV-W, WMV, CMV,

Table 1. Viruses found in cantaloupe populations during the spring of 1988.

	Number of positive samples[1]								
Dates	PRSV-W	WMV	ZYMV	TbRSV	CMVvi	CMVcr	SqMV	Unknowns	#Sample assayed
3-30-88	0	0	0	0	0	0	0	0	11
4-07-88	0	0	0	2	0	0	0	0	23
4-12-88	0	0	0	2	0	0	0	0	14
4-20-88	0	0	0	6	0	0	0	0	34
4-27-88	2	0	0	15	0	0	1	1	36
5-03-88	20	6	6	25	3	11	6	2	47
5-10-88	10	9	4	17	4	6	1	21	52
5-18-88	5	6	2	8	0	0	0	32	56
5-24-88	7	16	8	5	1	0	0	15	50
5-31-88	0	0	0	0	0	0	10	9	22

[1] Samples assayed with an enzyme-linked immunosorbent assay (A_{405nm}).

and ZYMV, were detected on 27 April or later. The incidence of CMV and ZYMV, 7.2% and 5.8%, respectively, was the lowest of the viruses tested. Since infection by the aphid transmitted viruses occurred late in the growing season, only the late maturing melons had a noticeable yield reductions. Many of the samples were infected with two or more viruses. When this occurred, symptom expression was more severe than when only single infections occurred. Eighty of the samples were classified as "unknowns" and this group had at least three symptom types. Efforts are currently being made to identify these viruses.

ZYMV is a recent introduction to the LRGV. ZYMV has become a major concern in some muskmelon production areas, fortunately, the incidence of the virus is low in the LRGV. Recently, lettuce infectious yellows (Duffus et al., 1986) and squash leaf curl (Flock and Mayhew, 1981) have caused devastating damage to cantaloupes in southern California, Arizona, and Mexico. These viruses are transmitted by whiteflies. Whiteflies have been found in south Texas but the populations are very low. If the whitefly populations do not increase drastically, these viruses should not be a problem here.

Several methods have been tried to control the spread of viruses, such as elimination of plants that harbor the virus, planting border rows of plants to attract the insects and then spraying to kill the insects, and use of stylette oils that coat the plant. These practices have met with only limited success. The best and most efficient control of melon viruses is through use of resistant varieties. Unfortunately, commercial varieties with high levels of resistance are not available. Sources of resistance to PRSV-W and ZYMV exist in "wild" cucurbits, but the fruit quality of these plants is very poor. Incorporation of this resistance into a good quality commercial variety will require a 5-10 year breeding effort. This material is in the melon breeding program at Weslaco and new breeding lines are being developed. However, the new lines may still be susceptible to other viruses. The real challenge in the breeding program will be to combine resistance to all the viruses into one variety. When this occurs, production problems caused by melon viruses should only be an unpleasant memory.

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Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

Preplant Seed Treatments for Improving Earliness and Uniformity in Germination of Pepper Seeds for Transplant Production

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Additional Index Words: *Capsicum* spp., seed priming, hardening, pregermination

ABSTRACT

Growers of vegetable transplants have expressed concern over the erratic seed germination problem posed by bell peppers, *Capsicum annuum*. Preplant treatments consisting of soaking seeds in various salt solutions, growth regulators, B vitamins, and distilled water at various time intervals were conducted to determine their effects on germination. Signficant increases were not found in total germination of any preplant treatments, however, preplant soaking of pepper seeds in areated solutions of $NaNO_3$, KNO_3, GA_3, and in distilled water for specified times, followed by drying, improved earliness and uniformity of germination.

INTRODUCTION

The introduction of the speedling system for growing transplants has proved to be an effective and efficient system for many vegetable crops. However, the recent use of this system in the Rio Grande Valley of Texas and other areas has clearly demonstrated the erratic seedling emergence in peppers. For this system to work effectively, rapid and uniform emergence must occur such that all of the plants are at approximately the same stage of development when planted in the field.

Numerous papers have been published about pregermination treatments of seeds to improve germination (Dimov, 1977; Ells, 1963; Gerasimenko, 1973; Kanchan, 1973; Kotowski, 1926; Nagarathnam, 1963; Nelson, 1980; Rogers, 1980; Sinkovics, 1974; Sosa-Coronel, 1982; Taylor, 1977; Watkins, 1983). However, there are conflicting reports as to the effectiveness of such treatment and in our preliminary tests many of the previously reported improvements could not be duplicated with pepper seed.

Soaking pepper seeds in various salt solutions at certain concentrations has been reported to increase germination and uniformity of emergence (Dimov, 1977; Ells, 1963; Gerasimenko, 1973; Kanchan, 1973; Kotowski, 1926; Nagarathnam, 1963). In a process known as 'hardening,' the effects of growth regulators on germination has been examined and several workers have shown that GA_3 stimulates emergence (Kanchan, 1973; Nelson, 1980; Rogers, 1980; Sosa-Coronel, 1982; Watkins, 1983). 'Hardening' has also been shown to accelerate emergence as much as 4 days. Sinkovics (Sinkovics, 1974) found that seed treated with solutions of meso-inosital, nicotinic acid, and cobalamine germinated 2-3 days earlier than untreated seed. The resulting seedlings were more viable,

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had better developed root systems, and when transplanted in the field, resulted in earlier, larger, and higher quality yield. Pregerminated pepper seed sown in the field emerged earlier and with greater uniformity than dry seed was found by Taylor (Taylor, 1977).

MATERIALS AND METHODS

'Grande Rio 66' pepper seeds were treated in constantly aerated water or various chemical solutions in 40 × 600 mm glass chromatographic tubes mounted on ringstands and removed before radical emergence. Air was pumped into the tubes using standard aquarium pumps through a series of tubing and rubber corks. After each treatment, the seeds were removed from the tubes, rinsed with distilled water, and forced air dried for 24 hours at a temperature of 38C. Seeds were then placed in 100 × 15mm Petri dishes that were lined with moistened paper towels and germinated in total darkness at 27 ± 2C. All treatments were replicated four times with 50 seeds each. The number of days to germination and per cent germination occurring each day was determined for 14 days in all experiments. Analysis of variance followed by Duncan's Multiple Range Test (5% level) was used to analyze all data.

Four experiments were conducted. In the first, seeds were aerated in 15,000 ppm solutions of KH_2PO_4, $MnSO_4$, $MgCl_2$, $NaNO_3$; 10,000 ppm solutions of $ZnSO_4$, KNO_3, and $(NH_4)_2SO_4$ and a distilled water control for 48 hours. The second experiment involved bubbling seeds for 10 hours in 25 ppm solutions of gibberellic acid (GA_3), indoleacetic acid + .4 ml ETOH/100 ml distilled water, and kinetin; 250 ppm solutions of nicotinic acid, pyrodoxine hydrochloride, thiamine hydrochloride a distilled water control and a control of distilled water of .4 ml ETOH/100 ml distilled water. Seeds were bubbled in 250 ppm solutions of GA_3, IAA, and kinetin for 10 hours with a distilled water control in the third experiment. The last experiment involved aerating seeds for 12, 24, 36 and 48 hours in distilled water. Dry seeds were placed in Petri dishes at the same time aeration began to be used as a comparison for the various pregermination treatments.

RESULTS AND DISCUSSION

The results of experiment 1 showed no significant increases in total germination among the chemical salt treatments when compared to the distilled water control, and with KH_2PO_4 showing a significant decrease (Table 1). However, KNO_3 and $NaNO_3$ both significantly increased earliness by day 3 at 41.5 and 39.0%, respectively, when compared to the distilled water control at 17.0%.

Significantly improved differences in total germination were not found in experiment 2 using any of the hormone materials over the controls. However, GA_3 did significantly increase earliness by day 5, and several of the treatments including kinetin, nicotine acid, and pyrodoxine, significantly decreased overall germination (Table 2). Differences were also noted between the two controls. A significant delay occurred in the number of days to germination for the distilled water + .4 ml/100 ml ETOH control, although there was no signficant effect on total germination. This delay was also shown in the IAA treatment in which alcohol was used to dissolve the IAA.

In experiment 3, GA_3 showed significantly higher total germination than the distilled water control or the IAA treatment and earliness of germination was significantly higher at day 4 than for all the other treatments (Table 3).

Table 1. Cumulative daily germination percentage of 'Grande Rio 66' seeds after aerating in various chemical solutions at a temperature of 27 ± 2C for 48 hours, and dried for 24 hours; averaged from four replications of 50 seeds each for 14 days.[z]

Treatment (Aerated)	PPM	Days from Placement in Petri Dishes			
		3	4	5	14
Distilled Water		17.0b	71.5*a	78.5a	81.5a
KH_2PO_4	15,000	14.5b	45.5b	55.0*b	69.0b
$MnSO_4$	15,000	27.0ab	78.5a	73.5*a	80.5a
$MgCl_2$	15,000	31.5ab	70.0*a	74.5a	82.0a
$NaNO_3$	15,000	39.0a	72.5*a	76.5a	82.0a
$ZnSO_4$	10,000	14.5b	69.5*a	80.0a	82.5a
KNO_3	10,000	41.5a	76.5*a	80.5a	83.0a
$(NH_4)_2SO_4$	10,000	29.5ab	72.5*a	75.5a	81.0a

[z] Mean separation among treatments indicated vertically by a-b; by Duncan's Multiple Range Test, 5%.

* Indicates days when 50% germination was reached.

There were no overall significant differences in total germination in the last experiment (Table 4) where 12, 24, 36, and 48 hours of pregermination were tested in aerated distilled water. However, at day 4 after placement of seeds in Petri dishes, 50% germination had occurred for the 48 hour treatment compared with 0% for the dry treatment control. This again, indicated a definite increase in earliness of pepper seed germination as compared to the normal practice of planting dry, non-treated seed.

The results from this study show that certain pregermination treatments of pepper seeds followed by rapid drying with 38C forced air for 24 hours gives earlier, more uniform germination than non-treated seed. Four treatments clearly demonstrated improvements in earlier, more uniform germination which can help producers in their growing of transplant pepper plants. Those treatments consist of presoaking pepper seeds at 27C in aerated solutions of 15,000 ppm $NaNO_3$, 10,000 ppm KNO_3 for 48 hours, 250 ppm GA_3 for 10 hours, or in distilled water for 48 hours. Seed should then be rapidly dried with forced air at a temperature of 38C for 24 hours and planted, or may be stored at 10C and 50% relative humidity for 3 or 4 days without loss of germination.

Since this study was based on earliness and total germination of dry seed following presoaking treatment, it suggests that the same treatment might also benefit producers who direct seed peppers with conventional planters into their fields.

Table 2. Cumulative daily germination percentage of 'Grande Rio 66' seeds after aerating in growth regulators and B vitamins for 10 hours at a temperature of 27 ± 2C, and dried for 24 hours; averaged from four replications of 50 seeds each for 14 days.[z].

Treatment		Days from Placement in Petri Dishes					
(Aerated)	Conc.	5	6	7	8	9	14
Ethyl Alcohol +	.4%	00.5d	08.5d	23.5cd	34.0b	51.5*b	72.5ab
Distilled Water	-	12.0b	32.5b	51.5*b	64.0a	74.0a	81.5a
Gibberellic Acid	25 ppm	19.5a	45.5a	62.5*a	72.0a	76.5a	79.5a
Indoleacetic Acid	25 ppm	00.0d	02.0e	06.5fg	19.0c	32.0c	59.5bc
Kinetin	25 ppm	00.0d	00.0e	00.0g	00.0d	00.0d	01.0d
Nicotinic Acid	250 ppm	06.5c	18.5c	30.0c	42.0b	52.0*b	64.5bc
Pyridoxine	250 ppm	01.5cd	03.0e	12.0ef	19.5c	30.5c	54.0c
Thiamine	250 ppm	00.5d	02.5e	16.0de	30.5bc	44.5bc	68.5ab

[z] Mean separation among treatments indicated vertically by a-g; by Duncan's Multiple Range Test, 5%.

* Indicates days when 50% germination was reached.

Table 3. Cumulative daily germination percentage of 'Grande Rio 66' seeds after aerating in growth regulators (250 ppm) for 10 hours at a temperature of 27 ± 2C, and dried for 24 hours; averaged from four replications of 50 seeds each for 14 days.[z].

Treatments (Aerated)	Days from Placement in Petri Dishes								
	1	2	3	4	5	6	7	8	9
Distilled Water	00.5a	00.5a	00.5a	00.5a	06.0c	15.0c	27.5c	44.0b	58.0*b
Kinetin	01.0a	01.0a	01.0a	01.5b	15.5b	35.0b	51.0*b	67.5a	75.5a
Gibberellic Acid	00.5a	00.5a	00.5a	21.5a	40.5a	62.5*a	73.0a	78.5a	80.0a
Indoleacetic Acid	00.0a	00.0a	00.0a	00.5b	13.5bc	26.0bc	35.0c	52.0*b	64.0b

[z] Mean separation among treatments indicated horizontally by a-c; by Duncan's Multiple Range Test, 5%.

* Indicates days when 50% germination was reached.

Table 4. Cumulative daily germination percentage of 'Grande Rio 66' seeds after aerating in distilled water for 12, 24, 36, and 48 hours at a temperature of 27 ± 2C dried for 24 hours and compared with dry seed placed in Petri dishes at the same time aerating began; averaged from four replications of 50 seeds each for 14 days.[z]

Treatment	Days from Placement in Petri Dishes				
	3	4	5	6	14
Dry	00.0b	00.0d	29.0d	55.0*b	83.0a
12 hours	00.0b	00.5d	39.0cd	60.0*b	83.5a
24 hours	00.0b	24.0b	55.5*b	63.5b	78.5a
36 hours	00.0b	16.5c	49.0bc	62.5*b	80.0a
48 hours	05.5a	50.0*a	71.5a	77.0a	80.0a

[z] Mean separation among treatments indicated vertically by a-d; by Duncan's Multiple Range Test, 5%.

* Indicates days when 50% germination was reached.

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Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

Nitrogen Fertilizer Needs of Cabbage Estimated From Soil and Crop Indices

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Additional Index Words: Soil test NO_3-N, Internal nitrogen requirement, land forming.

ABSTRACT

General N fertilizer guidelines for cabbage (*Brassica oleracea* var capitata L. f. alba DC.) in the Lower Rio Grande Valley (LRGV) of Texas have been established; however, the response to N fertilization is often erratic because of various factors including land leveling and previous cropping. The objectives of this investigation were to determine the effect of indigenous soil N on cabbage response to N fertilization and the internal N requirement for cabbage. Crop N uptake was correlated with preseason soil NO_3-N levels. Yield response to N fertilizer was unlikely if soil NO_3-N levels from 0 to 120 cm deep exceeded 17 ppm. Soil NO_3-N affected crop N uptake more markedly than did fertilizer N. The internal N requirement of cabbage ranged from 26.2 to 28.1 kg N/metric ton of dry matter and increased with yield and N supply.

Nitrogen is the primary nutrient needed by crops on irrigated soils in the Lower Rio Grande Valley (LRGV) of Texas. Crop response, however, is often erratic because distribution and concentration of soil mineral N are affected by land leveling (Heilman and Thomas, 1961), crop residue management (Thomas and Heilman, 1966), previous cropping and fertilizer practices (Hipp and Gerard, 1971), and irrigation (Thomas, et al., 1970). Several investigators (Carter et al., 1974; Dow et al., 1969; Roberts et al., 1980) have used soil test NO_3-N to estimate crop response and the amount of additional N fertilizer needed for a specified yield. Hipp and Gerard (1971) reported that in the Lower Rio Grande Valley (LRGV) of Texas yield of grain sorghum probably would not respond to N fertilizer when soil NO_3-N from 0 to 120 cm deep exceeded 120 kg/ha. Stanford (1966) suggested a method that estimates the N fertilizer needs for optimum yield from the crop's internal requirement (CR) for N, the amount of potentially available soil N, and the efficiency of N fertilizer use. The CR is defined as the minimum N content of the above-ground plant portion that is associated with optimum production.

Cabbage (*Brassica oleracea* var capitata L. f. alba DC.) is a major vegetable crop in the LRGV. Many fertilizer trials have established general N fertilizer guidelines. Information, however, has not been published on the CR of cabbage or on the relationship between soil NO_3-N and the crop's response to N fertilizer. This study was established to determine the effect of indigenous soil N on cabbage response to N fertilizer and to establish the CR for cabbage.

MATERIALS AND METHODS

The effects of soil NO_3-N levels on cabbage response to N fertilizer were studied on a Hidalgo sandy clay loam (Typic calciustolls) using a randomized, split-plot design with 4 replications. Main plots were cut and fill areas of a field on which a previous N rate study (Thomas and Heilman, 1966) had provided four levels of residual N. Average depth of cut and fill was 15 cm. Each subplot consisted of 8 double-row beds, 18 m long. Plots were irrigated at planting and twice more during the study. Subplots received 0, 67, 134, and 202 kg N/ha as ammonium nitrate which was broadcast and disked into the soil immediately preceding planting. Superphosphate at rates of 28 and 14 kg P/ha was applied to the cut and fill areas, respectively. Soil samples were taken before fertilization at 30-cm vertical intervals to a depth of 120 cm in all plots and analyzed for NO_3-N (Harper, 1924).

Cabbage cultivar 'Globe YR' was planted in November and harvested February through March. Plant population was about 69,000 plants/ha. Total biomass and marketable cabbage yields were determined. Nitrogen yields were calculated from the total N content of above ground plant material. The Kjeldahl-Gunning procedure was used to determine total N (AOAC, 1945). Analysis of variance and regression techniques were used to evaluate the relationships among cabbage yield, N uptake, N fertilizer, soil NO_3-N and CR.

RESULTS AND DISCUSSION

The response of cabbage to N fertilization (Nf) as measured by total dry matter and marketable yields were altered by land forming (L), and N fertilization of the preceding sorghum crop (Ns) (Table 1). Marketable yields were related to total yield ($r = 0.87^{**}$) and constituted approximately 54% of the total plant production. Other studies (Heilman and Thomas, 1961; Thomas et al., 1974) have shown that removal of surface soil in land forming reduced the soil's capacity to supply N, and decreased the availability of P and other plant nutrients. The significant interactions L × Ns and L × Nf show differences in yield responses to N fertilizer and residual N on the cut and fill areas (Table 2). The Ns × Nf interaction reflects the smaller yield response to direct N application as the level of residual N increased. Yield response to N fertilizer was greatest on the cut area.

Residual N-crop response. Relative yields, expressed as percentage of maximum yield (Fig. 1) and N uptake by nonfertilized cabbage (Fig. 2) were correlated with preseason soil NO_3-N levels, which accounted for 85 and 81% of the variance in marketable yields and N uptake, respectively. Yield response by cabbage to N fertilizer would be unlikely if the soil NO_3-N from 0 to 120 cm deep exceeded 17 ppm or 300 kg N/ha.

Residual N-fertilizer N interaction. The relationships among N fertilizer applications, soil NO_3-N, marketable cabbage yields, dry matter, or N uptake were best described by polynomial functions (Table 3). As the application rate of N increased, yields and N uptake increased, but at a diminishing rate. Also, as soil NO_3-N levels increased, maximum potential yields increased and the amount of N fertilizer required for maximum yields decreased (Fig. 3).

Coefficients of determination, ($R^2 \times 100$), suggested that fertilizer N and soil NO_3-N, when considered as separate N sources, accounted for 85, 81, and 83% of the variance in yields, dry matter, and N uptake, respectively (Table 3). Beta coeffi-

Table 1. Analysis of variance of marketable and total cabbage yields, and N uptake as affected by land forming (L), N applied to previous crop (Ns), and N applied to cabbage (Nf).

Sourced of variation	Degrees of freedom	Yields of		Nitrogen uptake
		cabbage	dry biomass	
L	1	*	*	*
Ns	3	**	**	**
Nf	3	**	**	**
L × Ns	3	*	*	n.s.
L × Nf	3	**	**	n.s.
Ns × Nf	9	*	*	n.s.
L × Ns × Nf	9	n.s.	n.s.	n.s.

* Significant at the 5% probability level.

** Significant at the 1% probability level.

n.s. Not significant.

cients indicated that soil NO_3-N (B = 1.92) had a greater effect than fertilizer N (B = 1.00) on crop N uptake. The N fertilizer-residual N interaction may be due to the effect of fertilizer on the plants' ability to obtain soil N by stimulating root development, which resulted in greater root exploration for N.

