Wiedenfeld

JOURNAL

OF THE

RIO GRANDE VALLEY HORTICULTURAL SOCIETY

#### ABOUT COVER:

#### TAM VERACRUZ jalapeno pepper

'TAM VERACRUZ', a hot jalapeño pepper, is one of 8 new broad spectrum virus resistant pepper varieties developed by the Texas Agricultural Experiment Station at Weslaco. The compact single stem plant (for machine or hand harvest) sets early large thick walled fruits, with cuticular cracks, uniform maturity at high temperatures. It is widely adapted and ideally suited for fresh market and processing. It was released as an exclusive to PETOSEED COMPANY, Saticoy, CA.

Photo courtesy: Benigno Villalón, Pathologist-Breeder, Tex. Agric. Exp. Sta. Weslaco, Texas 78596.

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ELIGIO 'Kika' de la GARZA 1991 Recipient of The Arthur T. Potts Award

Eligio 'Kika' de la Garza was born in 1927 in Mercedes, Texas but grew up in Mission, Texas his parents home. During his youth 'Kika' de la Garza like many boys spent his after school, and summer vacation time working the many Lower Rio Grande Valley cotton and vegetable fields. In 1945 'Kika' enlisted in the U.S. Navy but since WWII ended that same year he was honorably discharged and returned to graduate from Mission high school in 1947. In 1952, 'Kika' de la Garza graduated with an LLB degree from St. Mary's University law school in San Antonio, TX., passed the State Bar of Texas Dec. 1951, and earned a Doctor of Jurisprudence from St. Mary's May, 1970. Also, he graduated from the U.S. Army's artillery school, taught artillery training in the U.S. while serving during the Korean conflict, 1951 to 1952, and in 1952 became a practicing attorney with the McAllen law firm of Rankin, Kern & Martinez. In 1953, 'Kika' de la Garza married the former Lucille Alamia and they have three children: Jorge, Michael, and Angela.

'Kika' de la Garza began his public service career in 1953 as a Texas State House Congressman representing the 111th district which includes all of Hidalgo, County Place 3. Rep. de la Garza served six consecutive two-year terms in the Texas State House, only leaving in 1964 to begin his representative career with the 89th U.S. Congress. Congressman 'Kika' de la Garza has represented the 15th U.S. Congressional District which includes: Atascosa, Brooks, Duval, Frio, Hidalgo, Jim Hogg, Jim Wells, Karnes, La Salle, Live Oak, McMullen, San Patricio, Starr, Wilson, Zapata and parts of Gonzales and Nucces counties and he will be serving his 14th consecutive term with the 102nd U.S. Congress in January 1991. Rep. de la Garza has been a member of the House Agriculture Committee during his entire House service and has served as Chairman of this committee since January 1981, a position he was re-elected to for 1991. Rep. de la Garza's activities in the U.S. House have ranged from committee policy decisions in agriculture, to areas including educational promotional activities through bilingual education, improved trade relations between developing and developed countries, and to protecting the U.S. fishing industry. During his U.S. House service Rep. de la Garza's record has included active promotion of legislation to protect and improve farm and rural economies through crop stabilization programs, expanded agricultural export trade, rural development, soil conservation, and agricultural credit. Rep. de la Garza has been especially active in promoting the maintenance of agricultural research programs, of which, the Rio Grande Valley can be particularly grateful to Rep. de la Garza for staunchly supporting the U.S.D.A.-Agricultural Research Service, Subtropical Agricultural Research laboratory in Weslaco, Texas. As Chairman of the U.S. House subcommittee on Agricultural Department Operations, Research and Foreign Agriculture form 1967 to 1979, 'Kika' de la Garza played a key role in drafting more stringent laws dealing with pesticide use and safety, and animal health. Rep. de la Garza has also been prominent in efforts to establish and maintain a stabilization program for U.S. sugar growers and has kept a close and determined interest in assuring programs which protected major agricultural areas from invasions by costly and destructive foreign insect pests like the fruit fly. Prior to Rep. de la Garza's Chairmanship of the full House Agriculture Committee, he served on committees with direct influence on the merchant marine, fisheries, wildlife, conservation, environment, narcotic abuse, U.S. Customs Service, and alcohol, tobacco and firearms. In international concerns Rep. de la Garza who is fluent in Spanish became the first congressman from the Texas-Mexico area to serve on the U.S.-Mexico Interparliamentary Group. In 1978 Rep. de la Garza became Chairman of this group which involves consultations with representatives of the Mexican Congress and plays a significant role in today's ongoing free trade agreement with Mexico. Congressman 'Kika' de la Garza was awarded in 1979 the Order of the Aztec Eagle, Mexico's highest honor for foreigners and he is the first member of the U.S. House to receive this award. 'Kika' de la Garza is a past or present member of the Mission, McAllen, Alice, Pharr, Edinburg, and Rio Grande Valley Chamber of Commerce, the American Legion post #1 of Pharr, TX. as well as many fraternal societies.

This Society honors U.S. Congressman Eligio 'Kika' de la Garza not only for his service and political leadership in agriculture policy and trade, but for his support of agricultural research which benefits the people of Texas and especially those of the Rio Grande Valley. Also, we honor him for his service and innovative political leadership as Chairman of the U.S. House Agriculture Committee which benefits people the world over. [G.E.L., 1991].