Internal N requirements. The average CR for cabbage as determined from the slope of the linear regression of N uptake on marketable yields (Fig. 4) was 6.0 kg N/metric ton. However, since yield response to N diminished with increasing higher N rates, a more precise estimate of the CR was obtained from the relationship between dry-matter yield and N uptake (Fig. 5). Variations in N uptake accounted for 92.27 of the yield variance. A maximum dry matter yield of 9.8 metric ton/ha was associated with the uptake of 375 kg N/ha. The 3.8% N concentration suggested that luxury consumption of N occurred. Heilman, et al., (1961) reported that optimum marketable cabbage yields were associated with N concentrations of the cabbage plant near 2.8% (dry wt basis). For a marketable cabbage yield of 53.3 metric ton/ha (90% of maximum, 8.8 metric ton/ha of dry matter) the crop requirement for N would be 247 kg/ha. With nonfertilized cabbage, and a limited N supply, a yield of 8.1 metric ton/ha was associated with the uptake of 211 kg N/ha. Peck (1981) suggested 250 to 350 kg N/ha was needed for dry matter yields of 8 to 12 metric ton/ha.

The CR concept may be used to estimate the amount of N fertilizer needed to attain a selected production level with different amounts of indigenous soil N (Table 4). A yield goal of 50 metric ton/ha of marketable cabbage on a soil containing 6 ppm NO_3-N requires the application of 154 kg N/ha of fertilizer. The potentially available soil N

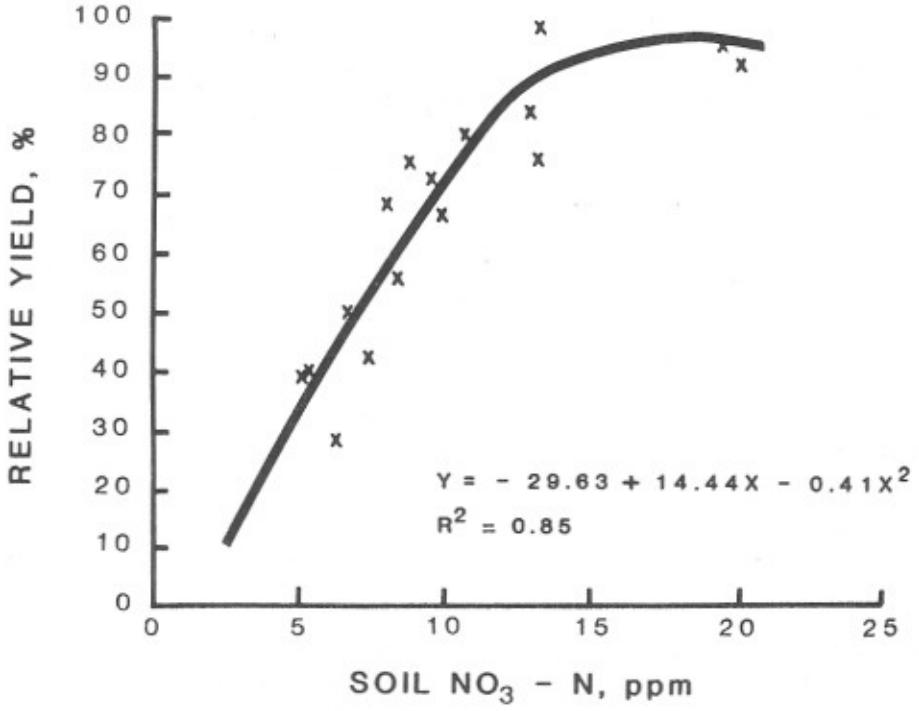

Fig. 1. Relative yield of cabbage as a function of the soil NO_3-N concentration.

Table 2. Marketable cabbage yields as affected by direct and prior applications of N fertilizer and land forming.

N applied to cabbage	Land forming	Cabbage yield				Overall mean
		N applied to prior crop, kg/ha				
		0	67	134	202	
kg/ha		metric tons/ha				
0	Cut	19.8	28.6	34.9	41.8	31.3a*
	Fill	42.1	47.0	52.0	49.2	47.6b
67	Cut	38.8	43.6	43.8	54.5	45.2b
	Fill	51.5	53.0	68.0	57.5	57.6c
134	Cut	44.6	47.0	55.0	57.7	51.0c
	Fill	59.6	60.3	64.5	61.0	63.3d
202	Cut	54.5	56.0	50.9	59.3	55.2c
	Fill	62.7	61.3	67.1	59.2	62.6d
Overall Mean	Cut	39.4a	43.8ab	46.2b	53.3c	45.7
	Fill	54.0c	55.5c	62.9d	56.7cd	57.3

* Column or row overall means followed by a common letter are not significantly different at the 5% probability levels according to Duncan's multiple range test

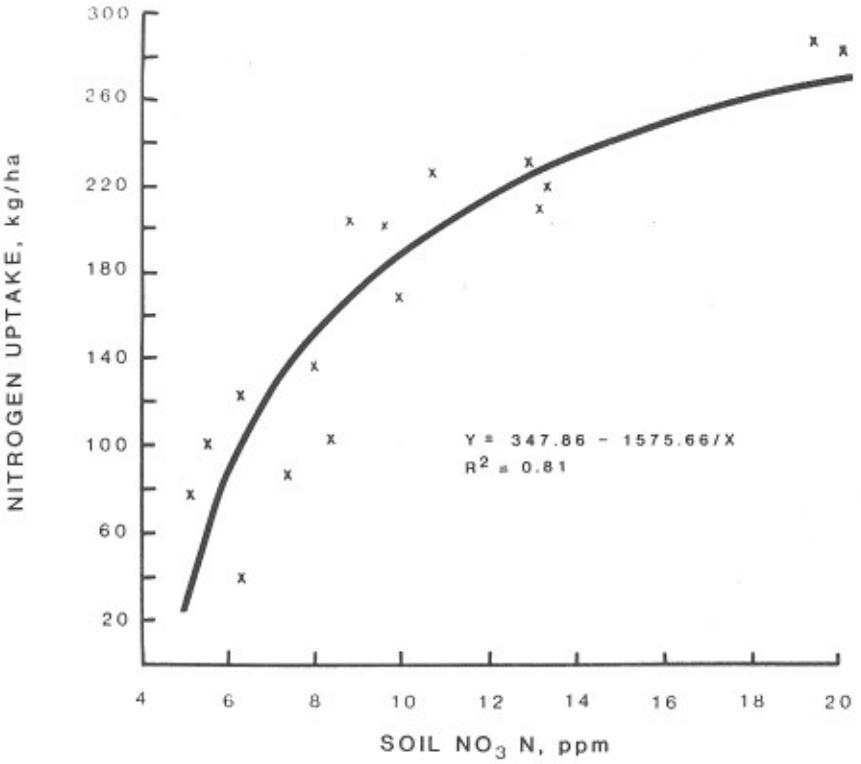

Fig. 2. Nitrogen uptake by cabbage as a function of soil NO_3-N concentration.

Table 3. Equations regressing yields of marketable cabbage (Yc, metric ton/ha), dry matter (Ydm, metric ton/ha) and N uptake (Yn, kg/ha) on N fertilizer application (Nf, kg/ha) and soil NO_3-N (Nr, ppm).

Equation	Regression Equations	R^2
1	$Yc = 11.67 + 0.286Nf - 0.0006Nf^2 + 7.253Nr - 0.192Nr^2 - 0.0074NfNr$	0.85**
2	$Ydm = -0.52 + 0.0384Nf - 0.00007Nf^2 + 1.0673Nr - 0.0288Nr^2 - 0.00104NfNr$	0.81**
3	$Yn = 107.99 + 1.132Nf - 0.0019Nf^2 + 37.86Nr - 0.887Nr^2 - 0.0165NfNr$	0.83**

** Significant at the 1% probability level.

Table 4. Nitrogen fertilizer (Nf) required for selected yields at different soil NO_3-N levels based on the crops nitrogen requirement (CR).

Soil NO_3-N	Yield	CR*	Available N	N deficit	Efficiency	NF
ppm	Metric ton/ha	kg/ha	kg/ha	kg/ha	%	kg/ha
6	50	211	85	126	81	154
10	56	271	190	81	82	99
14	56	271	235	36	84	43

* Calculated on dry weight basis. Mean moisture content of green cabbage-91.2%

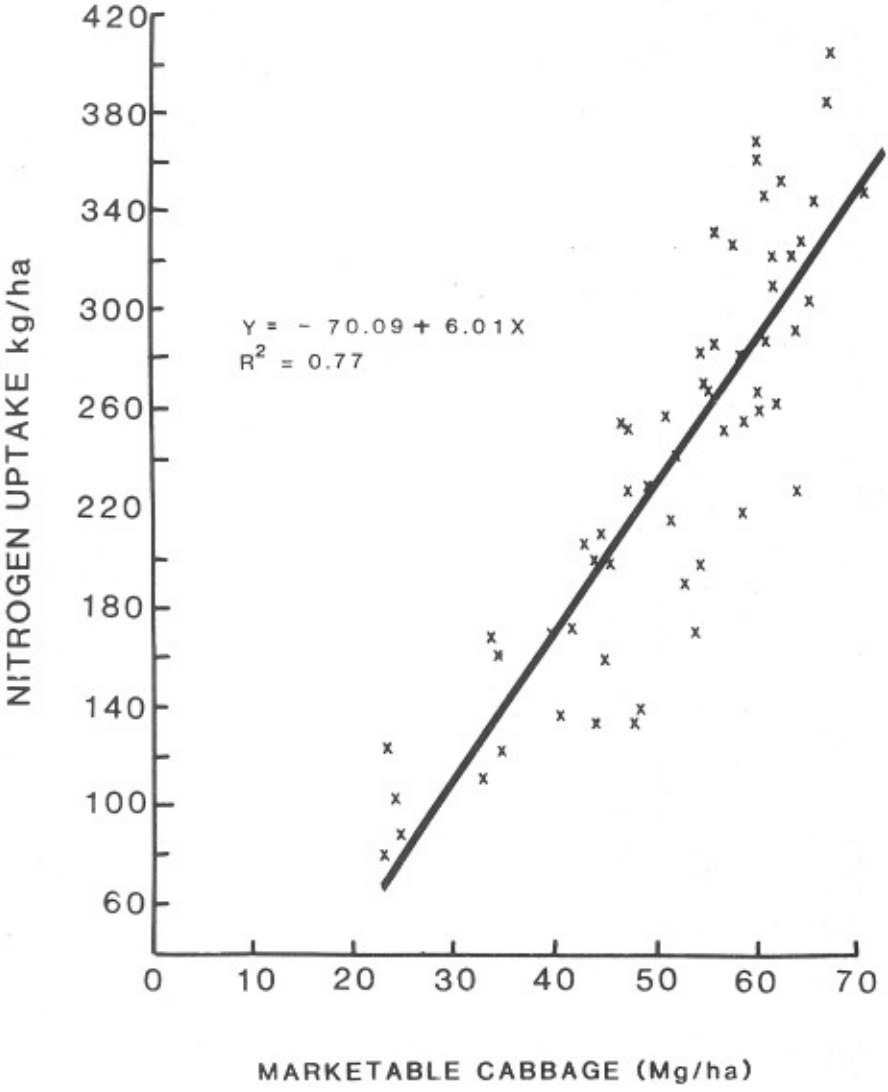

Fig. 3. Marketable cabbage yields as a function of N fertilizer and soil NO_3-N.

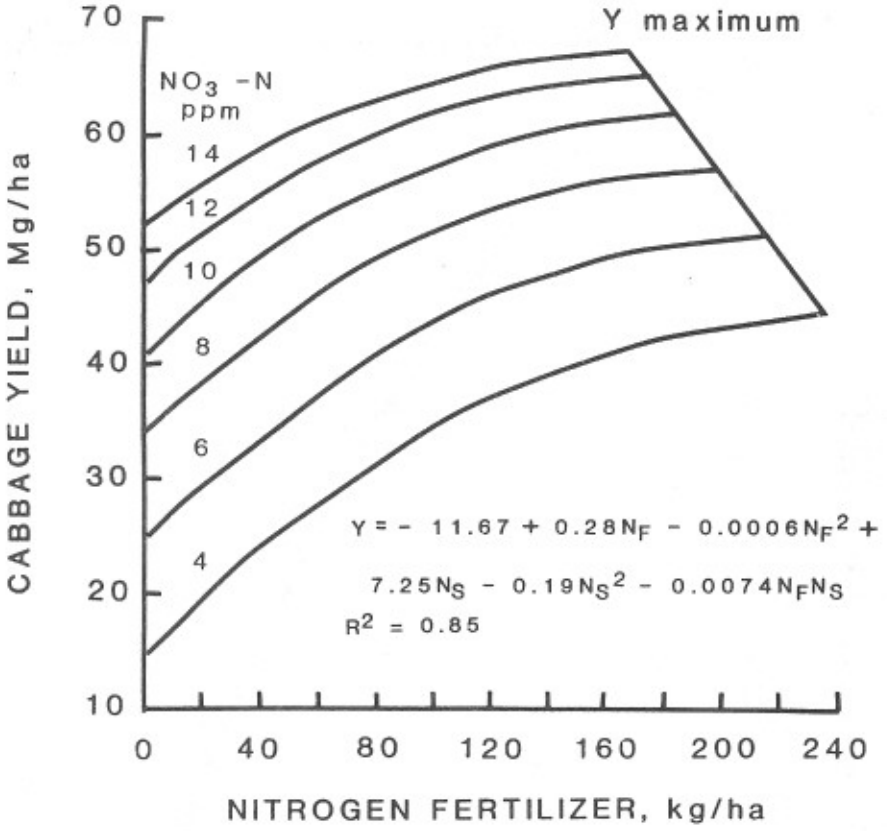

Fig. 4. Nitrogen uptake a function of the marketable cabbage yield.

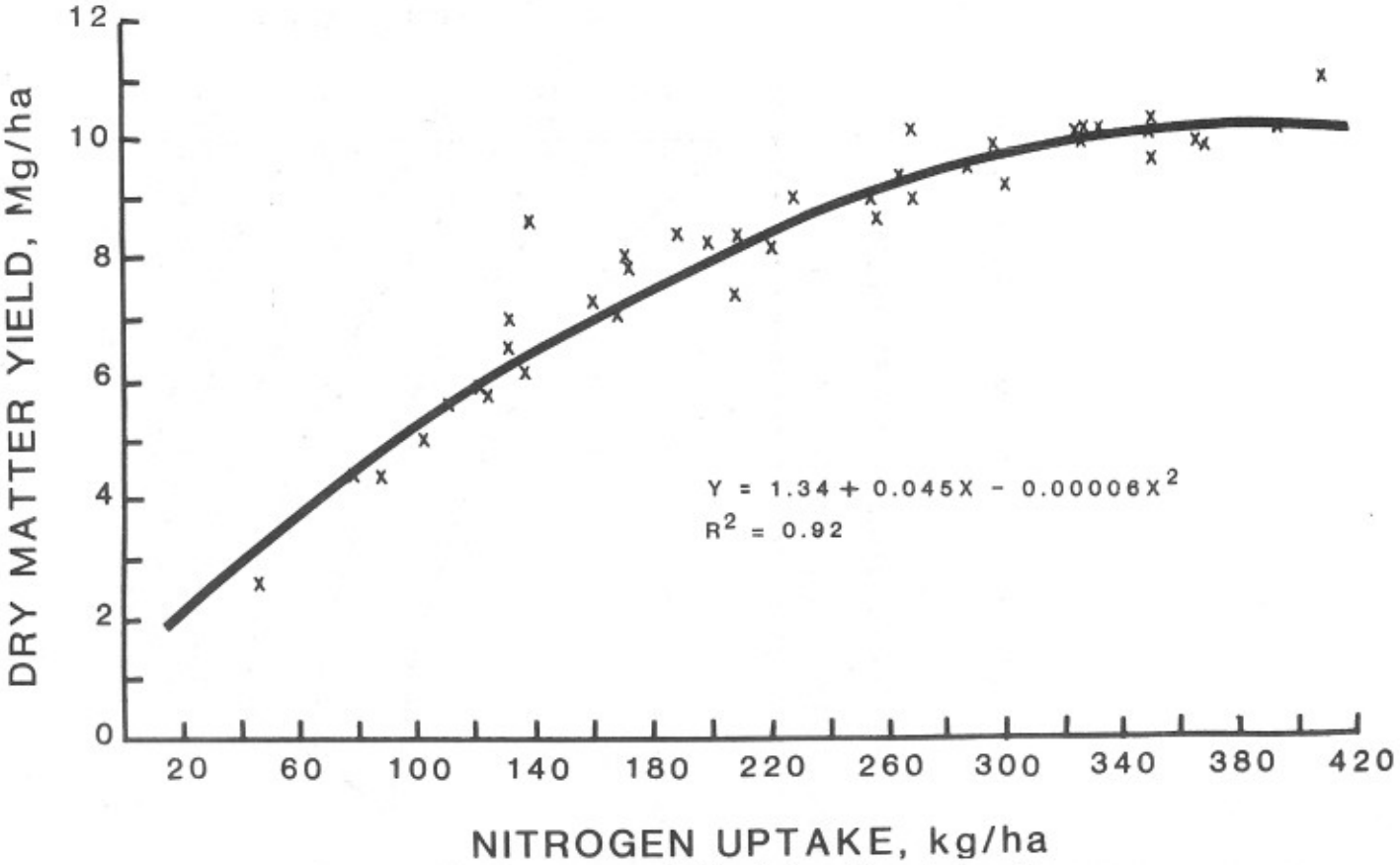

Fig. 5 Dry matter yield in relation to N uptake by cabbage.

was expressed in terms of N uptake using the relationship between soil NO_3-N and N uptake (Fig. 2). Fifty tons/ha of marketable cabbage, equivalent to 8.15 metric ton/ha of total dry biomass, requires the uptake of 211 kg N/ha (Fig. 4). The N deficit is 126 kg/ha, assuming 81% efficiency of utilization 154 kg N/ha is required.

Efficiency of N utilization decreased as the rate of applied N and the level of indigenous soil N increased (Table 5), and increased as the yield level increased (Table 3). Regression equations 3 and 4 (Table 3) were used to estimate N uptake at selected N fertilizer and soil NO_3-N levels.

Results indicated that indigenous soil N can contribute significantly toward the N requirement of cabbage and that consideration of the amount residual fertilizer N in soil in formulating N fertilizer recommendations should improve the efficiency of N utilization.

Table 5. Calculated* nitrogen fertilizer use efficiency by cabbage as affected by application rate and soil NO_3-N.

Nitrogen applied	Soil NO_3-N, ppm			
	6	10	14	18
kg/ha	% Recovery**			
20	100	93	86	80
40	96	89	83	76
80	88	82	75	68
120	81	74	67	61
160	73	66	60	53
200	65	59	52	46

* Regression equation 3 (Table 3) used to calculate N uptake.
** Percent N recovery = 100 (Total N - total N for check/total N applied.)

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Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

Determination of Postharvest Losses and Storage Life of 'Texas Grano 1015Y' Onion

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ABSTRACT

Postharvest losses were determined in 'Texas Grano 1015Y' onion (*Allium cepa* L.) bulbs stored at 1, 7, 13, 20, 27, or 34C. Storage lives at these temperatures were estimated by determining the sprouting percentages after onions were transferred to 27C every 2 weeks. The total weight loss ranged from 1.5 to 8.2% at 8 weeks except at 34C storage where 75% weight was lost primarily through decay. Sprouting was the main cause of weight loss at 7, 13, and 20C after 10 weeks. Water loss rates of onions were between 0.1 to 3.0 g/kg •day. The expected storage life without sprouting during a subsequent 2 week period for handling was estimated to be 8 week at 1C and 27C; 6 week at 7 and 20C; 4 week at 13C; 2 week at 34C, respectively. However, black mold (*Aspergillus niger*) seriously reduced marketability in bulbs stored at 27 and 34C. The most desirable storage temperature was 13 or 20C and storage lives were estimated to be 4 to 6 weeks.

Texas produced 158,000 tons of spring onions in 1987 which accounted for more than 50% of the U.S. early market (Texas Dept. Agri./U.S. Dept. Agri., 1988). The short-day onion cultivar 'Texas Grano 1015Y' is a mild and relatively good storing onion (Pike and Leeper, 1982) which has become an important cultivar in Texas, occupying about 25% of onion production area (Texas Dept. Agri./U.S. Dept. Agri. 1988).

Spring onions are consumed as fresh onions and storage is not common. However, a short term storage of spring onions would be beneficial for marketing, such as control of supply or export. Most previous studies on onion storage have been done with long-day onions which are grown in northern states and harvested in the fall (Stow, 1975/a/; Stow, 1975/b/; Stow and Ward, 1978). Spring onions harvested in a hot and humid condition need different consideration than those onions harvested in a cool and dry season.

The best storage condition for onions has been reported as 0C and 65 - 70% relative humidity (RH) (Hardenburg et al., 1986). However, cost of refrigeration makes it economically prohibitive to store spring onions in Texas. High temperature storage inhibits sprouting but promotes decay and growth of black mold (*Aspergillus niger* Tiegh) (Pike and Leeper; 1982, Stow, 1975/a/; Stow, 1975/b/). Since the refrigeration cost will be less at higher storage temperature and storage losses will increase as storage temperature rises, the highest temperature that minimize storage losses is preferred to optimize storage cost and losses.

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The main losses of onions during storage are caused by sprouting, decay, and water loss (shrinkage or desiccation), and the order and magnitude of these losses depends on the cultivar, cultural conditions, harvesting and handling, and storage condition (Thompson et al., 1972). Most onion storage experiments have been done at constant temperatures. However, to estimate true storage life, we must consider both storage life in constant temperature and shelf life after removal from storage because the storage temperature affects sprouting after storage (Karmarkar and Joshi, 1941; Stow and Ward, 1978).

This experiment was conducted to determine a suitable temperature for storage of 'Texas Grano 1015Y' onion bulbs with minimum losses and to determine practical storage life.

MATERIALS AND METHODS

'Texas Grano 1015Y' onion bulbs were harvested at the Texas A&M University Research and Extension Center at Weslaco, 25 Apr, 1985, and transported to College Station and stored at 27C until 10 May. About 40 to 50 bulbs, averaging 10 kg in weight, were placed in 30 × 30 × 30 cm fiber-glass boxes with a perforated bottom and stored at 1,7,13,20,27, or 34C. The boxes were stacked on a blower and air was blown constantly through the onions at 24 cm/sec during the experiment. Relative humidity in storage room was not controlled and average RH's were 90,82,63,61,45, and 41% at 1,7,13,20,27, and 34C, respectively. A two stage nested design, four boxes as replications nested in storage temperature, was used in this experiment.

Initial and final weights were measured before and after sprouted and decayed bulbs were removed. Bulbs infected by only black mold were not removed. Total weight loss rate was calculated from weight losses due to water loss, sprouting, and decay. Percentages of sprouted and decayed bulbs were used as sprouting and decay rate. Water loss rate was calculated from weight loss between each measurement before sprouted or decayed bulbs were removed. Data were analyzed after arc sine transformation.

About 30 bulbs were transferred to a 27C room from 1,7,13,20, and 34C room at two week intervals and their sprouting rate was investigated.

Estimated storage life under each temperature was defined as the storage which produced a total loss less than 10% and no sprouting within 2 weeks after transfer to 27C. This protocol simulated the losses during handling and marketing periods.

RESULTS AND DISCUSSION

Sprouting percentage was negligible at all temperatures until 6 weeks. However, more than 70% of bulbs sprouted after being stored at 7,13, and 20C for 10 weeks (Table 1). The 13C storage showed the highest sprouting rate followed by 7 and 20C storage. No sprouting were observed until 12 weeks at 1C and 10 weeks at 27C.34C storage was effective to prevent sprouting but observation was stopped after 10 weeks due to high rate of decay. This result was similar to previous reports (Karmarkar and Joshi, 1941, Stow, 1975/a/; Thompson et al., 1972). Sprouting response of short-day onion to storage temperatures seemed to be similar to long-day onions but occurred in a shorter period of time.

Decay was negligible at all temperatures (< 1%) except 34C. Decay percentages at 34C were 7.3, 57.4, and 74.5% at 4,6, and 8 weeks, respectively. Most decay was due

to neck rot. Black mold was so severe in 34C storage that the surface of the bulbs looked black and unmarketable. At 27C, infection by black mold and thrips reduced marketability considerably (No data were collected). At temperatures lower than 20C, the losses were negligible from decay, black mold, and thrips.

Water loss rate was proportional to storage temperature and was the main source of weight loss at all storage temperatures except 34C (Table 1). Storage at 34C produced the highest water loss rate for all the periods. This could be explained by the low RH in the 34C room and high water loss from decayed bulbs (Stow, 1975/b/). The rate of water loss at 27C storage increased until 4 weeks and then decreased to half after that. It appeared that the high water loss rate was due to the drying of outer scales during the early storage period and the decreased rate was due to the prevention of further water loss by the dried scales (Stow, 1975/b/). At storage temperatures lower than 20C, water loss rate increased when the bulbs sprouted.

Total weight losses, consisting of water loss and decay, ranged from 1.5 to 8.2% at all storage temperatures after 8 weeks. The magnitude of the loss increased as storage temperatures increased and most was due to water loss (Table1). However, the loss suddenly increased to more than 70% at 7, 13, and 20C after 10 weeks, primarily due to sprouting. The total weight loss increased rapidly at 34C after 8 weeks mainly from neck rot and water loss. The decay was so severe that measurement was stopped at 8 weeks. Bulbs stored at 27C lost weight slowly and had 11.5% loss at 10 weeks.

Water loss was the main source of weight loss until sprouting was initiated at 10 weeks in storage at temperatures below 27C. Total weight loss was estimated at less than 8% for 2 months in storage. These loss rates seemed to be higher than about 2% a month as observed by others (Stow, 1975/b/) and this was regarded as a cultivar difference.

If we assume 10% weight loss as a maximum for storage, the acceptable storage lives for each temperature would be 12 weeks at 1C; 10 weeks at 27C; 8 weeks at 7, 13, and 20C; and 2 weeks for 34C. However, 34C was not believed appropriate because of danger that the incidence of neck rot and black mold could be high. This estimation is only for constant temperature storage, and we need to consider a subsequent period of 2 weeks for handling and marketing after removal from storage as a shelf life.

Cumulative sprouting percentages after transfer to 27C are shown in Table 2. Transfer after 2 weeks had no effect on sprouting. Onions transferred after 4 weeks did not sprout in 2 weeks. Bulbs stored for 6 weeks did not sprout until 2 weeks after transfer, except 13C storage. This means the maximum storage life at 13C is 4 weeks even though the bulbs can be stored for 8 weeks at constant 13C. Bulbs transferred after 8 weeks at 7, 13, and 20C sprouted within a week. Bulbs stored at 1 and 34C for 8 weeks did not sprout until 2 weeks after transfer. Therefore, the storage lives without sprouting during 2 weeks at 27C after transfer were 8 weeks at 1, 27 and 34C; 6 weeks at 7 and 20C; 4 weeks at 13C.

The high rate of sprouting from bulbs stored at 34C after transfer from 4 and 6 weeks in storage were closely associated to the high rate of decay. Usually, the decay enhanced sprouting. The relationship between decay and sprouting was not clear but changes in hormones were suspected (Stow, 1975/b/).

The maximum storage life, with less than 10% weight loss and without sprouting after 2 weeks of handling and marketing, can be obtained by combining the results of Table 1 and 2 by choosing the shorter periods of storage. Maximum storage times would be 8 weeks at 1 and 27C; 6 weeks at 7° and 20C; 4 weeks at 13C; and 2 weeks at 34C. However, 8 weeks at 27C and 2 weeks at 34C would be shortened if we consider damage from black mold and thrips. Storage at 27C seemed to be promising only if black mold could be controlled.

Table 1. Effect of storage temperatures on sprouting, decay, water loss rate, and total weight loss of 'Texas Grano 1015Y' onion bulbs.

Source of loss	Storage temp. (C)	Weeks in storage					
		2	4	6	8	10	12
Sprouting (%)	1	0	0	0	0	0	0
	7	0	0	0	0	79.9	92.2
	13	0	0	0	2.0	97.0	-
	20	0	0	0.5	2.5	71.2	93.5
	27	0	0	0	0	0	1.0
	34	0	0	0	0	-	-
	Significance			ns	*	*	*
Water loss (g/kg onion •day)	1	0.2	0.2	0.2	0.2	0.3	0.4
	7	0.2	0.3	0.4	0.5	0.5	0.7
	13	0.5	0.5	0.6	0.7	0.7	1.0
	20	0.8	0.9	1.0	0.7	0.8	1.4
	27	1.6	2.0	1.2	0.8	0.9	0.8
	34	1.8	2.0	3.6	2.8	2.6	-
	Significance	*	*	*	*	*	*
Total weight loss (%)	1	0.3	0.8	1.1	1.5	2.0	2.7
	7	0.5	1.0	1.6	2.2	90.1	98.0
	13	0.8	1.7	2.5	5.2	99.0	-
	20	1.3	2.6	4.6	7.4	73.9	97.0
	27	2.5	5.4	7.3	8.2	9.3	11.5
	34	2.4	12.1	58.5	74.7	-	-
	Significance	*	*	*	*	*	*

ns, *Non significant and significant at 5% level, respectively. Each value is a mean of four replications.

Table 2. Cumulative sprouting percentages of onion bulbs after transfer to 27C from storage at 1, 7, 13, 20, and 34C for 2, 4, 6, and 8 weeks.

Storage		Sprouting (%)			Estimated storage life (wk)[z]
Temp. (C)	Wks	Wks after transfer			
		0	0	4	
1	2	0	0	0	
	4	0	0	0	
	6	0	0	10.0	
	8	0	0	60.0	8
7	2	0	0	0	
	4	0	0	0	
	6	0	0	3.7	6
	8	0	55.2	75.9	
13	2	0	0	0	
	4	0	0	0	4
	6	0	3.8	7.7	
	8	0	54.8	58.1	
20	2	0	0	0	
	4	0	0	0	
	6	0	0	3.6	6
	8	0	7.4	18.5	
34	2	0	0	3.3	
	4	0	0	0	
	6	0	0	54.8	
	8	0	0	16.7	8

[z]Estimated maximum storage life without sprouting during 2 weeks after transfer from constant temperature storage to 27C. For more detail, see text.

Unless an efficient new method for the control of black mold and decay becomes available, lowering storage temperature below 20C seemed to be the only way for successful onion storage even though sprouting would shorten shelf life. In this experiment the most desirable storage condition was 13 or 20C for the least cost of refrigeration, and maximum storage at these temperatures was estimated to be 4 to 6 weeks.

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Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

Hydrophilic Polyacrylamide and Fertilizer Affect Growth and Water Relations of *Chlorophytum comosum* and *Plectranthus australis* During Winter Production

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Additional Index Words: hydrogel, foliage plant, spider plant, Swedish ivy.

ABSTRACT

A polyacrylamide hydrogel (Agrosoke) mixed into the medium at rates of 1.5 or 2.25 kg/m^3 (2.5 or 3.75 lb/yd^3) resulted in increased number of runners and dry weight of shoots and roots of *Chlorophytum comosum* 'Vittatum' but had no effect on shoot fresh weight, number of irrigations, and days to wilt. Agrosoke resulted in a reduction of shoot: root ratio (dry weight). A slow-release fertilizer (Nutricote used at 6.0 kg/m^3) resulted in a greater number of shoots, more frequent irrigation, and fewer days to wilt than a lower rate of 3.0 kg/m^3 (5 lb/yd^3). The higher rate of fertilizer promoted shoot but not root growth. Agrosoke did not affect fresh or dry weights of shoots or frequency of irrigation in *Plectranthus australis*, but doubled root dry weight. Days to wilt also increased by Agrosoke at a rate of 2.25 kg/m^3 (3.75 lb/yd^3). Agrosoke at both rates increased the amount of water being retained in the medium on a per pot basis but did not affect pH or electrical conductivity of the medium leachate. *Plectranthus australis* caused the leachate pH to decrease by more than one unit in 10 weeks, whereas *Chlorophytum comosum* only resulted in a 0.4 unit drop in leachate pH after 17 weeks.

Synthetic water-absorbing polymers have been studied for their effects on improving water-holding capacity of soilless media (Flannery and Busscher, 1982; Ingram and Yeager, 1987; Johnson, 1984), plant growth responses (Ingram and Yeager, 1987; Taylor and Halfacre, 1986; Wang and Boogher, 1987), nutrient retention (Henderson and Hensley, 1985), plant water relations (Gehring and Lewis, 1980) and postharvest longevity (Poole and Conover, 1983) of plants. Viterra hydrogel was found to retain more nutrients in a pure sand medium (Henderson and Halfacre, 1986) but did not increase the growth of chrysanthemum (Still, 1976). Moisturite had no beneficial effect in the production of *Ligustrum japonicum*, whereas Liqua-Gel promoted the growth of *Lingustrum lucidum*, particularly at low fertility (Taylor and Halfacre, 1986).

[1]Mention of a trade name of a proprietary product is only for the convenience of identifying a product. It does not constitute a guarantee or warranty of the product by Texas A&M University or by the Journal and does not imply its approval to the exclusion of other products which may also be suitable.

Agrosoke, made of polyacrylamide, resulted in 50% greater growth of *Chlorophytum comosum* when used at twice the recommended rate (replacing 10% of the medium volume with hydrated material), and improved water use efficiency of plants during summer production (Wang and Boogher, 1987). In the above test, the fully hydrated hydrogel was mixed into the medium, but this practice was very inconvenient for commercial practice. Most hydrogel studies were conducted under warm seasonal conditions. It is not known whether plants will respond to hydrogel during cool production cycles. This report describes the effect of incorporating dry Agrosoke into the growth medium on plant growth, medium properties and water relations at two fertilizer levels during winter production.

MATERIALS AND METHODS

Uniform rooted single-shoot liners of variegated spider plant, *[Chlorophytum comosum* (Thunb.) Jacues]. 'Vittatum', were planted one per 15-cm (6-inch) plastic pot with a volume of 2 liters (0.53 gallon) on December 15, 1986. The growth medium consisted of equal volumes of aged pine bark (<1.3 cm or 0.5 inch) and sphagnum peat moss amended with 3 kg/m^3 (5 lb/yd^3) of fine-ground dolomitic limestone (Dolcita, Montgomery, AL) and 1.0 kg/m^3 (1.65 lb/yd^3) of Micromax (a micronutrient source, Sierra Chemical Co., Milpitas, CA). The experiment was a 3 × 2 factorial with 3 levels of Agrosoke (Grosoke International, Fort Worth, TX) at 0, 1.5 or 2.25 kg/m^3 (0, 2.5 or 3.75 lb/yd^3) and 2 levels of Nutricote 16N-4.3P-8.3K (type 180) slow-release fertilizer (Plantco, Inc., Bramelea, Ontario, Canada) at 6 or 3 kg/m^3 (10 or 5 lb/yd^3) mixed into the growth medium prior to planting.

Three rooted single-node Swedish ivy, (*Plectranthus australis* R. Br.), cuttings were planted on January 7, 1987 in the same type of pots and medium as used above with 6 kg/m^3 (10 lb/yd^3) Nutricote fertilizer in the medium. Treatments were the three rates of Agrosoke described previously. *P. australis* plants were pinched twice to promote lateral branching.

Experimental units consisted of one pot per treatment replicated 11 times in a randomized complete block design. All plants were grown in a greenhouse covered with polypropylene shade fabric and a single layer of polyethylene (152 μm or 6 mil in thickness), providing approximately 22% of full sun (420 mol/m^{-2}/s^{-1} maximum PPF or 2900 ft-c of light). Air temperatures during the experimental period were 14 to 35C.

All pots had the same weight of medium (450 g or 1 lb) at the time of transplanting. Pots were irrigated twice, each with 500 ml (17.6 fl. oz.) of water, immediately after potting. All pots were watered indiscriminately for 4 additional times as needed to ensure adequate expansion of the hydrogel in the medium. Leachates were collected and pH and electrical conductance (EC) measured at the 5th irrigation (24 days after planting), using the pour-through method (Yeager at al., 1983). Pots were then observed daily and irrigated with 500 ml of water as required. The number of irrigations was recorded for each pot. Water applied to *C. comosum* after March 17, 1987 contained 1.0 g/liter (14 oz/100 gallon of a 20N-8.6P-16.6Kwater soluble fertilizer.

Leachate samples were collected for the second time from *P. australis* and *C. comosum* at 10 and 17 weeks, respectively, after planting. Width of *P. australis* was determined after leachates were collected. Number of shoots and runners of *C. comosum* were counted. Each pot was then given 200 ml (7 fluid oz.) of water, weighed after 30

minutes, and placed in an interior environment with 8 $\mu mol/m^{-2}/s^{-1}$ (55 ft-c) PPF from 0800 to 1730 HR and 24 ± 2C air temperature. Relative humidity was not controlled and ranged between 55% and 75%.

Shelf life of plants was assessed as the number of days required for a plant to reach first wilt. Total water loss due to transpiration and evaporation was obtained by calculating the difference between the original pot weight and that at wilting.

After wilting, pots were watered and allowed to stand in water for 24 hours. Pots were drained and plants were harvested after another 24 hours. Shoots and roots were separated and fresh weights determined (with the exception of *P. australis* roots). Dry weights were determined after three days at 70C in a forced air dryer.

RESULTS AND DISCUSSION

C. comosum. Agrosoke did not interact with fertilizer rate to affect plant growth. Amending the growth medium with Agrosoke resulted in increased numbers of runners but had no effect on shoot number and fresh weight (Table 1). Root fresh weight, dry weights of shoots and roots, as well as total fresh and dry weights were enhanced by Agrosoke with no difference between rates. Since Agrosoke promoted the dry weight of shoots proportionally more than the shoots (although no statistical comparisons were made), the shoot:root dry weight ratio decreased accordingly. Number of irrigations and days to wilt were not affected by Agrosoke (Table 1).

The high fertilizer rate resulted in 60% more shoot weight (Table 1). However, root fresh and dry weights were unaffected, thus increasing the shoot:root ratio. High fertilizer rate increased plant water requirement and decreased days to wilt (Table 1), possibly due to the higher water demand as the result of larger plant size.

Previous research indicates that *C. comosum* requires high fertility (Hipp et al., 1979) and photoperiod ≥ 14 hours (Hammer, 1976) for optimum growth and runner production. The 6 kg/m^3 (10 lb/yd^3) Nutricote apparently did not provide the optimal fertility as indicated by the relatively low number of runners as compared to that reported by Hipp et al. (1979). Also, it is possible that the cool production temperatures in this study decreased the fertilizer release rate, causing low nutrient availability to roots (Harbaugh, 1985; Lemont et al., 1987). It has been recommended that slow-release fertilizer be used in combination with occasional liquid feed to ensure adequate nutrient supply, particularly during the cool period (Harbaugh, 1985).

P. australis. Pot weight after irrigations were similar to those of *C. comosum* (Table 2). Plants were slightly wider at the 1.5 kg/m^3 rate of Agrosoke, but exhibited no visual difference from the control. Application of Agrosoke had no effect on shoot fresh or dry weights. However, root dry weight increased over 100% when Agrosoke was used in the medium, with no difference between the two rates (Table 2). The shoot:root ratio was again reduced for *P. australis.* The number of irrigations was unaffected by Agrosoke possibly because the high rate of water loss in this species overshadowed the limited amount of extra water retained by Agrosoke. The days to wilt increased at the high Agrosoke rate.

Incorporation of Agrosoke into the potting medium increased the water content of the medium on a per pot basis at the termination of the experiment (Tables 1 and 2), indicating that there was little or no deterioration of this material over the relatively short production period. Because hydrogel materials respond differently to various medium amendments, with ferrous ions being particularly destructive to some

Table 1. Effect of Agrosoke and Nutricote on water retention of medium and on growth and water relations of *Chlorophytum comosum* 'Vittatum'[z].

Treatment	Pot wt after 5 irrigations (g/pot)	No. of irrigations[y]	Days to wilt	No. of shoots	No. of runners	Fresh wt (g)			Dry wt (g)			Shoot/ root ratio (dry wt)	Total water loss[x] (g/pot)
						Shoot	Root	Total	Shoot	Root	Total		
Agrosoke [kg/m³ (lb/yd³)]													
0	1241	13.5	18.3	7.6	4.9	182	77	259	12.6	5.9	18.5	2.3	772
1.50 (2.25)	1305	13.3	18.3	8.1	5.8	195	90	285	13.9	7.3	21.2	2.0	792
2.25 (3.75)	1324	13.7	19.0	8.2	6.0	196	98	294	14.1	8.0	22.0	1.9	808
LSD 0.05	17	NS	NS	NS	0.7	NS	7	18	1.0	1.0	1.7	0.2	28
Nutricote [kg/m³ (lb/yd³)]													
3 (5)	1284	12.6	18.9	6.9	4.3	146	89	235	10.7	7.4	18.1	1.5	783
6 (10)	1295	14.4	17.4	9.1	6.8	236	88	323	16.4	6.8	23.2	2.6	797
LSD 0.05	NS	0.6	0.6	0.7	0.6	11	NS	15	0.8	NS	1.4	0.2	NS

[z]There was no interaction between Agrosoke rate and Nutricote (16N-4.3P-8.3K slow release fertilizer) level.

[y]During the production period. The first five irrigations are excluded.

[x]Total water loss due to evaporation and transpiration during the interior holding.

Table 2. Effect of Agrosoke on medium water retention and on plant growth and water relations of *Plectranthus australis*.

Rate of Agrosoke [kg/m³(lb/yd³)]	Pot wt. after 5 irrigations (g/pot)	Plant width (cm)	fresh wt (g)	Dry wt (g)			Shoot/ root ratio (dry wt)	No. of irrigations[z]	Days to wilt	Total water loss[y] (g/pot)
				Shoot	Root	Total				
0	1261	65.4	391	18.7	6.9	25.3	3.1	12.2	11.9	671
1.50 (2.5)	1333	68.6	400	18.7	14.1	32.7	1.5	11.5	12.3	724
2.25 (3.75)	1346	66.8	409	18.6	14.0	32.6	1.4	12.0	13.2	767
LSD 0.05	15	2.3	NS	NS	3.3	3.0	0.7	NS	1.0	39

[z]During the production period. The first five irrigations are excluded.

[y]Total water loss due to evaporation and transpiration during the interior holding.

Table 3. Leachate pH and electrical conductance of *Chlorophytum comosum* 'Vittatum' and *Plectranthus australis* after the initial five irrigations and at the end of production as affected by Agrosoke and fertilizer rates.

	Chlorophytum comosum[z]				Plectranthus australis			
	Electrical conductance (dS/m)		pH		Electrical conductance (dS/m)		pH	
Treatment	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Agrosoke [kg/m³ (lb/yd³)]								
0	1.54	1.13	6.3	6.0	1.83	0.36	6.0	5.0
1.50 (2.25)	1.58	1.21	6.3	6.0	1.71	0.44	6.1	4.9
2.25 (3.75)	1.55	1.13	6.3	5.9	1.88	0.46	6.0	4.9
LSD 0.05	NS	NS	NS	NS	NS	NS	NS	NS
Nutricote [kg/m³ (lb/yd³)]								
3 (5)	1.24	0.59	6.3	5.9				
6 (10)	1.87	1.72	6.4	6.0				
LSD 0.05	0.10	0.15	NS	NS				

[z]There was no interaction between Agrosoke rate and Nutricote level.

hydrogel structures (James and Richards, 1986; Johnson, 1984; Wang, 1987). It is important the composition of the material, i.e., polyacrylamide, polyvinylalcohol, or starch grafted material, used in a given experiment be reported.

Neither initial nor final EC of the medium leachate was affected by Agrosoke (Table 3), indicating that this hydrophilic polymer did not cause salt accumulation in the medium solution. Some materials may retain extra salts in the medium, prevent nutrients from being leached out, or retain nutrients for a longer time (Handerson and Hensley, 1985; Taylor and Halfacre, 1986).

Leachates from *P. australis* had low final EC (Table 3), but did not show any visual symptoms of nutrient deficiency such as leaf chlorosis or stunted growth. The rapid growth rate of *P. australis* may have caused a large fraction of the released nutrients to be taken up, leaving very little in the medium solution. The use of water with low EC (0.04 dS/m) also contributed to the low EC at the termination of this experiment.

Neither initial nor final pH was affected by Agrosoke (Table 3). However, the high fertilizer level used on *C. comosum* increased leachate EC. The pH of leachate from *P. australis* dropped by more than one unit over 10 weeks, whereas the leachate pH of *C. comosum* decreased only slightly after more than 17 weeks of growth (Table 3). It was found previously that root systems of certain species released hydrogen ions to the medium, resulting in a fast, drastic reduction in medium pH (Lang and Reed, 1987). These suggest that it may be inadequate to control medium pH only by adding liming materials at planting.

The results in this and a previous study (Wang and Boogher, 1987) suggest that Agrosoke hydrogel may be used to promote plant growth or to increase postharvest longevity of plants. Its effect may be more significant when used during summer production when a plant's fast growth may be limited by stress due to high temperatures and greater water requirement. Agrosoke did not interact with slow-release fertilizer and appropriate amounts of fertilizer must be applied for optimum plant growth.

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Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

Sodium Tetrathiocarbonate - Potential New Fungicide for Control of *Phytophthora* in Citrus Groves

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Index Words: *Phytophthora citrophthora, P. parasitica,* soil-borne disease

ABSTRACT

Sodium tetrathiocarbonate releases carbon disulfide when added to water and applied to soil. Laboratory tests were conducted to determine the effect of this chemical on growth and sporulation of *Phytophthora citrophthora* and *P. parasitica*, which cause Phytophthora crown and root rot of citrus in Arizona. Zoospore motility, zoospore cyst viability, sporangia production, and mycelial growth were reduced in the presence of sodium tetrathiocarbonate. Application of sodium tetrathiocarbonate as a soil drench could reduce inoculum production and subsequent new infections by *P. citrophthora* and *P. parasitica*.

When added to water and applied to soil, sodium tetrathiocarbonate (Enzone, Unocal Corporation) releases carbon disulfide. Carbon disulfide was first used as a partial soil sterilant in 1894 (Girard, 1894; Oberlin, 1894). During a field trial in two Yuma orange groves, application of this material reduced the subsequent recovery of *Phytophthora parasitica* Dastur from treated soil, suggesting that sodium tetrathiocarbonate (STTC) may inhibit inoculum production by this plant pathogenic fungus. Laboratory studies were initiated to determine the effects of this chemical on various stages in the life cycle of *P. citrophthora*, (Smith and Smith) Leonian and *P. parasitica*.

MATERIALS AND METHODS

Zoospores were produced by growing isolates of *Phytophthora citrophthora* and *P. parasitica* on V-8 juice agar (V8A) petri plates for 5 days at 24C. Four 6-mm-diameter agar disks were removed from the edge of an actively growing culture of each isolate and placed in a 60-mm-diameter plastic petri-dish containing 7 ml of 1.5% nonsterile soil extract (Matheron et al., 1988). Numerous sporangia formed after incubation of agar disks for 72 hr at 21C. Sporangia were induced to release zoospores by chilling at 4C for 20 min. After rewarming to 25C, agar disks were removed from each petri dish. Solutions with 4.8, 24, and 120μg/ml of STTC were added to equal volumes of the zoospore suspensions, producing final concentrations of 2.4, 12, and 60μg/ml. Control zoospore suspensions received an equal volume of water only. Zoospore suspen-

sions were maintained at 25C and observed microscopically to determine the maximum elapsed time for complete cessation of motility. Zoospores would encyst after the cessation of motility. The majority of zoospore cysts would adhere to the bottom of each petri dish, where the number of cysts with intact cell walls in four randomly selected microscope fields (2.2mm^2) at 75 × was recorded after 4 hr in the presence of STTC.

To determine the viability of encysted zoospores remaining on the bottom of each petri dish, the treatment mixture was removed and replaced with 5 ml of 10% clarified V-8 juice broth (V-8 juice centrifuged for 10 min. at 1000 g, then dilution of the supernatant with sterile distilled water). After incubation for 19 hr at 21C, the average number of germinating zoospore cysts in four randomly selected microscope fields at 75 × was used to determine percent germination.

Six-mm-diameter leaf disks of lemon were colonized by *P. citrophthora* and *P. parasitica* by placing surface-disinfected disks on V8A cultures of these fungi for 48 hr at 24C. Eight colonized leaf disks were placed between two layers of fiberglass screen on a 2.5 cm layer of nonsterile sandy loam soil in a 10-cm-diameter × 10-cm-deep plastic pot and covered with an additional 5-cm layer of soil. The soil in each pot then was drenched with water containing 122, 245, or 490 μg/ml of STTC in sufficient quantities to thoroughly moisten the soil. Control pots were drenched with water only. Pots were allowed to drain freely, incubated for 72 hr at 25-28C, then leaf disks were removed, rinsed with water, and stained and fixed with acid fuchsin in 85% lactic acid. The number of sporangia along the margins of each leaf disk were counted.

The effect of STTC on mycelial growth of *P. citrophthora* and *P. parasitica* was tested by growing each pathogen on V8A for 5 days at 24C, then removing five 6-mm-diameter agar disks from the edge of the actively growing culture and placing them in a 9-cm-diameter plastic petri-dish containing 20 ml of 5% clarified V-8 juice broth (adjusted to pH 7.0 with KOH) amended with STTC at concentrations of 245, 612, 1,225, 1,837, and 2,450 μg/ml. Control petri-dishes contained only broth. After 72 hr, radial growth of mycelia was measured from the edge of each inoculum disk. All experiments were established in a completely randomized design and conducted two to four times.

RESULTS AND DISCUSSION

Results of this study reveal an inhibitory effect of STTC on various stages in the life cycle of *P. citrophthora* and *P. parasitica* (Table 1). The zoospores are highly sensitive to the chemical, as complete cessation of zoospore motility occurred after 4-6 minutes in the presence of STTC at 2.4 μg/ml.

When zoospores do not encounter host tissue to infect, they encyst by producing a cell wall. When conditions are favorable, zoospore cysts can germinate and produce a microsporangium, which in turn releases a motile zoospore. Germination of zoospore cysts did not occur when zoospores of *P. citrophthora* or *P. parasitica* encysted in the presence of STTC at 12 μg/ml.

Inhibition of sporangium production and mycelial growth required higher concentrations of the chemical. Control of sporangium production by both species of *Phytophthora* was almost complete at a STTC concentration of 490 μg/ml, while restriction of mycelial growth was virtually complete at a chemical concentration of 1,837 μg/ml.

STTC is being evaluated as a postplant nematicide at concentrations of 122-245 μg/ml. Our research findings suggest that these concentrations of the chemical could be highly inhibitory under field conditions to zoospore motility and lethal to zoospore cysts of *P. citrophthora* and *P. parasitica*.

After STTC was applied to a sandy loam soil in a Yuma citrus grove, the carbon disulfide concentration decreased daily and could not be detected after 7 days. This suggests that multiple applications would be required to suppress *Phytophthora* activity.

The possibility of a single pesticide with activity against *Phytophthora* and nematodes is an interesting prospect. Further evaluation of sodium tetrathiocarbonate as a potential fungicide for control of Phytophthora crown and root rot of citrus is now in progress.

Table 1. Summary of inhibitory effects of STTC on growth and sporulation of *Phytophthora citrophthora* and *P. parasitica*.[y]

Stage in life cycle	*Concentration of STTC* (μg/ml) required for at least 90 percent inhibition of *P. citrophthora*	*P. parasitica*
Zoospore motility	2.4	2.4
Zoospore encystment	>60[z]	60
Viability of encysted zoospores	12	12
Sporangia formation	490	490
Mycelial growth	1837	1837

[y] Each value is an average of at least eight replicate determinations.

[z] A 69 percent reduction in number of zoospore cysts occurred in the presence of STTC at 60 μg/ml, the highest rate tested in this portion of the study.

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Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

A Rapid Test for Detecting Phytophthora spp in Citrus

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ABSTRACT

Enzyme linked immunosorbent assay (ELISA) was used to detect the presence of *Phytophthora* fungus in citrus tissues. ELISA was found sensitive, fast and reliable in detecting *Phytophthora* that was present naturally or artificially introduced. ELISA can be used as a diagnostic tool for early detection of *Phytophthora* diseases. ELISA kits are commercially available.

Species of *Phytophthora* cause major economic loss to the citrus industry in Texas. Foot rot with or without gummosis on the trunk and branches, brown rot of fruits, and blights on twigs and leaves are symptoms associated with Phytophthora diseases. *P. parasitica* Dastur is the most prevalent species which is associated with citrus in Texas (Timmer, 1973). Until recently, a minimum of 3 to 4 days was required to confirm the association of *Phytophthora* spp. with a disease of citrus. Presently, use of enzyme linked immunosorbent assay (ELISA) (Clark and Adams, 1977; Clark, 1981) has proven to be a fast, sensitive, and reliable tool for diagnosis of *Phytophthora* diseases on citrus. ELISA is a diagnostic procedure that involves the use of an antibody produced against a foreign object in an animal such as a rabbit. These antibodies are used to 'trap' the pathogen present in biological systems such as the roots or shoots of a plant. The presence of trapped pathogens in an antibody sandwich is visualized by certain color reactions. ELISA is widely used as a diagnostic tool for several plant pathogens. However, its use for detecting *Phytophthora* in citrus is a recent development. This study is part of a joint project with Agri-Diagnostics, Cinnaminson, NJ.

MATERIALS AND METHODS

ELISA kits: The kits were supplied by Agri-Diagnostics Associates to study the use of ELISA as a diagnostic tool for the detection of *Phytophthora* diseases of citrus in Texas. The kit includes a polystyrene plate coated with antibodies produced against Phytophthora; enzyme labeled antibodies; substrate for the enzyme; stop solution; and buffers.

Test materials: The test materials used in ELISA were different types of citrus tissue and soil with or without *Phytophthora* infestation either naturally occurring or artificially induced. Table 1. shows the type of test materials, their conditions, and ELISA results.

Antigen extraction and test procedure: The test plant tissue was washed thoroughly in running water, blot dried and extracted in a mortar using 1:10 w/v extraction buffer. Liquid nitrogen was used to pulverize the tissue. For soil test, suspensions were made with extraction buffer or water, mixed well, and allowed to stand for one hour. The supernatant was carefully removed and used as the test solution. Liquid nitrogen was added to the fungal cultures and were ground in a mortar, and extracted with the buffer. The test procedure based on the typical double sandwich as described by Clark and Adams (Clark and Adams, 1977) was modified by Agri-Diagnostics.

RESULTS AND DISCUSSION

As shown in Table 1, pure culture, plant parts or soil artificially infested with *P.*

Table 1. Type of test materials, their conditions, and ELISA results.

Test material	ELISA reaction
1. Roots of 3 year old sweet orange trees on sour orange rootstock in the field	Positive
2. Roots of 6 month old sour orange grown in pots in the green house	Positive
3. Roots of 6 month old sour orange in pots; *P. parasitica* added to the soil and kept in the green house	Positive
4. Field collected grapefruit with brown rot symptoms	Positive
5. Grapefruits and oranges inoculated with *P. parasitica*, and kept in lab conditions	Positive
6. Pure culture of *P. parasitica*	Positive
7. *P. parasitica* infested soil suspension in extraction buffer	Positive
8. Extraction buffer only	Negative
9. Culture of *Alternaria* spp.	Negative
10. Healthy roots of sour orange grown hydroponically	Negative
11. Positive control supplied with the ELISA kit	Positive

parasitica, and the grapefruit from the field with brown rot symptoms were positive in ELISA. Roots of symptomless sour orange from the field showed positive reaction. Roots of sour orange grown hydroponically; controls including the extraction buffer and fungi *Alternaria* gave negative reaction. ELISA is a valuable tool for early detection of *Phytophthora* in single or mixed infections, especially of post harvest diseases (Eckert and Brown, 1986). Detection of *Phytophthora* spp in apparently healthy trees allows the grower to implement effective control measures, before the disease spreads. The commercial availability of Phytophthora diagnostic kits is an added advantage. The time required to test a sample was 4 hours.

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Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

Comparison of Fungicides for Control of Powdery Mildew of Cantaloupe

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Index Words: *Cucumis melo*, *Sphaerotheca fuliginea*, fungal disease

ABSTRACT

Powdery mildew of cantaloupe, caused by *Sphaerotheca fuliginea*, is a perennial and often devastating disease in Arizona. During 1987 and 1988, potential new fungicides were evaluated in field trials for disease control. In 1987, Bayleton, Rally and Spotless provided significant disease control. In 1988, Rally and Spotless significantly reduced development of powdery mildew, while Bayleton and Tilt were less effective. Uneven development of powdery mildew within the plot may partially explain the apparent lack of significant disease control in 1988 by Bayleton and Tilt.

Powdery mildew of cantaloupe is a perennial and often devastating disease in the desert southwest. Disease symptoms first appear as small, white, superficial spots on cantaloupe stems and leaves. As these lesions enlarge, they appear powdery, increase in number and coalesce, eventually covering stems and both leaf surfaces. Infection on young leaves can result in general chlorosis and eventual death of the affected leaf. Severely affected leaves become brown and dessicated, with resultant premature defoliation. Cantaloupe fruit are free of visible infection; however, severely infected plants yield prematurely ripened fruit that lack flavor. The reduction of yield is proportional to the duration and severity of the disease.

Powdery mildew of cantaloupe is favored by low relative humidity, dry soil conditions, moderate temperatures, reduced light intensity, and succulent plant growth. Spores of the fungus can germinate in the absence of free water and in a relative humidity of less than 20% (Sitterley, 1978).

MATERIALS AND METHODS

During 1987 and 1988, fungicide trials were established at the Yuma Valley Agricultural Center to examine the efficacy of new fungicides for controlling this disease in the desert Southwest. The cantaloupe cultivar 'Topmark' was planted March 19 in 1987 and March 2 in 1988 on 80-inch wide beds. Replicate treatments were randomized in a complete block design, consisting of 50 feet of row with a plant spacing

of 12 inches. Fungicides tested in 1987 were Bayleton, Rally, and Spotless; the trial in 1988 included Bayleton, Rally, Spotless, and Tilt. Fungicides were applied four times in 1987 (May 22, June 4 and 18, and July 2) and three times in 1988 (May 19, June 1 and 22). Disease incidence and severity was determined by collecting 25 leaves at random from each replicate of each treatment at crop maturity and counting the number of powdery mildew lesions present.

RESULTS AND DISCUSSION

Results of these field tests are summarized in Tables 1 and 2. In the 1987 trial, all tested fungicides significantly reduced disease levels. Disease pressure was moderate in 1987 and the distribution of fungal lesions within the test plot was fairly uniform.

For the 1988 test, Rally and Spotless provided significant control of powdery mildew; Bayleton and Tilt did not provide control. Disease levels were generally higher than those observed in 1987, although the distribution of fungal lesions was highly variable. The disease gradient ranged from highest in the southeast to lowest in the northwest corner of the plot. This highly skewed pattern of disease development caused a large variation in disease levels among the replicates in each treatment, which may partially explain why Bayleton and Tilt did not perform well in this trial. No symptoms of phytotoxicity were observed.

Powdery mildew of cantaloupe usually is caused by *Erysiphe cichoracearum* DC or *Sphaerotheca fuliginea* (Schlecht. ex Fr.) Poll. (Sitterley, 1978; French, 1987). Microscopic examination of conidia from diseased cantaloupe leaves revealed well-developed fibrosin bodies, which suggested that *Sphaerotheca fuliginea* was present in these fungicide trials (Yarwood, 1978).

Table 1. Effect of fungicide treatments on development of powdery mildew on cantaloupe in 1987 field trial.

Treatment	Rate of active ingredient per acre	Number of[y] lesions
Control	--	42.00a[z]
Spotless 25 W	0.02 lb.	7.00b
Bayleton 50 W	0.25 lb.	6.25b
Rally 60 DF	0.061 lb.	2.25b
Rally 60 DF	0.13 lb.	0.50b
Spotless 25 W	0.04 lb.	0.50b

[y] Each value is the average number of lesions recorded from 25 leaves collected at random from each replicate plot in a treatment.

[z] Values followed by the same letter are not significantly different (P = 0.01) according to Duncan's Multiple Range Test.

Table 2. Effect of fungicide treatments on development of powdery mildew on cantaloupe in 1988 field trial.

Treatment	Rate of active ingredient per acre	Number of[y] lesions
Control	--	132a[z]
Bayleton 50 W	0.06 lb.	86ab
Tilt 3.6 EC	0.06 lb.	76ab
Rally 40 W	0.08 lb.	16b
Spotless 25 W	0.04 lb.	12b

[y]Each value is the average number of lesions recorded from 25 leaves collected at random from each replicate plot in a treatment.

[z]Values followed by the same letter are not significantly different (P = 0.05) according to Duncan's Multiple Range Test.

When this report was written, only Bayleton was registered for use on cantaloupe; however, Rally was close to registration. Check the current status of Rally when considering control measures for powdery mildew of cantaloupe.

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Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

Evaluation of New Fungicides for Control of Sclerotinia Leaf Drop of Lettuce

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Index Words: *Sclerotinia sclerotiorum*, fungal disease

ABSTRACT

Leaf drop of lettuce, caused by *Sclerotinia sclerotiorum*, is a sporadic, but destructive, disease in Arizona. Field trials were established during 1987 and 1988 to evaluate potential new fungicides for disease control. Ronilan and Rovral, the two materials currently registered for use on lettuce for Sclerotinia leaf drop, were consistently among the most effective fungicides for disease control. Levels of disease control equivalent to that provided by Rovral and Ronilan were observed with CGA-449, SC-0858, SDS-65311, Bay HWG 1608, and Spotless. These field tests have identified several potential new fungicides for control of leaf drop of lettuce caused by *S. sclerotiorum*.

Leaf drop of lettuce in Arizona is caused primarily by *Sclerotinia sclerotiorum* (Lib.) de Bary, although *S. minor* Jagger occasionally is recovered from diseased plants. Approximately 85% of the 40,000 acres of lettuce produced in Arizona during 1987-88 was located in western Arizona, where initial planting begins in late August and final harvest occurs about mid-April. The incidence of lettuce drop can be high during February, March, and April, when cool wet periods favor disease development (Troutman, 1982.)

The dicarboximide fungicides, Rovral (iprodione) and Ronilan (vinclozolin), currently provide effective disease control (Johnston, 1981; Rowe, 1982; Springer and Johnston, 1982). Recently, however, in vitro development of resistance to dicarboximide fungicides by *Sclerotinia minor* has been reported (Porter and Phipps, 1985 a,b; Brenneman et al., 1987). This development suggests the need for continued testing of new compounds for effectiveness in the control of Sclerotinia leaf drop of lettuce.

MATERIALS AND METHODS

Fungicide trials were established at the Yuma Valley Agricultural Center during 1987 and 1988. Inoculum of *Sclerotinia sclerotiorum* was produced in 2-L glass containers by seeding moist sterilized barley grain with sclerotia of the fungus. After three months of incubation at 24-27C in the laboratory, abundant sclerotia were formed. The mixture of sclerotia and infested grain was used as inoculum. Lettuce (Vanguard 75) was seeded in mid-November, with double rows 12 inches apart on beds 40 inches wide.

After thinning the lettuce at the 3 to 4 leaf stage to a 12 inch spacing, 400 cm^3 of the dried mixture of sclerotia and infested grain was distributed evenly on each lettuce bed in a band 20 inches wide and 50 feet long. Fungicide treatments were applied to the entire surface of treated beds immediately after inoculum distribution (early January) and again 2 to 3 weeks later.

Treatments were replicated four times in a randomized complete block design, with each replicate consisting of 50 feet of bed which contained two 50 foot rows of lettuce. Furrow irrigation was used for the duration of these tests. Disease development was monitored by recording the number of collapsed lettuce plants.

RESULTS AND DISCUSSION

The results of these fungicide trials are summarized in Tables 1 and 2. In the 1987 trial (Table 1), all tested compounds except Bay HWG 1608 and Baycor significantly reduced

Table 1. Effect of fungicides on severity of lettuce drop in 1987 field trial.

Treatment	Rate of Product/Acre	Percent Diseased Plants	% Increase in[y] Potential Yield
Control	--	44a[z]	--
Bay HWG 1608 1.2 EC	12 fl. oz.	39ab	11
Baycor 50 W	2 lb.	38 ab	14
Bay HWG 1608 1.2 EC	24 fl. oz.	37ab	16
Spotless 25 W	0.5 lb.	36abc	18
SC-0858 50 W	1 lb.	36abc	18
CGA-449 50 W	2 lb.	31bcde	30
SC-0858 50 W	2 lb.	26cde	41
Spotless 25 W	2 lb.	26cde	41
Spotless 25 W	1 lb.	25de	43
Rovral 50 W	2 lb.	25de	43
Ronilan 50 W	2 lb.	21e	52

[y]The percent increase in potential yield was derived by comparing the number of healthy plants in plots treated with fungicides to the number of healthy plants in nontreated (control) plots.

[z]Values followed by the same letter are not significantly different (P = 0.05) according to Duncan's Multiple Range Test.

Table 2. Effect of fungicides on severity of lettuce drop in 1988 field trial.

Treatment	Rate of Product/Acre	Percent Diseased Plants	Percent[y] Marketable Heads
Control	--	48 a[z]	21 d
SC-0858 50 W	2 lb.	28 b	43 bc
SDS-65311 50 W	1 lb.	27 bc	48 abc
Bay HWG 1608 1.2 EC	3.3 qt.	26 bc	36 cd
Ronilan 50 W	1 lb.	23 bc	52 ab
Rovral 50 W	2 lb.	22 bc	53 ab
SDS 65311 50 W	2 lb.	22 bc	42 bc
Rovral 50 W	1.5 lb.	17 bc	54 ab
Spotless 25 W	4 lb.	16 bc	46 abc
CGA-449 50 W	2 lb.	16 bc	53 ab
Ronilan 50 W	2 lb.	14 c	57 a

[y] Percentage of heads that would be of acceptable quality for commercial harvest.

[z] Values followed by the same letter are not significantly different (P = 0.05) according to Duncan's Multiple Range Test.

the incidence of disease and increased yields, provided that a sufficient rate of fungicide was applied. No symptoms of phytotoxicity were observed. In the 1988 trial, all tested materials significantly reduced the incidence of disease; the percent of marketable heads was increased by all fungicides except Bay HWG 1608.

Rovral and Ronilan, the two compounds registered for use on lettuce for control of Sclerotinia leaf drop, were consistently among the most effective fungicides for disease control. Levels of disease control equivalent to that provided by Rovral and Ronilan were observed with CGA-449, SC-0858, SDS-65311, Bay HWG 1608, and Spotless in 1988.

Disease incidence was evaluated at the onset of leaf drop and periodically thereafter until crop maturity. Disease development was linear during each field trial for all treatments. These field tests evaluated the efficacy of fungicides in preventing infection initiated by soilborne inoculum of *S. sclerotiorum*, but did not evaluate control of disease developing from aerial infections caused by ascospores of the fungus. The linear development of disease over time suggests that there was no multiplication of inoculum for the duration of each field trial. This is not unusual for development of leaf drop of lettuce caused by *S. sclerotiorum* in Arizona, as the temperature, humidity, and moisture required for development of apothecia and ascospores do not occur regularly. Infection of lettuce plants by soilborne inoculum led to rapid plant death.

These field trials have identified several potential fungicides for control of leaf drop of lettuce caused by *Sclerotinia sclerotiorum*. Further tests and evaluations of each material by the manufacturer will determine whether any of these new materials will be registered in the future.

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Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

An Update on IR-4 Pesticide Testing in the Lower Rio Grande Valley of Texas in 1988 and 1989

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ABSTRACT

The Interregional Research Project No. 4 (IR-4) was organized in 1964 to support registration of pesticides on minor crops. IR-4 has been responsible for over 3,500 minor use registrations. IR-4 experiments, at the Subtropical Agriculture Research Lab in 1988-1989, included 12 pesticides and 14 crops. The pesticides included 4 fungicides, 1 nematicide, 2 insecticides, 1 acaricide, and 4 herbicides. Crops included celery, kale, cauliflower, bell peppers, cucumbers, summer squash, cabbage, watermelon, cantaloupe, green onions, blackeye peas, mustard greens, grain sorghum, and grape ivy. Pesticides were evaluated for efficacy and phytotoxicity.

The Interregional Research Project No. 4 (IR-4) was organized in 1964 to support the registration of pesticides for minor crops. IR-4 is a cooperative program, between Animal Drug and Pesticide Manufacturers, U.S. Food and Drug Administration, U.S. Environmental Protection Agency, U.S. Department of Agriculture, and State Agriculture Experiment Stations, aimed at generating the necessary data to allow expansion of existing pesticide labeling to include minor crops. Minor crops include many vegetable and ornamental crops produced in the Lower Rio Grande Valley (LRGV) of Texas. The program functions to identify minor crop needs, determine the necessary data required for labeling, and generate the data through field experimentation and laboratory residue analysis. The end result is that many products are cleared for uses that would not otherwise have been considered by manufacturers. Since its inception in 1964, the IR-4 program has achieved over 3,500 minor use registrations.

This paper is a brief summary of the IR-4 projects conducted by the USDA-ARS. Subtropical Agricultural Research Laboratory at Weslaco, TX, in fall of 1988 and spring of 1989.

MATERIALS AND METHODS

To insure uniformity of testing across study locations, explicit study protocols were supplied by IR-4 for each test. Field and greenhouse trials were carried out using U.S. Environmental Protection Agency guidelines and locally generated operating procedures. The treatments usually included a check plot, two rates of the target chemical

(1 × and 2 ×), and standard treatment of a pesticide commonly used in the region. All experimental trials were arranged in a randomized complete block design. Herbicides trials also included a check that was maintained weed free.

Pesticide applications were made using a CO_2 pressurized, tractor mounted sprayer which was calibrated immediately prior to use. Any required pesticide incorporation or other cropping practices were done using regionally accepted production practices. At the Weslaco location, all field experiments were watered by furrow irrigation.

RESULTS AND DISCUSSION

Common names, trade names, and manufacturers of the pesticides tested in the 1988-89 IR-4 program are shown in Table 1. The chemical may be marketed under several trade names and formulations. The trade names shown identify the specific formulation used in these tests.

Fungicides included in the testing program are shown in Table 2. Triforine (N,N-1,4-piperazinediylbis (2,2,2-trichlor-ethylidene)-bis-[formamide]) was tested in a greenhouse study on grape ivy for control of powdery mildew. Triforine is effective against a variety of fungal agents in stored fruits as well as on roses and other ornamentals. Triforine was not phytotoxic to grape ivy. Powdery mildew was not present in this trial so efficacy could not be evaluated.

Table 1. Common names, trade names and manufacturers of pesticides tested in IR-4 program at Weslaco, Texas in 1988 and 1989.

Common name	Trade name	Manufacturer
Fungicides		
benomyl	Benlate	E.I. du Pont de Nemours
carboxin	Vitavax	Uniroyal Chemical Co. Inc.
iprodione	Rovral	Rhone-Poulenc Ag. Co.
triforine	Funginex EC	Chevron Co.
Nematicides		
fenamiphos	Nemacur	Mobay Corp.
Insecticides		
chlorpyrofos	Lorsban 4E	Dow Chemical Co.
fonofos	Dyfonate	ICI Americas Co.
Acaricides		
fenbutatin-oxide	Vendex	E.I. du Pont de Nemours
Herbicides		
clomazone	Command EC	FMC Corp.
diquat	Diquat Herbicide HA	Chevron Co.
fluazifop-p-butyl	Fusilade 2000	ICI Americas Co.
prometryn	Caporal	Ciba-Geigy Corp.

Table 2. Phytotoxicity ratings for fungicides and nematicides tested in IR-4 program at Weslaco, Texas, fall 1988 and spring 1989.

Pesticide	Crop/season	Rate		Phytotoxicity*
Fungicides		lb ai/A	kg ai/ha	
benomyl	grain sorghum/fall '88	0.5	0.56	none
		1.0	1.12	none
carboxin	bell peppers/spr '89	1.125	1.26	none
		2.25	2.52	none
iprodione	mustard greens/fall '88	0.25	0.28	none
		0.50	0.56	none
		1.0	1.12	none
		2.0	2.24	none
triforine	grape ivy/fall '88	0.75**	0.84**	none
		1.5**	1.68**	none
Nematicide				
fenamiphos	blackeye peas/spr '89	2.0	2.24	none
		4.0	4.48	none
	watermelon/spr '89	2.0	2.24	none

* Phytotoxicity by visual rating scores of none = no phytotoxicity, slight = <20%, moderate = 20 - 50%, severe = 50 - 70%, and excessive = >70% of plants with injury symptoms.

** Rate expressed as lb ai/100 gallons or kg ai/378.5 L.

Iprodione [3-(3,5-dichlorophenyl)-N-(1-methylethyl)-2,4-dioxo-1-imidazolidine-carboxamide] is an effective contact fungicide for control of a variety of plant diseases including Rhizoctonia, Fusarium, Helminthosporium and others. Expansion of the labeling to include iprodione use as a seed treatment or as a contact foliar treatment on mustard greens has been proposed. Experimental trials in the LRGV found no phytotoxicity on mustard greens. An abscence of fungal diseases on this years crop precluded evaluation of efficacy.

Benomyl [Methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate], a systemic fungicide, is currently labeled for use on several vegetable, fruit, and field crops. Trials were conducted to support the expansion of the label to include the control of head mold in grain sorghum. The benomyl treatments were nonphytotoxic to the grain sorghum; however, environmental conditions were not conducive to head mold development so no efficacy rating could be done.

Carboxin (5,6-dihydro-2-methyl-1,4-oxathiin-3-carboxamide) is a systemic fungicide used as a seed treatment for control of smut in small grains and a variety of seedling diseases such as *Rhizoctonia solani*. Carboxin was being considered for control of southern blight in bell peppers. The fungicide treatments proved to be non-phytotoxic to the bell peppers in the Weslaco tests.

Fenamiphos [Ethyl 3-methyl-4-(methylthio) phenyl(1-methylethyl) phosporamidate] was the only nematicide included in the Weslaco IR-4 program during 1988 and 1989. Fenamiphos gave effective nematode control with no phytotoxicity to the blackeye peas or watermelon crops.

Phytotoxic effects from the tested insecticides are summarized in Table 3. No phytotoxicity was detected on any of the test species at any application rate.

Fonofos (O-Ethyl-S-phenylethylphosphonodithioate) is a soil applied insecticide used for control of wireworms, cutworms, rootworms, and some foliar pests in corn, cole crops, beans, peppers, onions, and other vegetable and agronomic crops. Studies were conducted to generate data in support of expansion of the current label to include summer squash, cucumber, and cantaloupe for control of foliar feeding insects. Fonofos proved to be effective for control of insects on these crops with no visible phytotoxicity.

Chlorpyrifos [O,O-Diethyl O-(3,5,6-trichloro-2-pyridyl)-phosphoro-thioate] is a widely used insecticide for control of a variety of pests in field, fruit, nut and vegetable crops. Chlorpyrifos may be applied as a foliar treatment, a seed treatment or as an in-

Table 3. Phytotoxicity ratings for insecticides and acaricides tested in IR-4 program at Weslaco, Texas in 1988 and 1989.

Pesticide	Crop/season	Rate		Phytotoxicity*
		lb ai/A	kg ai/ha	
chlorpyrofos	green onion/fall '88	1.0	1.12	none
		2.0	2.24	none
fonofos	summer squash/spr '89	4.0	4.48	none
		8.0	8.96	none
	cucumber/spr '89	4.0	4.48	none
		8.0	8.96	none
	cantaloupe/spr '89	4.0	4.48	none
		8.0	8.96	none
fenbutatin-oxide	watermelon/spr '89	1.0	1.12	none
		2.0	2.24	none

* Phytotoxicity by visual rating scores of none = no phytotoxicity, slight = <20% injury, moderate 20 - 50% injury, severe 50 - 70% injury, and excessive = >70% injury to plants.

corporated soil treatment. The IR-4 trials were aimed at including green onion on the label for control of the onion maggot.

Fenbutatin-oxide {Hexakis (2-methyl-2-phenylpropyl)-distannoxane}, trade name Vendex, was the only acaricide included in these studies (Table 3). There was no detectable phytotoxicity to the watermelon following treatment with fenbutatin-oxide for spider mite control. Spider mite infestations were inadequate to evaluate efficacy at Weslaco, however, fenbutatin-oxide has a history of effective spider mite control on other crops.

Herbicides were evaluated for efficacy and crop phytotoxicity. The phytotoxicity ratings are summarized in Table 4. Prometryn [2,4-bis (isopropylamino)-6-(methylthio)-s-triazine] was tested as an "over-the-top" treatment on two varieties of celery. This study was undertaken to generate data to support expansion of the current label to include such use in Texas. Prometryn applied at 1 and 2 lb ai/A (1.12 and 2.24 kg ai/ha)

Table 4. Phytotoxicity ratings for herbicides tested in the IR-4 program at Weslaco, Texas in 1988 and 1989.

Pesticide	Crop/season	Rate		Phytotoxicity*
		lb ai/A	kg ai/ha	
clomazone	cabbage/fall '88	1.0	1.12	severe
		2.0	2.24	none
	bell peppers/spr '89	1.0	1.12	none
		2.0	2.24	none
	summer squash/spr '89	0.5	0.56	none
		1.0	1.12	none
	cucumber/spr '89	0.5	0.56	none
		1.0	1.12	none
diquat	bell peppers/spr '89	0.5	0.56	moderate
		1.0	1.12	moderate
fluazifop-p-butyl	cauliflower/fall '88	0.25	0.28	none
		0.5	0.56	none
	kale/fall '88	0.25	0.28	none
		0.5	0.56	none
prometryn	celery/fall '88	1.0	1.12	none
		2.0	2.24	none

* Phytotoxicity by visual rating scores of none = no phytotoxicity, slight - <20%, injury, moderate = 20 - 50%, injury, severe = 50 - 70% injury and excessive = >70% injury to plants.

gave excellent weed control and resulted in no detectable phytotoxicity in the transplant celery. The weed control was compared with preplant incorporated trifluralin and was not different in this study.

Fluazifop-p-butyl {(R)-2-[4-]5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy] propanoic acid} is a selective herbicide for control of most grasses. Broadleaf species are very tolerant of fluazifop-p-butyl and it generally can be used to remove grasses from broadleaf crops. The studies conducted on cauliflower and kale were designed to support labeling of fluazifop-p-butyl for use in these crops. The 0.25 and 0.5 lb ai/A (0.28 and 0.56 kg ai/ha) rates gave excellent grass control with no detectable phytotoxicity to the cauliflower or kale.

Clomazone [2-[(2-chlorophenyl)methyl]-4,4-dimethyl-3-isoxazolidinone] is currently labeled for selective weed control in soybeans as a preplant incorporated treatment. Several production areas have requested expansion of the label to include vegetable and ornamental crops. Clomazone treatment resulted in excellent weed control at the tested rates with no detectable phytotoxicity on the kale, bell peppers, summer squash, or cucumbers. Cabbage proved to be very sensitive to clomazone under the environmental conditions present in the LRGV. Direct seeded cabbage was killed by the 2.0 lb ai/A (2.24 kg ai/ha) treatment and was very severely injured with 1.0 lb ai/A (1.12 kg ai/ha) treatement. Clomazone may have a place in some LRGV vegetable production systems; however, further investigation of use rates and cultivar sensitivity will be required.

Diquat [6,7-dihydrodipyrido[1,2-α:2',1'-c]pyrazinediium ion] is a contact herbicide that is effective for control of seedling weeds. An IR-4 request for the use of diquat as a shielded, directed spray in bell peppers was investigated. The diquat had no adverse effect on bell peppers if it did not contact the plant foliage, however, it proved difficult to shield adequately to prevent contact while still spraying close enough to the peppers to control "in-row" weeds. The application technology needs further refinement to permit this treatment to be widely adopted.

In October 1988, the U.S. Congress amended the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA '88) to require that all pesticides and uses registered prior to November 1984 be reregistered against current standards. This reregistration process will likely effect a majority of pesticides currently registered on minor crops. The IR-4 program, while continuing to support new registration will be involved in the necessary work of reregistration. The IR-4 program continues to be an important, efficient and cost effective pathway for labeling of pesticides in minor crops.

Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

Modern Tools for Rapid Diagnosis of Plant Diseases

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Additional Index Words: c-DNA, ELISA, Serology.

ABSTRACT

Diagnostic tools for diseases based on serology, nucleic acid probes, and redox reactions are available for rapid assay of large number of samples for plant pathogens. Such tools are reliable, easy to use, and commercially available. Apart from routine diagnosis, such tools can be used to generate information on ecology, epidemiology, disease resistance, and strain differences among pathogens.

Proper and timely diagnosis of diseases is important for efficient control of crop diseases. Culturing of micro-organisms in selective media or in specific biological indicator plants, and morphological studies of the pathogen with appropriate optical systems enable an investigator to diagnose plant diseases. However, these procedures are time consuming, and not applicable to large scale screening. For practical management of crop diseases, fast and early diagnosis of the disease(s) is very critical. Progress in biochemistry, immunology, and biotechnology has helped to create several powerful tools for rapid diagnosis of plant diseases. Enzyme linked immunosorbent assay (ELISA), for example, offers sensitive, fast, reproducible, and quantitative detection of pathogens in various tissues and soil (Clark and Adams, 1977; Lister and Rochow, 1979; Skaria et al., 1985; Miller et al. 1989b; 1989a). ELISA involves the use of an antibody system, developed against a particular pathogen to detect similar pathogens in plant tissues or soil. Various forms of ELISA have been developed and used extensively for diagnosis of plant diseases caused by viruses, fungi, bacteria, spiroplasmas, mycoplasmas, and fungal toxins (Miller and Martin, 1988). Various types of ELISA are currently used by investigators. The solid phase can be polystyrene plates, beads, or nitrocellulose paper. The enzyme labeled antibody can be from the same source as that was used to capture the antigen (direct ELISA), or it can be an anti-antibody made in another animal (indirect ELISA). Protein A labeled with an enzyme can be used in indirect ELISA in place of a labeled antibody. Enzyme labeled Protein A and anti-antibodies are commercially available, therefore it saves the time to prepare a conjugated antibody. For some disease detection an indirect ELISA works better than a direct test. The investigator has to work out the best procedure for his/her host/pathogen conditions.

Nucleic acid hybridization is a new technique that detects plant pathogens based on the genetic information on their nucleic acid strands (RNA or DNA) (Owens and Diener, 1981). This procedure involves labeling of a specific piece of the nucleic acid with a radioactive or non-radioactive label, and its subsequent use to detect complementary nucleic acids present in the test plants. Compared to ELISA, the nucleic acid test is more specific since the diagnosis is based on unique genetic information in the organism. The need for the use of radioactive probes is the main factor that limits the use of this procedure for large scale screening. Large scale screening of plant samples would be possible especially when non-radioactive probes become available.

Recently, oxidation - reduction reactions have been exploited to set up a commercial test kit for the diagnosis of gram-negative bacteria that are pathogenic to plants (Biolog, Inc., CA). This is a simple, easy to use, computer-aided diagnostic procedure that can be done with the use of appropriate bacterial culture medium. Commercial kits for plant disease and mycotoxin diagnosis are available from the sources listed in Table 1.

REAGENTS AND OTHER MATERIALS

ELISA: The key reagents in ELISA (Clark and Adams, 1977) are the antibodies developed against a given pathogen in an animal such as rabbit, mouse, goat, or horse. Antibodies are proteins produced by these animals as part of the specific immune response to a foreign substance. Antibodies obtained by injecting a rabbit, for example, with Citrus Tristeza Virus (CTV) react specifically with CTV. These specific antibodies are used as probes for detecting CTV in citrus tissue. The G type immunoglobulin (IgG) of the antibodies isolated from the sera is divided into two parts, one to coat a solid phase, for example, a 96-well polystyrene plate, and the second part is used to make conjugated-antibodies by covalently binding an enzyme, for example, alkaline phosphatase. The IgG antibodies bound to the solid phase will capture the antigen particles (here, CTV) in the plant sap that is being tested. The addition of a conjugated antibody in turn detects and binds to the CTV particle forming a "sandwich," with CTV in the middle and antibodies on the two sides. Addition of a colorless substrate solution (eg. p-nitrophenol phosphate) into the test well results in a color reaction if the well contains a "sandwich" with an enzyme labeled antibody. If a sandwich is not present, there is no color reaction which means there is no CTV present. The intensity of the color is proportional to the number of sandwiches, ie. number of CTV particles present. The color intensity can be measured with a spectrophotometer. Thus, ELISA is capable of giving both qualitative and quantitative assessment of the pathogen in the test sample.

Monoclonal and polyclonal antibodies: The antibody produced in an animal followed by the injection of an antigen originates from several antibody-producing cell lines, hence, polyclonal antibodies. Polyclonal antibodies are very useful in broad spectrum assays for a given pathogen. The antibodies are not necessarily identical, however, they are capable of detecting certain antigenic determinants on the antigen. A monoclonal antibody is identical to the rest of the antibodies in the population, and all are derived from a single, cloned cell, hence monoclonal antibodies. Monoclonal antibodies are excellent tools for detecting specific strains of a pathogen, but they may not be universally appropriate for general screening of a pathogen comprised of several strains or types. The monoclonal antibody developed by Jordan and Hammond (Jordan and Hammond, 1988) is one of the exceptions to this; as it has very wide affinity to the

virus particle, and the system is capable of detecting the presence of several different viruses that belong to the PVY group of viruses. Monoclonal antibodies are available for diagnosis of viruses, fungi, and bacteria. So far, antibody systems have not been used for routine diagnosis of nematodes, however, monoclonal antibodies have been developed against secretory granules in the esophageal glands of *Meloidogyne* species (Hussey, 1989). Such systems could be useful in studying the disease mechanism associated with nematode infection.

Table 1. ELISA and other diagnostic kits that are available commercially.

VIRUSES & VIRUS-LIKE PATHOGENS		
Diagnostic kits	**Type**	**Source**
Fruit tree viruses	ELISA	Agdia Inc, IN
Cereal viruses	ELISA	"
Ornamental plant viruses	ELISA	"
Vegetable viruses	ELISA	"
Potato viruses	ELISA	"
Field crop viruses	ELISA	"
Spiroplasma citri	ELISA	"
Poty virus Group	ELISA	"
Potato Spindle Tuber Viroid	cDNA probe	"
FUNGI		
Phytophthora spp	ELISA	Agri-Diagnostics, NJ
Pythium spp	ELISA	"
Rhizoctonia spp	ELISA	"
Scleritinia spp	ELISA	"
BACTERIA		
Plant pathogenic bacteria	ELISA & Fluorescence	Adgia Inc, IN
Plant pathogenic bacteria	Redox reaction	Biolog Inc, CA
FUNGAL TOXINS		
Aflatoxin	ELISA	Neogen Corp, MI
T-2 Toxin	ELISA	"
Vomitoxin	ELISA	"
Zearalenone	ELISA	"

Direct and Indirect assays: As various modifications of immunoassays have been developed for plant disease diagnosis, the merits of using a particular system has to be tailored to suit the user's needs. The common form of ELISA is the direct sandwich method as described above. Indirect ELISA uses, for example, an enzyme or fluorescence-labeled goat antibody to detect a rabbit antibody bound to the pathogen; or a labeled protein A that binds to the Fc fragment of an IgG bound to the pathogen.

Nucleic acid probes: In nucleic acid hybridization tests, eg. for virus diagnosis, the key element is a complementary DNA (cDNA) probe prepared for a unique part of the genome of that virus. The cDNA will be used to detect complementary strands of nucleic acid in the test plants (Owens and Diener, 1981). cDNA probes are successfully used to screen potato tubers for the presence of Spindle Tuber Viroid. (Owens and Diener, 1981; Singh and Crowley, 1985).

DISCUSSION

Modern diagnostic tools based on serology and nucleic acid probes are invaluable tools that make disease diagnosis simpler and faster. Before these modern tools, typically a minimum of three or four days were required for a positive diagnosis, where as with ELISA, it is now possible to diagnose the association of a pathogen within few hours. The ability to screen large number of samples with minimum labor is helpful in disease management, epidemiology, and in breeding for disease resistance (Skaria et al., 1985; 1984; Clement et al., 1986). Also, these modern tools help clear some of the misconceptions in plant pathology and also generate new information regarding plant disease development (Skaria et al., 1985). The commercial availability of diagnostic kits; enzyme-labeled second antibody and Protein A, etc, make disease diagnosis a less cumbersome procedure and the simplicity of the tests make it universally applicable. Many antigens are stable enough for ELISA reactions (Lister et al., 1985), therefore, it is possible for an investigator in a country with no modern diagnostic tools to send "captured particles" of the pathogen via international mail without violating the quarantine regulations of the receiving country. The Poty virus monoclonal antibody system in plant disease diagnosis is a highly valuable single diagnostic tool that has the ability to diagnose the presence of different viruses that belong to one virus group.

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Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

REVIEW

Zinc Stress on Citrus

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Additional Index Words: nutrient foliar sprays, yield, fruit quality, vegetative growth.

ABSTRACT

Identification of citrus mottle-leaf in the early 1930's as an expression of zinc deficiency stimulated five decades of research to find the most effective measures to control the problem. So far, zinc foliar sprays have proven to be the best treatment, whereas, soil applications with zinc were disappointing in most cases. Severity of mottle-leaf appears to be the most important criterion determining citrus responses to corrective zinc foliar sprays. Severely affected trees are likely to respond with improvements in yield, fruit size, external and internal fruit quality, and tree vigor, but mildly affected trees may not respond at all. Edaphic conditions leading to high incidence of zinc deficiency are described as well as currently recommended measures to control the problem on citrus in Texas, California, and Florida.

A nutritional survey of citrus orchards was conducted in the lower Rio Grande Valley of Texas in the year following the devastating 1983 freeze. According to leaf standards proposed by Embleton et al. (1973), 100% of the samples were low or deficient in zinc (Swietlik and LaDuke, 1985). This survey and a widespread occurrence of mild zinc deficiency symptoms in the citrus orchards, provided the stimulus for a study aimed at assessing the economic significance of Zn deficiency. The data collected during the four-year-long study, as well as information previously generated in this and other citrus growing areas, prompted this review. Special emphasis is placed on describing conditions leading to the development of Zn deficiency, techniques to correct the problem, and explaining the possible reasons for variability in citrus responses to corrective measures. Most of the research data and observations presented, were generated in California, Florida, and Texas. Information collected on non-citrus crops is included, whenever such inclusions may clarify or add dimension to the subject. The information and interpretations can assist growers in optimizing the management of Zn stress problems in their orchards and may also be useful for those, in the scientific community, who are interested in zinc nutrition.

Factors Affecting Zinc Availability

It is estimated that the average total zinc concentration in the lithosphere is 80 ppm, which is low enough to classify zinc as a micronutrient. While total zinc is uniformly distributed in the soil profile, the available fraction decreases sharply with depth (Lindsay, 1972).

There is a high positive correlation between the amount of organic matter present in the soil and the amount of extractable or available zinc (Martens et al., 1966). This relationship may explain why severe cases of Zn deficiency in citrus have been observed in areas where the surface soil has been removed during leveling (Parker, 1935; Swietlik, unpublished observations). Under south Texas conditions, uncovering highly calcareous layers of soil, can also contribute to Zn deficiency (Navrot et al., 1967; Navrot and Ravikovitch, 1969).

Two explanations are offered to account for high zinc deficiency incidence on calcareous soils. First, the solubility of Zn decreases with an increase in pH. Soils containing free calcium carbonate, i.e. calcareous soils, fall in the pH range of 7.4 and higher (Lindsay, 1972). The soils considered most suitable for citrus in Texas (Brennan, Hidalgo, and Willacy series) are calcareous throughout or only in the deeper part of the soil profile, with pH ranging from 6.6 to 8.4. (United States Department of Agriculture, 1981). According to Lindsay and Norwell (1969) and Lindsay (1972), the solubility of Zn in soils decreases 100-fold for each unit increase in pH. Using their model, I have estimated that the concentration of soluble zinc in citrus soils in Texas range from 0.001 ppb (parts per billion) at pH 8.4 to 0.7 ppb at pH 7.0. Thus, the higher the pH, the greater the probability that Zn deficiency will develop. Nutrient solution studies on sour orange seedlings (Swietlik, unpublished) revealed that a Zn concentration > 0.001 ppb is needed to sustain normal seedling growth. Comparing this figure with soil soluble Zn concentrations helps to explain why the more alkaline conditions lead to higher incidence of zinc deficiency. The second theory explaining widespread Zn deficiency on calcareous soils is based on the absorption of this element on calcium carbonate, which depresses Zn availability to the plants (Jurinak and Bauer, 1956; Navrot et al., 1967; Navrot and Ravikovitch, 1969).

Sandy, acidic soils are inherently low in total zinc content (Lindsay, 1972), because quartz is generally low in this element. Leaching, under high rainfall, further contributes to zinc depletion. These conditions prevail in most Florida orchards where zinc deficiency is a problem.

Our observations in Texas indicate that symptoms of zinc deficiency are frequently found on citrus where soils create restricted root zones due to hardpans, soil compaction and/or poor drainage. Similar observations were also noted on citrus in California (Parker, 1934) and elsewhere on other plant species (Lindsay, 1972). The restriction of the feeding zone of newly planted citrus trees may also contribute to their higher sensitivity to Zn deficiency.

Some California researchers (Parker, 1935; Labanauskas et al., 1963) and observations in Texas (Swietlik, unpublished) indicate that zinc deficiency on citrus are more pronounced during the cooler, winter months. Labanauskas et al. (1959) found that orange leaves sampled in May through November had higher Zn concentrations than those sampled from December to April the following year. Since only spring cycle leaves were sampled, their age increased with each subsequent collection. Thus, the changes in Zn concentration reflected not only seasonal changes but also changes in

leaf age. The two could not be separated. In Texas, where citrus trees produce several flushes of growth during a year, Leyden and LaDuke (1984) analyzed, at monthly intervals, matured grapefruit leaves formed during the most recent cycle of growth. With this approach, they found no clear seasonal trends in leaf Zn concentration.

The fact that fertilizer practices may have a significant effect on leaf Zn levels in citrus trees should be taken into account when interpreting results of leaf analysis. Heavy nitrogen fertilization was reported to intensify Zn deficiency of citrus in California and Florida (Reuther and Smith, 1950; Smith et al., 1954; Parker, 1934) but Labanauskas et al. (1960) found no such relationship, presumably because of a high zinc level in the soil of the experimental site. Under the same conditions, however, phosphorous fertilization reduced Zn leaf level suggesting that P has a much more dramatic effect on Zn than nitrogen. Also, earlier studies with citrus indicated a negative effect of P on Zn (Bingham and Martin, 1956; Reuther and Crawford, 1946) but the relationship was insignificant in citrus trees grown on acid, sandy soils in Florida (Reuther et al., 1949). The existence of an antagonism between phosphorus and zinc has also been found in other plant species (Rudgers et al., 1970). In Texas, phosphorus fertilization of citrus is either none or minimal, thus inducing Zn deficiency by overfertilization with phosphorus is improbable. So far, N has been identified as the single, most limiting nutritional factor for citrus in Texas. Consequently, the rates of that element should be adjusted to optimize yields and fruit quality rather than to maximize Zn accumulation in trees. Though the deficiency of the latter should be corrected with different means, unnecessary overuse of nitrogenous fertilizers, however, should be avoided.

Patterns and Correction of Zinc Deficiency

Zinc deficiency results in yellowing of the areas between the leaf veins, while the leaf tissue adjacent to the midrib and main lateral veins remains green. These symptoms are frequently referred to as leaf mottling and the condition is called "mottle-leaf" or "frenching". At very acute stages, the leaves become narrow and small with chlorosis affecting the whole leaf surface. Under severe Zn deficiency, the new growth may be greatly inhibited and sparse, leading to defoliation and shoot dieback. Yield and fruit size are reduced, fruit shape is abnormal, juice content is reduced, and rind thickness is increased (Parker, 1937b). Such severe stages of Zn deficiency are rarely encountered in Texas. Most often the mild symptoms, consisting of several shoots with mottle-leaf per tree canopy, are encountered. The symptoms are more pronounced on orange than grapefruit trees and on the south rather than the north side of the tree. Recently, Zhang and Wu (1989) reported that at higher irradiance, plants require more Zn for normal growth but the mechanism of that relationship was not explained. In Texas, leaf samples collected from orchards with mild zinc deficiency typically contain 12-20 ppm Zn on a dry weight basis (Leyden and LaDuke, 1984; Swietlik and LaDuke, 1985).

Early investigations on mottle-leaf in California concentrated on the use of massive soil applications (50-75 lbs per tree) of ferrous sulfate (Parker, 1934). Chandler et al. (1931) discovered that ferrous sulfate treatment was able to correct a problem of "little-leaf" on deciduous trees. The etiology of that disease was believed to be the same as that of citrus mottle-leaf. The reversal of symptoms was explained by the presence of zinc impurity in a technical grade of ferrous sulfate rather than by

the presence of iron. Soon, this finding was confirmed on citrus (Parker, 1934).

This discovery was followed by an exploration of various zinc application techniques to citrus such as: soil dressing, trunk injections, and foliar spray treatments (Parker, 1934). Soil applications proved unpredictable and at times injurious to the trees because they required the use of massive rates of zinc sulfate. Similarly, trunk injections of zinc crystals cr a solution of zinc sulfate were found to be commercially not feasible due to phytosanitary considerations and technical difficulties with the injection. On the other hand, foliar sprays with zinc sulfate produced satisfactory results and gained widespread acceptance.

Early trials in California consisted almost entirely of severely affected trees (Parker, 1934, 1935, 1936) with as much as 68-100% of tree foliage mottled (Parker, 1937a, 1937b). Most of those trees were low in vigor, showed shoot dieback, and produced below average yields of poor quality. In grapefruit, this was characterized by small fruit size of abnormal shape, thick rinds with resinlike formations, and low juice content (Parker, 1937b). Under those conditions, a single foliar spray with zinc sulfate was sufficient to eliminate or greatly reduce mottle-leaf, increase tree vigor, yield, and fruit quality (Parker, 1934, 1935, 1936, 1937a, and 1937b). In one experiment, the yield of severely affected grapefruit trees increased 5.5 fold following a single zinc foliar spray applied during bloom in early March (Parker, 1937b). Blossom density was not affected which points out the fact that the yield increase resulted from increased fruit set and fruit size. Less spectacular yield responses were noted on grapefruit trees moderately affected by mottle-leaf (approximately 30-40% of foliage showing symptoms) (Parker, 1937b). In these cases, yields increased by 20% and fruit number by 14% with fruit size showing only a mild increase, as indicated by the average number of fruit per field box decreasing by 4.9%. On grapefruit trees with only 5-10% of the foliage showing symptoms, a single foliar spray with zinc sulfate during anthesis gave yield increases of only 10% (Parker, 1937b). The author concluded that, "mild symptoms of mottle-leaf are accompanied by only slight decreases of yield."

In early studies on alleviating Zn deficiency, the efficacy of various zinc materials, concentrations, volumes of spray, time of application, and inclusion of spray additives were tested (Parker, 1937a). The duration of the response to zinc foliar sprays was prolonged when higher concentrations of chemicals were used, when applications were made before major flushes of growth, and when high volume of sprays were employed. Various materials such as zinc sulfate, metallic zinc dust, zinc oxide, zinc sulfide, and zinc carbonate were found equally effective when used as foliar sprays at equivalent zinc concentrations. Dusting the leaves with finely divided metallic zinc or various insoluble zinc compounds was generally less effective than foliar sprays.

Early recommendations for Zn foliar sprays in California called for 10 lbs of $ZnSO_4 \cdot 7H_2O$ plus 5 lbs of lime in 100 gallons of water (Parker, 1937a). The addition of lime was necessary to prevent leaf injury from excessive Zn concentrations; the lime acted as a precipitating agent. Although such sprays were effective, negative side effects, given below, were noticed. Addition of zinc materials to an oil pesticide spray was found to negatively affect the spreading properties of the latter. Moreover, heavy deposits on leaf surfaces from a combination of zinc sulfate and lime resulted in a build-up of citrus mites and scale insects (see papers cited by Embleton et al. 1965). Additionally, zinc foliar sprays had to be repeated every year

due to limited or no Zn translocation from sprayed to unsprayed new leaves (Labanauskas et al., 1961, 1963, 1964, 1969a; Leyden and LaDuke, 1984; Embleton et al., 1988; Stewart et al., 1955; Smith, 1966).

The setbacks mentioned above renewed interest in soil Zn application in California (Embleton et al., 1965) and Florida (Leonard et al., 1958; Steward and Leonard, 1963) but their effectiveness was never clearly established. In one study in Florida, however, when zinc sulfate was broadcasted and ploughed in around 2-year-old orange trees, significant increases in leaf zinc were observed during the next 5 years (Smith and Rasmussen, 1959). The rate of zinc ranged from 25 to 150 lbs/acre. Apart from the elevated leaf zinc, no other benefits were reported.

Limited movement of ionic zinc in the soil is the primary reason for poor effectiveness of soil treatments with various zinc salts. The use of chelated sources of Zn on Florida's acidic soils did not produce desired results either (Stewart and Leonard, 1963). Under those conditions, zinc chelates easily revert to iron chelates (Lindsay, 1972). Under neutral or slightly alkaline conditions, however, ZnDTPA chelate may be expected to produce good results (Lindsay, 1972), but the author knows of no study on citrus to support this hypothesis.

Labanauskas et al. (1969) developed low residue zinc foliar sprays using diluted solutions of zinc sulfate (36% Zn) without lime addition. Foliar sprays at 1 lb $ZnSO_4$ (36% Zn) per 100 gal of water proved to be effective in elevating leaf zinc level up to 75 ppm and in correcting zinc deficiency symptoms. At the same time they caused no leaf or fruit injury and left no visible residue on sprayed leaves.

In California, foliar sprays with zinc sulfate to moderately deficient 'Valencia' and 'Washington' navel orange trees, and symptomless 'Eureka' lemon trees did not result in fruit yield increases, although, leaf symptoms were successfully eliminated or reduced (Embleton et al., 1965, 1988; Labanauskas et al., 1963; Labanauskas and Puffer, 1964). No effect on fruit quality was noted with the exception of Valencia trees whose fruit showed reduced juice content as a result of Zn treatment (Labanauskas et al., 1963). The concentration of Zn in unsprayed leaves were: 14 ppm for Valencia orange (Labanauskas et al., 1963), 12-15 ppm in another experiment with Valencia orange (Labanauskas and Puffer, 1964), 12-23 ppm for Washington navel (Embleton et al., 1988), and 11-13 ppm for Eureka lemon (Embleton et al., 1965). The common characteristic of the trees used in those experiments was their moderate expression of zinc deficiency or, in the case of lemons, their absence. The latter was somewhat surprising since leaf analysis indicated a serious deficiency.

In Florida, Griffiths and Enzor (1953) reported no effect of one or two annual zinc foliar sprays on vegetative growth and fruiting of young Valencia orange trees planted in a sandy soil typical of the Lakewood series at Lake Placid. However, Zn nutritional status of the trees was not given. The experiment was conducted over four years. Wutscher and Obreza (1987) reported that the omission of two annual foliar sprays with zinc and manganese over 7 years and that with iron over 4 years did not affect vegetative growth and fruiting of 'Pineapple' orange trees, despite the fact that Zn and manganese leaf levels dropped to deficient ranges for 3 to 4 years. However, leaf symptoms of deficiency of those elements were not noted.

In Texas, Leyden (1983) and Leyden and LaDuke (1984) reported no response in yield or in fruit size to one or two annual foliar sprays of zinc applied in May or May

and July on grapefruit ('Ruby Red' or 'Star Ruby') or 'Marrs' orange trees. They used $ZnSO_4$ and a zinc chelate at concentrations equivalent to 432 and 187 ppm metallic zinc, respectively. The unsprayed trees showed only moderate zinc deficiency symptoms, which were successfully eliminated or reduced by the treatments. The experiments were 3 to 7 years long. Zinc leaf levels in unsprayed trees ranged from 16 to 23 ppm in Ruby Red grapefruit and 11-18 ppm in Marrs orange. The Zn level in unsprayed Star Ruby trees was judged low or deficient based on leaf standards but it was not specified.

In the most recent experiments in Texas, zinc foliar sprays to Ruby Red grapefruit and Valencia orange trees, with approximately 1-2% of leaves mottled, did not induce significant responses in yield, fruit size, and vegetative growth during the 4-year experimental period (Swietlik, unpublished). Depending upon the year of study, from one to three foliar sprays with zinc sulfate were applied at concentration equivalent to 216 ppm metallic zinc. The latter schedule was designed to maximize the number of flushes covered by the sprays. The sprays were effective in correcting leaf symptoms and elevating leaf Zn content to an optimum range. Very limited, yet statistically significant, movement of zinc from sprayed to new foliage was observed. In unsprayed trees, zinc leaf concentration ranged from 13 to 26 ppm in Valencia orange, 12-26 and 17-46 ppm in Ruby Red grapefruit in two separate experiments, respectively.

In another experiment in Texas, small growth increases were realized from combined zinc, manganese, and iron foliar sprays applied three times at monthly intervals to mature Ruby Red grapefruit trees (Swietlik and LaDuke, 1985). The trees were seriously injured by freeze in the preceding year and were severely pruned back to crotches between the trunk and main limbs. All three elements were low in the foliage of unsprayed trees (Zn-19 ppm, Mn-23 ppm, Fe-59 ppm) but the expression of deficiencies was very mild. Experimental design did not permit determining which element contributed the most to the response.

Zinc Spray Recommendations

To correct deficiency, zinc foliar sprays may be applied at any time during the year but low temperatures during winter will limit the rate of foliar absorption. Since young foliage most effectively absorbs zinc, application at the end of major flushes of growth will be most beneficial. From the stand-point of fruit production, the end of spring cycle growth or shortly thereafter appears to be the most critical timing.

Zinc foliar spray recommendations vary between citrus producing states. In Florida, one or two foliar sprays are recommended in the form of zinc sulfate or zinc oxide (Koo, 1984). The first spray should be applied during the post-bloom period. The standard concentration is 1200 ppm metallic zinc which corresponds to 2.8 lbs zinc sulfate (36% Zn) per 100 gal of water.

In California, the standard concentration is 430 ppm metallic zinc which is equivalent to 1 lb of zinc sulfate (36% Zn) per 100 gal of water (Platt, 1981; Meith, 1982). Treatment of the spring flush of growth is recommended when it is two-thirds to almost fully expanded. Under severe deficiency conditions, treating subsequent flushes of growth is recommended.

In Texas, an application of zinc foliar spray by the end of bloom is recommended. If symptoms persist, as might be the case under conditions of a severe deficiency, the

sprays should be repeated at the end of summer and fall growth flushes. The latter may be especially needed, since deficiency expression is usually most severe during the winter months. Orchards with a history of severe deficiency, may require one maintenance spray by the end of bloom or in the post-bloom period to prevent the reoccurrence of symptoms. The standard concentration is 216 ppm metallic zinc when zinc sulfate is used. This concentration is equivalent to 0.5 lbs of zinc sulfate (36% Zn) per 100 gal of water. While higher concentrations of zinc sulfate applied at bloom occasionally induce mild leaf speckling on grapefruit, the low concentration spray has proven satisfactory in controlling deficiency symptoms and elevating the leaf concentration of zinc to an optimum range. The use of a suitable, nonionic, wetting agent in the tank mix is recommended. When proprietary zinc products are used, the concentrations employed should be those recommended by the manufacturers.

CONCLUSIONS

The severity of zinc deficiency symptoms appears to be the most important criterion determining the responses of citrus trees to corrective zinc foliar sprays. When 5-10% or more of the leaves are affected, yield, fruit quality, and vigor are likely to improve with sprays. Mildly affected fully grown trees, showing mottle-leaf on several shoots within the canopy, are not likely to respond to zinc foliar sprays.

In the absence of deficiency symptomatology data, judging the tree zinc nutritional status based only on the results of leaf analysis and current leaf standards, may not be sufficient to accurately predict tree responses to zinc foliar sprays. This fact should not lessen the importance of leaf analysis as the most reliable diagnostic tool, especially in situations involving multi-nutritional disorders. Results on citrus are somewhat similar to those reported for deciduous fruit trees (Swietlik and Faust, 1984).

In most cases soil applications of zinc materials are not effective in controlling zinc deficiency on citrus. Under Texas conditions, the most severe cases of zinc deficiency are likely to occur in leveled areas where a significant amount of the top soil has been removed and the uncovered soil layer contains high level of calcium carbonate.

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ABSTRACT

Post-Harvest Treatments for Mexican Fruit Fly Control on Citrus: An Update

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For 30 years, the fumigant ethylene dibromide (EDB) was used against the Mexican fruit fly, Anastrepha ludens (Loew), hereafter called the fly, which is endemic to Mexico, Central and South America, and a quarantine pest of citrus in the United States. In 1984, EDB was banned as a post-harvest treatment of citrus. A schedule for methyl bromide (MB), a substitute fumigant, was approved in 1984 as a post-harvest treatment of grapefruit, orange, and tangerine against the fly. The approved schedule for MB, 40 g/m³ for 2 h when fruit flesh or pulp temperature is greater than 21.1°C (70°F), kills 99.9968% of the eggs and larvae of the fly within fruit.

Most fly eggs, laid in the host grapefruit, hatch within 4 days and during the next 20 to 40 days develop into first, second, and third larval stages, (approximately 0.5 to 1 cm in length) before leaving the fruit to pupate. Thus, any or all of the immature stages of the fly might be present in harvested grapefruit.

An effective post-harvest treatment must kill 99.9968% of the insects in a load of 25,000 to 50,000 fruit, (this percentage is considered to be 100% at the marketplace). Standards for Texas grapefruit and oranges dictate "worm-free" fruit.

The Animal and Plant Health Inspection Service of the United States Department of Agriculture is responsible for approving schedules for post-harvest treatments. They have approved two treatments for citrus fruit against the Mexican fruit fly. The first and oldest treatment is cold storage, and the second is MB. Cold treatment was approved in the early 1930's, 20 years before the EDB treatment approval. Cold storage treatment is rarely used today except when fruit are shipped overseas.

Methyl bromide and cold postharvest treatments against the fly as well as the irradiation of infested fruit and exposure of the fruit to phosphine gas, are currently being tested on citrus at our laboratory in Weslaco to assure their ability to achieve quarantine security. Irradiation, fumigation, and cold storage treatments are single treatments, but a postharvest treatment combination of cold storage with MB has shown promise. Four days of 10 to 12.2°C cold storage will provide 80% kill coupled with a dosage of MB (lower than 40 g/m³) will kill the remaining 20%.

In summary, the approved MB treatment is comparatively inexpensive and requires only 2 hrs of treatment time to kill greater than 99.9968% of the fly. Irradiation treatment at 25,000 rads requires even less time, but requires an expensive adequate facility with proper security. Phosphine treatment, at 0.125 g/m³ requires 2 or more days, and cold storage treatment requires 14 days at 10-12.2°C to achieve 99.9968% fly kill.

Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

ABSTRACT

The Effect of Narrow-Row Culture on Cantaloupe Yield and Quality

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Melons are usually produced in the Texas Rio Grande Valley on beds constructed at 80" centers. However, specific locations within other areas such as Arizona and California have produced melons on narrower bed spacing including 60" centers without adversely affecting quality or yield. Spacing on the available equipment seems to determine the bed spacing used by a given producer. Other crops such as cotton, sorghum and corn are successfully grown in the Texas Rio Grande Valley on narrow-row spacing. Therefore, plots were installed to compare melon production on narrow spacing (30" rows to make 60" beds) and conventional spacing (40" rows to make 80" beds). Certain beds were also lateral-pruned to determine the effects of reduced vine growth on melon yield and quality. Each plot was harvested 3 times over 10 days taking only the ¾ to full slip melons. Soluble solids and melon size were the same regardless of spacing. The yield per acre with 60" bed spacing was 37% greater than with conventional 80" bed spacing. The 37% increase in yield is achieved with a much smaller percentage increase in establishment and harvest costs. Lateral pruning provided no detectable advantage but at the same time had no adverse effect on yield. Reduced bed spacing represents a major economic opportunity for melon producers in the Texas Rio Grande Valley.

ABSTRACT

The Evaluation of Production Practices in Early Season Lettuce

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Early season lettuce in the Rio Grande Valley is planted in the months of September and October, and usually harvested in late November and December. This early production period is characterized by a number of problems including: erratic stand establishment due to heat dormancy of the seed, tip-burn, premature bolting, and irregular maturity. All of these cultural and physiological disorders are related to high average temperatures (75-80°F) that persist in the late summer and early fall. The purpose of this study was to evaluate these traits for a number of different cultivars and production practices used to reduce these problems.

Eight cultivars including: 'Acacia', 'Empire', 'Excell', Great Lakes 659-MI', Great Lakes 659-700', 'Valtex 39', Valtex 40', and 'Viva' were evaluated on fine sandy loam soils in Starr County near Rio Grande City. The effect of direct seeding was compared to transplanting for stand establishment, yield, and uniformity at maturity. Comparisons were made among and within treatments and cultivars. Among the seed treatments, raw seed produced a significantly more erratic stand then either primed or coated seed, which did not differ statistically. Transplanted plots produced the most uniform stands. The yield of transplanted plots averaged 701 boxes/acre, while direct seeded plots averaged only 368 boxes/acre. 'Valtex 39' produced the highest yield when transplanted (800 boxes/acre), but the lowest yield when direct seeded (258 boxes/acre). The 'Great Lakes' cultivars were intermediate. The uniformity of maturity was best in the transplanted fields and only required two harvests to collect 80• of the harvestable heads, while the direct seeded plots required three harvests for the same result. The incidence of premature bolting was lowest for 'Valtex 39' and 'Valtex 40'; and no differences existed for head solidity among any of the cultivars. 'Valtex 40' and 'Great Lakes 659-MI' had the least amount of tip-burn while 'Excell' had significantly more lesions.

Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

ABSTRACT

Breeding Beans For Virus Resistance

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Virus diseases of crops are fundamentally different from bacterial and fungal disorders, and potentially more serious. These disorders often require unique management methods that include: regulatory controls, remedial use of pesticides, and genetic resistance. Regulatory measures such as crop-free periods and the elimination of alternate hosts are useful methods but not guaranteed. Pesticides can augment the regulatory process by eliminating the virus vectors and alternate hosts, although this approach is expensive and never completely effective. The development of genetically resistant cultivars is the safest, easiest, and most economical way to protect crops from virus diseases.

*The purpose of this research was to incorporate resistance to Bean Yellow Mosaic Virus (BYMV) and Clover Yellow Vein Virus (CYVV) into a standard common bean (**Phaseolu vulgaris** L.) cultivar. These viruses are two of the more important diseases of common beans, and are capable of causing substantial crop losses. Resistance was incorporated into 'Midnight,' a standard dry black bean cultivar grown throughout North America. Resistance to BYMV is conferred by the dominant **By-2** gene available in 'Great Northern 1140'; while resistance to CYVV is conferred by the recessive **cyv** gene and found in breeding line B-21.*

*The **By-2** gene was incorporated into 'Midnight' using a standard backcross procedure. In the fourth backcross generation (BC-4) resistant plants were selfed, with the progeny tested and resistance confirmed in BC-4F_2 and BC-4F_3, respectively. The **cyv** gene was transferred to 'Midnight' using the simultaneous self and backcross method through the BC-4 generation. Resistant individuals were identified in BC-4F_2 and confirmed in BC-4F_3. New virus resistance breeding lines will be available in late 1990.*

Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

ABSTRACT

Cut Flowers in the Rio Grande Valley

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A series of cutflower cultivar demonstrations were began in August, 1988 to provide information on cutflowers that would be current and relivant to the Lower Rio Grande Valley. Criteria for cutflower crop selection are as follows:

1. *Can be produced in fall through spring when demand and prices are highest.*
2. *Adaptable to native soil and water without too many amendment modifications.*
3. *Will grow under Lower Rio Grande Valley high light intensity and temperatures when establishing the crop in late summer.*
4. *Tolerant of local disease and insect pressures without excessive demands on pesticide use.*
5. *Adaptable to growing in field conditions.*
6. *Availability of adapted cultivars in the selected crops.*

Chrysanthemums (Mums) were selected as the first crop to be considered. Seventeen standard mum cultivars were planted in a randomized completed block design and evaluations were made during growing, disbudding and flowering stages. Mums will fit into the six criteria established for cutflower crop selection in the Lower Rio Grande Valley. Of the seventeen cultivars evaluated, eleven cultivars were selected for field grown standard mum production possibilities.

Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

ABSTRACT

Effect of Water Salinity on Rooting Woody Ornamental Cuttings

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Shoot tip cuttings of Buxus microphylla 'Japonica' 10 to 12 cm in length were taken in February, April, June, October and December from stock plants grown under 70% full sun. Factorial rooting experiments were conducted consisting of two sources of mist water (electrical conductance of 0.96 to 1.50 and 0.01 to 0.03 mg/cm^{-1}) and five levels of IBA (0, 1250, 2500, 5000, and 10000 ppm). Cuttings were rooted in a mist propagation bed and then evaluated. Rooting percentages were highest when cuttings were taken in April, June and October. Misting with the low salinity water increased percentage rooting and root fresh weight compare to high salt water, and was most effective for cuttings taken in June and October. Cuttings not treated with IBA had 68% maximum rooting (June) under low salt mist, whereas misting with the high salt water resulted 24% maximum rooting (October). High IBA concentrations (2500 ppm or greater) generally increased rooting percentage, number of roots per cutting, root length and root fresh weight. Pittosporum tobira shoot tip cuttings taken in February had better rooting than those taken in June. Rooting June cuttings under low salt mist resulted in much improved rooting performance over that rooted under high salt water mist, whereas this difference was not observed in February cuttings.

Journal Rio Grande Valley Horticultural Society, Vol. 42, 1989.

ABSTRACT

Protecting Tropical Foliage Plants from Ethylene-Induced Leaf Drop

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Ethylene is a plant hormone produced as a gas by ripening fruit and during combustion of petroleum fuels. As a hormone, ethylene is active in concentrations as low as 1/100 part ethylene per million parts (ppm) of air. Ethylene is notorious for causing premature death of cut flowers and leaf drop in a number of horticultural plants. 'China Doll' is a newly developed tropical foliage plant with major economic potential as a retail horticultural product. However, severe leaf drop occurred at certain retail outlets within 3 to 7 days after arrival of a 'China Doll' shipment. Similar plants held at the nursery facility retained all leaves. The rapid leaf drop was not triggered by low light or lack of water. Plants exposed to only 0.5 ppm of ethylene for 24 hours lost all leaves within 3 days. If the plants were first sprayed with 0.125 mM silver thiosulfate (STS), leaf drop was completely prevented even at 2 ppm of ethylene. Higher concentrations of STS which blocks the action of ethylene on plants caused severe leaf burn. Treatment of 'China Doll' with STS effectively prevented leaf drop in response to ethylene contamination produced during transport or at the retail location.

Memorial

Dr. James R. Thomas

1920 to 1989

USDA-ARS Research Soil Scientist

James R. "Dick" Thomas' career in agriculture spanned more than 40 years from its early bringing at Brigham Young University in the 1940's. Dick's pursuit of a B.S. degree in Agronomy was interrupted by World War II and from 1941 to 1945 Dick served in the U.S. Merchant Marine. At the War's end, he returned to BYU and completed his B.S. in 1946 and his M.S. in 1947 in Agronomy. Following completion of his M.S., Dick became a Research Agronomist with the Army Chemical Corp's Research and Development section. He stayed in this position until 1951 when he entered Washington State University to pursue a Ph.D. degree in Soil Science. Dick worked as a Research Assistant and an Experimental Aid while at WSU. In 1955 he completed the Ph.D. program and soon accepted a position as Soil Scientist with the USDA-ARS at Newell, S.D. At Newell, Dick's research focused on the improvement of forage quality and vigor under dryland conditions. Dick transferred from S.D. to Weslaco, Texas in 1958. During his tenure at Weslaco, Dick achieved a rating of GS-14 and served as Research Investigation Leader for two years guiding investigations into the interactions of soil fertility and salinity with plant nutrition. Dick's research efforts lead to significant contribution in the areas of remote sensing, soil and water research and soil-water-plant interactions. Among these many accomplishments were several of importance to agricultural production in the Lower Rio Grande Valley of Texas. His research efforts showed that sweet pepper fruit yields and susceptibility to bacterial soft rot both increased with nitrogen fertilization and that leaf nitrogen concentrations decreased markedly with the onset of fruiting. This observation allowed production to control soft rot during shipping by applying the bulk of nitrogen fertilization early in the season. Dick demonstrated that fertilizer use efficiency could be improved by adjusting application rates to account for irrigation water regime, crop residue and residual fertilizer. He developed a method for determining the nitrogen fertilizer requirements for leveled soils based on the soils capacity to mineralize nitrogen.

Dr. Thomas' research on irrigation and fertilization of sugarcane made a substantial contribution to the current recommendations for sugarcane management in the LRGV. This research enhanced the understanding of the relationships among nitrogen fertilizer rates, irrigation-water regime, row spacing, juice quality and cane and sugar yields. The end result of these investigations was an improved efficiency in sugarcane production in south Texas.

It is not possible to detail the full extent of Dick Thomas' contribution to the advancement of agriculture. His wisdom and insight will be greatly missed by his friends and colleagues and the agricultural community of the LRGV.

Call for Papers

Papers are requested for inclusion in Volume 43, 1990 of the Journal of the Rio Grande Valley Horticultural Society. Manuscripts of a scientific or practical nature pertaining to horticulture will be considered for publication. All papers, including written versions of presentations from the Annual Institute, will be subject to review. Separate guidelines for the preparation of research and non-research papers are printed in the back of this issue. The deadline for submission of papers for Volume 43, 1990 is 1 July 1990. Manuscripts for publication in the Journal may be sent to:

Journal Editor
Rio Grande Valley Horticultural Society
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Guidelines for Authors
Non-Research Reports

Papers not specifically presenting research data are acceptable for publication. Field demonstrations, historical documentation, reviews, observations, etc. will be considered. While not necessarily following the format outlined for scientific research papers, non-research papers will be subject to peer review prior to acceptance. Reviewers will evaluate usefulness of the information, readability, and the manuscript's contribution to the goals of the Journal.

Non-research papers should be well organized, concise, and free of grammatical or typographical errors upon submission. Organization of non-research papers may depend on the information presented and should follow chronological or other logical order. Headings and subheadings may be utilized for organization. Headings should be capitalized and centered, while subheadings with the first letter capitalized should be placed at the head of the paragraph and underlined. An abstract summarizing the paper should precede the text as with research papers. Guidelines for research papers may be followed as they apply. Photographs, figures, and tables are encouraged to supplement the text. Page charges for non-research papers are $5.00 per page.

At least one author must be a member of the Rio Grande Valley Horticultural Society. All manuscripts for publication and further questions regarding submission of papers may be sent to:

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

Guidelines for Authors
Research Reports

Submit three copies of manuscripts doubled-spaced, including literature cited, tables, 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: Scientific research findings and observations, review or technique articles, reports of new pests or diseases, variety releases, etc., are acceptable for publication. Manuscripts of papers presented at the Annual Institute are encouraged. Research data previously published by the author may be submitted, subject to review by the editorial committee. Acceptance of manuscripts presenting previously published information will be based on usefulness of the information to Journal readers and the availability of the original publication. If the data have previously been published, copies of reprints should be included when the manuscript is submitted.

Papers should relate to horticultural topics. Manuscripts dealing with non-horticultural crops are acceptable if some application to horticultural science is evident. All manuscripts are subject to peer review by two associate editors who may seek additional reviews by appropriate specialists. Final approval for all manuscripts rests with the Journal Editor, and additional peer reviews may be used as required. Acceptance of a manuscript may depend on some revision following review. Manuscripts should be subjected to internal review prior to submission to the Journal, and the names of reviewers should accompany submissions.

At least one author of the paper must be a member of the Rio Grande Valley Horticultural Society. Invited papers are not subject to this requirement. Page charges for research papers are $15.00 per printed page.

Manuscript preparation should follow the style used by the Journal of the American Society for Horticultural Science. Specific guidelines for preparation of research papers follow:

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

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

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

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

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

The body of a research paper should be divided into sections such as **materials and methods, results, discussion,** followed by **acknowledgements** and **literature cited,** or other appropriate headings. Subheadings with the first letter capitalized may be placed at the beginning of paragraphs and underlined.

Names of proprietary substances, materials, and special apparatuses should be followed by parenthesized 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 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.).

Statistics: When treatments are a set of unrelated materials such as chemicals or varieties, Duncan's multiple range test or other multiple comparisons are appropriate. When treatments are a progressive series, such as rates, regression analysis is used. Factorial treatments are properly separated into main effects and interactions. For current statistical thought the following are cited:

Bryan-Jones, J. and D.J. Finney. 1983. On an error in "Instructions to Authors." HortScience 18:179-282.

Johnson, S.B. and R.D. Berger. 1982. On the status of statistics in Phytopathology. Phytopathology 72:1014-1017.

Peterson, R.G. 1977. Use and misuse of multiple comparison procedures. Agronomy J. 69:205-208.

Literature Cited: The Harvard System (author and date) of literature citation is used according to the guidelines for preparation of research papers for the Journal of the American Society for Horticultural Science. This system calls for citing the name(s) of author(s) and the year of publication in the text. Following the discussion section, and the heading literature cited, list citations alphabetically with hanging indentations. (See literature cited for statistics for example of listing citations).

Aims and Objectives of the Society

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

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

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

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

Anyone interested in horticulture can become a member of the Society. The annual dues of $10.00 include a subscription to the *Journal.* Subscriptions by institutions and libraries are $15.00 a year. Applications for membership or subscriptions should be sent to the Secretary, Rio Grande Valley Horticultural Society, Box 107, Weslaco, Texas 78596.

History of the Arthur T. Potts Award

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

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

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

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 such 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/Small Businesses	$ 10.00
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 as follows:

Citrus and Special Fruits
Vegetables
Ornamentals
Gardening and Landscape.

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 horticuture 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 Rule 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 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 appoint 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

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 in-

dividual Sections. These Sectional Committees shall be known as the Citrus and Special Fruits Committee, the Vegetable Committee, the Ornamentals Committee, and the Gardening and Landscaping 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 subcommittees 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.

1. *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 18 January 1983 by the Horticultural Society.

RIO GRANDE VALLEY HORTICULTURAL SOCIETY MEMBERSHIP, 1989

SPECIAL CONTRIBUTORS

AM-AG, Inc., Edinburg, Texas
CIBA-GEIGY Corp., Charlotte, N.C.
Dow Chemical Co., Midland, Michigan
Dupont & Co., Atlanta, GA
FMC Corp., Atlanta, GA
Kinney Bonded Warehouse, Donna, Texas
Merck Sharp & Dohme, Wilmington, DE
Mid-Valley Chemicals, Weslaco, Texas
Mid Valley State Bank, Weslaco
Mobay Corp., Kansas City, MO
ROHM & Haas Co., Philadephia, PA
Rhone-Poulene Ag Co., Research Triangle Park, N.C.
Texas Citrus Exchange, Mission, Texas
Valco Chemical Co., Harlingen, Texas
Wilbur Ellis-Tide Division, Edinburg, Texas

HONORARY

Dr. R.H. Cintron, Mercedes
R.T. Correa, Weslaco
Raymond Cowley, Weslaco
Stanley B. Crockett, Jr., Harlingen
Herbert A. Dean, Weslaco
George Godfrey, Prescott, AZ
R.A. Hensz, Weslaco
A.H. Karcher, Jr., Edinburg
Paul Leeper, Weslaco
Norman Maxwell, Weslaco
Charlie Rankin, Edinburg
Noel E. Ryall, Los Fresnos
George D. Schultz, McAllen
A.V. Shull, Edcouch
Bailey Sleeth, Weslaco

SPECIAL CONTRIBUTORS

Bentsen Development Co., Mission
Edinburg Citrus Association, Edinburg
Kinney Bonded Warehouse, Donna
Mid-Valley Chemicals, Weslaco
Mid Valley State Bank, Weslaco
Stuart Place Nursery, Harlingen
Tide Products, Inc., Edinburg

PATRONS

Barbee-Neuhaus Imp. Co., Weslaco
Ciba-Geigy, McAllen
Crockett Groves, Inc., Harlingen
Dow Chemical Co., McAllen
Magic Valley Savings & Loan, Weslaco
Production Credit Assn. of South Texas, Harlingen
Rhone Poulenc, El Campo
Rio Farms Inc., Edcouch
Sharyland Orchard & Nurseries, Inc., Mission
Tex-Ag Co., Inc., Mission
Texas Commerce Bank, McAllen
Tide Products, Inc., Edinburg
Union Carbide Corp., McAllen
Valley Garden Center, McAllen

SUSTAINING

Abash Insect Control, McAllen
Alamo Bank Of Texas, Alamo
Alamo Transplants, Alamo
Am-Ag, Inc., Edinburg
Asgrow Seed Co., Weslaco
Burton Auto Supply, Inc., Weslaco
Caldwell Jungle Nursery, Raymondville
K.P. Caskey Estate, Weslaco
Cherrington Nursery, Harlingen
Citrus Management Corp., Mission
Country Farm Nursery, Edinburg
Crest Fruit Co., Alamo
Curltex Citrus Nursery, Edinburg
D's Plants, La Feria
Davidson, C.E. and Mary, Mission
Donald Thompson Grove Care, Weslaco
Edinburg Improvements Assn., Edinburg
Esco Ltd. Co., Pharr
Everhard Nursery, McAllen
First City Bank, McAllen
First National Bank, Mission
First State Bank & Trust Co., Edinburg
First National Bank of Mercedes, Mercedes
FMC Corporation, San Antonio
Gene's Ornamental Farms, Los Fresnos
Green Valley Sales, San Benito
Guerra's Inc., Mission
Gulf Distributing Co., Weslaco
Gulfstream Green Houses, Los Fresnos
Harlingen Garden Club, Harlingen

Hertzler Hess Nursery, San Juan
Hidalgo County Farm Bureau, Pharr
Hidalgo Bank & Trust, Mercedes
Hidalgo Soil & Water Cons., Edinburg
Hidalgo Savings & Loan Assn., Edinburg
Interstate Fruit & Veg. Co., La Feria
J.S. McManus Produce Co., Weslaco
Jimmy Hill, McAllen
Knapp-Sherrill Canning Co., Donna
I. Kunik Co., McAllen
K-Y Farms, Harlingen
La Laguna Nursery, Mission
Janie B. Lee
Lewis Nursery, Pharr
Longwell Farms, Inc., Hargill
Lynn Jones Farms, Inc., Mission
Magic Valley Elec. Corp., Mercedes
Magic Valley Nursery, Pharr
Mid-Valley Chemicals, Weslaco
National Bank of Commerce, Edinburg
Pan American Bank, Brownsville
Patio Plantation, Edinburg
Pletcher's Wholesale Nursery, Inc., Harlingen
Pilar's Greenhouse, Harlingen
Precision Orchards, Mission
Pride of the Citrus of TX Inc., Mission
Resaca Nursery, San Benito
Roeder, Judy K., Weslaco
Rio Properties, Inc., Edinburg
Rohm & Haas Co., Memphis, TN
Seifried E., McAllen
Semco, Pharr
Smiley Grove Care, Mission
Southland Care Co., Edinburg
South Texas Tropical Foliage, Harlingen
Stauffer Chemical Co., Weslaco
Stuart Place Nursery, Harlingen
Sundor Brands, Weslaco
Sun-Up Growers, Mission
Sunrise Tropicals, Alamo
Sun World International, Coachella, CA
Texas Citrus Exchange, Mission
Texas Citrus Mutual, McAllen
Texas Valley Citrus Comm., McAllen
Texas Plant & Soil Lab, Edinburg
TexaSweet, McAllen

Townsend Implement Co., McAllen
Tropical Nursery, McAllen
Valco Chemicals, Harlingen
Valley Garden Center, McAllen
Valley National Bank, McAllen
W.T. Ellis Company, Mission
Walter Baxter Seed Co., Weslaco
Waugh's Fruit Ranch, McAllen
Weaks Martin Imp. Co., Inc., Mission
Willacy Soil & Water Con. Dist., Raymondville
Wood Implement Co., Inc., Donna

REGULAR

Albach, R.F., Weslaco
Amador, Jose, Weslaco
Anderson, N.L., San Benito
Arnall, Mrs. N., Weslaco
Arpaia, Mary Lu, Riverside, CA.
Ausmus, W.V., McAllen
Bailey, L.L., Kingsville
Baney, Carl, Linn
Barnes, L.W., College Station
Barrett, B., Alamo
Barron, Jorge Elizondo, Victoria, Tamaulipas, Mex.
Barter, Darlene, Mercedes
Bentzinger, H.A., Edinburg
Bevil, Lancer, Edinburg
Bibbs, Melissa, Mission
Blessington, Tom, Weslaco
Bogle, Clyde, Weslaco
Bogue, J., McAllen
Boren, R., McAllen
Boulton, G.A., Mission
Bovee, Craig, Edcouch
Bowlin, V., La Feria
Brabham, C.C., Jr., Lyford
Bravo, E., Mexico
Bromiley, Adele, Brownsville
Burns, Jim, Brownsville
Buford, W.R., Harlingen
Burger, David, Davis, CA.
Cadena, Lenore, Mercedes
Camp, Thomas, Oklahoma
Carpenter, M., Mission
Castle, W., Lake Alfred, FL.

REGULAR (Cont'd.)

Chambers, Cliff, McAllen
Chandler, K., Edinburg
Chandler, L.D., Tifton, GA
Chavez, Juan E., Mexico
Chilson Mr. & Mrs. Dale, Port Isabel
Christian, John E., Raymondville
Citrus Research Education Center, Lake Alfred, FL
Clark, E.W., Olmito
Coltharp, Sharon, McAllen
Connolly, C.C., McAllen
Corona, E.R., Primera
Cox, E., Weslaco
Crane, R.H., McAllen
Crawford, J., Sugarland
Crawford, R.K., McAllen
Cruse, R.R., Weslaco
Cunningham, Gary, McAllen
Davalos, G., Mexico
Davidson, Tom, Corpus Christi
Davis, Frank, Harlingen
De La Garza, G., Mexico
Dean, H., Weslaco
Demto, O.J., Spain
Duos, Gene, Los Fresnos
Eckhardt, R., McAllen
Edelson, J., Weslaco
Eggers Acres, Mission
Elizondo, A., McAllen
Escobar, Mrs. R.S., Pharr
Eubanks, Irene K., McAllen
Everitt, J.H., Weslaco
Fankhauser, G.H., Mission
Fankhauser, H.I., Mission
Fankhauser, D., Mission
Farrald, Carol, Elsa
Felker, P., Kingsville
Ferguson, James, FL.
Fernandez, Daniel, Mercedes
Flowers, Jud, Edinburg
Flowers, S., McAllen
Foerster, C.O., Elsa
Folger, D., Mission
Ford, S., San Juan
Forever.Aloe Plantation, Harlingen
Franco, Arturo Diaz, Progreso
Frazier, S., Harlingen
French, J.V., Weslaco
Fucik, J., Weslaco

Gage, Ed, San Antonio
Gallasch, P., Australia
Garcia, C., Spain
Garza, H., Weslaco
Gerberman, A.H., Edcouch
Gibbs, Melissa, Weslaco
Gibson, F.A., McAllen
Goff, Mrs. J., Harlingen
Goldsberry, Dennis, Donna
Gonzalez, C.L., Weslaco
Gonzalez, E.G., McAllen
Gonzalez, Ramiro, Mexico
Goode, J.P., Weslaco
Goodwin, G., Mission
Griffin, James, Texarkana
Grossman, D., McAllen
Hammar, Mary T., Donna
Harding, G., Raymondville
Harmon, Jay, Brownsville
Hartz, Tim, Weslaco
Heald, C.M., College Station
Hearn, J., Edinburg
Hefley, Ed, Weslaco
Henderson, S.W. Jr., Edinburg
Hensz, R.L., Harlingen
Hertz, A.E., Harlingen
Hertzler, B.M., San Juan
Hertzler, K., San Juan
Hickman, Michael, Weslaco
Hill, Jimmy, McAllen
Hoelcher, Nick, Pharr
Holcomb, Blaine, Mission
Holler, T., Mission
Hopkins, E., Elsa
Jacobs, J., Harlingen
Jeske, D.L., Alamo
Jeske, Glen, Alamo
Jones, L.F., Mission
Jones, Whitley, Mission
Karle, F.G., McAllen
Kersten, M., Donna
Klement, Jon, McAllen
Klement, Will, Mission
Kutzenburger, J., Harlingen
La Gow, H., Silver Spring, MD
Larson, L.V., Sherman, TX.
Laruick, H.E., Wisconsin

Lattimone, Mrs. K.C., Edinburg
Laverty, J.A., Los Fresnos
Lee, J., Brownsville
Leidner, T.G., Edinburg
Lester, Gene, Weslaco
Lewis, L., McAllen
Lime, B.J., Weslaco
Longwell, Don, Hargill
Longwell, Eldin, Edinburg
Love, Glenn and Beth, Weslaco
Magyar, T., Harlingen
Marguleas, H.P., CA.
Mart, Marion, Raymondville
Martinez, Jose, Weslaco
Mayeux, Herman, Harlingen
McCrate, Sean, Weslaco
McFarland, W., Edinburg
McLarty, Michael, Mission
McNar, Farms, McAllen
Meier, A.C., Mission
Menges, R., Weslaco
Meter, Van, San Benito
Meyerdirk, D., Riverside, CA.
Miller, J.C., College Station
Miller, M., Weslaco
Mitchell, R., Donna
Moreno, D.S., McAllen
Murden, D., Edcouch
Murray, Amelia., McAllen
Murray, C.E., McAllen
Neal, J.R., Mission
Nelson, Darrell, Donna
Netz, C.J., Brownsville
Newcomb, D.A., Palm Springs, CA
Nishuira, M., Japan
Nixon, P.R., Weslaco
Nunn, R.E., Edinburg
Orr, E.B., La Feria
Oswald, P., McAllen
Pape, J., Mission
Parker, Willette, San Benito
Paterson, D., Overton
Pehrson, J.E., CA.
Pena, M., Mexico
Petta, Jimmy, Chico, CA
Phillips, Mike, Bryan
Pierce, L., College Station

Pospishil, J., La Feria
Pratt, J.B., FL.
Psarros, N., Greece
Ramirez-Diaz, J., Mexico
Reinking, R.B., Harlingen
Rice, H.E., La Feria
Robacker, K., Mercedes
Rocha, M., Mexico
Rockers, D., Mission
Roeder, J., Weslaco
Roth, J., Weslaco
Rouse, R., Weslaco
Ruby Red Grove Service, Mission
Sakai, Mitsoru, McAllen
Saldana, G., Weslaco
Sauls, Julian, Weslaco
Schultz, Marvin E., McAllen
Schuster, F., Alamo
Scott, Andy, Edcouch
Scott, Bernard, Mission
Seal, Tommy, McAllen
Seifried, Ed, McAllen
Serna, R.R., Mexico
Sherman, D.R., Michigan
Skaggs, W., La Feria
Sluis, N., Edcouch
Smiley, R., Mission
Smith, Dorothy, McAllen
Smith, G.B., Harlingen
Smith, L., Edinburg
Smith, R.C., Donna
Snider, B.B, Harlingen
Spaulding, W., McAllen
Srdar, F., Minneapolis
Stein, E., Weslaco
Summy, K.R., Weslaco
Swietlik, D., Weslaco
Taylor, J.L., Edinburg
Teague, P., Arkansas
Teague, T., Edcouch
Texas Valley Citrus Comm, McAllen
Thomas, D., Weslaco
Thomas, J.R., Weslaco
Timmer, P., Lake Alfred, FL.
Tredemeyer, T.R., La Feria
Turley, Robert, Edinburg
Van Meter, C.L., San Benito

REGULAR (Cont'd.)

Vargas, J., Progreso
Villalon, B., Weslaco
Vogel, Don, Mercedes
Von Arnim, A.G., Sri Lanka
Wallace, D.K., Weslaco
Wallace, Ed., La Feria
Wang, Yin-Tung, Weslaco
Warren, D.G., Edinburg
Warren, W., McAllen
Whitlock, L., McAllen
Wiedenfeld, R., Weslaco
Wiegand, C., Weslaco
Wilerson, M.C., College Station
Wilhite, H., San Juan
Willacy Soil & Water Con. Dist., Raymondville
Wilkerson, M.C., College Station
Williams, J.L., Los Fresnos
Williams, R.R., McAllen
Williamson, D.L., Harlingen
Willis, P., Brownsville
Witbank, W., Gainsville, FL.
Wood, R., Weslaco
Woodall, Bill, Lansing, MI
Work, Alice, Harlingen
Wright, Paul O., Brownsville
Wutscher, H., Orlando, FL.

ABOUT COVER:

Caravelle Cantaloupe

Caravelle, tested as XPH 5364, by Asgrow Seed Company is noted for its very early maturity and high quality. In 1988 and 1989, the Texas Agricultural Extension Service in Hidalgo County conducted a post-harvest cantaloupe quality evaluation that rated each of the cultivars for flavor, texture, color and appearance. Out of the 20 cultivars from nine seed companies, Caravelle was determined to be the top cantaloupe overall.

Photo courtesy: Robert M. Turley, County Extension Agent-Horticulture, Edinburg, Texas 78539.