### Argi-Mek (Abamectin): A New Miticide for Control of Citrus Rust Mite

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Additional Index Words: avermectins, chemical control, phyllocoptruta oleivora.

#### ABSTRACT

In orchard spray trials conducted over several seasons, Agri-Mek R (abamectin) was compared to other experimental and labelled miticides for efficacy against citrus rust mite (CRM), Phyllocoptruta oleivora (Ashmead). In 1982, Agri-Mek at rates of 0.02 and 0.04 oz ai/100 gal tank mixed with 0.25% Narrow Range (NR) petroleum oil and applied by handgun in dilute sprays (12-15 gal/tree), provided longer residual CRM control than Agri-Mek without oil or the standard miticide, Vendex (fenbutatin oxide). In 1983, Agri-Mek at 0.0062 and 0.0125 lb ai (5 & 10 oz) / acre + 0.20% NR oil applied in semi-dilute sprays (250 gal/acre) by commercial sprayer, gave CRM control (> 60 days) comparable to that by Advantage (carbosulfan) or Vendex; all gave superior CRM control compared to Morestan (oxythioquinox), Ethion, or experimental SLJ-0312. In 1988, Agri-Mek at 0.0125 lb ai + 0.40% NR oil/acre applied by commercial sprayer provided CRM control comparable to that by Vendex with both treatments giving superior CRM control to that by Nomolt or Diaract (separate formulations of teflubenzuron) applied alone or tank mixed with 1.0% NR oil.

Agri-Mek<sup>R</sup> miticide (Merck Sharp and Dohme Research Laboratories, Three Bridges, N.J.) was labelled by the Environmental Protection Agency (August, 1989) for use on citrus to control the citrus rust mite (CRM), *Phyllocoptruta oleivora* (Ashmead). Abamectin, the active ingredient in Agri-Mek, belongs to a new class of chemical compounds called avermectins. Avermectins are natural products formed as a result of fermentation by the soil microorganism, *Streptomyces avermitilis*. The avermectins, while demonstrating toxicity against a wide range of invertebrate pest species, have proven particularly effective for control of phytophagous mites (Putter et al., 1981, McCoy et al., 1982).

In 1987 & 1988 an Experimental Use Permit (EUP) allowed Agri-Mek sprays to be applied on a limited acreage of commercial citrus (200 acres each season) in the Lower Rio Grande Valley (LRGV) of Texas. While this enabled some citrus growers and grove care operators to gain experience with Agri-Mek, the majority of the Texas citrus industry is still relatively unfamiliar with this new miticide. This paper reports the results of trials comparing Agri-Mek to other labelled and experimental miticides for efficacy against CRM. All trials were conducted at Texas A&I University Citrus Center Orchards (Weslaco, Texas). Some data have been reported previously (French 1982, 1984), as well as results of Agri-Mek efficacy trials against two species of spider mites (Tetranychidae): the Texas citrus mite, Eutetranychus banksi (McG), and the citrus red mite, Panonychus citri (McG). (French 1986, 1987; French and Villarreal, 1988).

#### MATERIALS AND METHODS

Chemical Formulations. The materials tested included: Agri-Mek 0.15 EC (abamectin), [a mixture of avermectins containing ≥80% avermectin B₁b (5-0-demethyl-25-de (1-methylpropyl)-25-(1-methylethyl) avermectin A₁a); Advantage 2.5 EC (carbosulfan), 2,3-dihydro-2,2-dimethyl-7-benzofuranyl [(dibutylamino)thio] methyl carbamate, (FMC Agric. Chem. Philadelphia, PA); Diaract 10% SC and Nomolt 10% EC (teflubenzuron), 1-(3,5-dichloro-2,4-difluorophenyl)-3-(2,6-difluorobenzol)-urea, (EM Industries, Inc. Hawthorne, NY); Ethion 4 EC, 0,0,0,0-tetraethyl S,S-methylene bisphosphorodithioate, (FMC Agric. Chem., Philadelphia, PA); Morestan 25 WP (oxythioquinox), 6-methyl-1, 3-dithiolo[4,5,-b] quinoxalin-2-one, (Mobay Chemical Corp, Kansas City, MO); SLJ-0312 50 WP, N-(3-Phenyl-4, 5-bis-((trifluromethyl)iminio)-2-thiazolidinylidene) benzene), (Mobay Chemical Corp, Kansas City, MO); and Vendex 4 L (fenbutatin oxide), Bis [tris (2-methyl-2-phenylpropyl) tin] oxide, (E.I. DuPont de Nemours and Co. Wilmington, DE).

Certain miticides were tested as tank mixes with Narrow Range (NR) Petroleum oil having the following specifications: with emulsifier and unsulfonated residue rating of 92% minimum; A.P.I. gravity at 15.5°C 34.8 minimum; 50% distillation point at 10 mm HG reduced pressure 440°F and 10-90% range of 80°F maximum (Sun Oil Co. Philadelphia, PA).

Evaluation of Agri-Mek in High Volume Sprays. Agri-Mek (0.02-0.04 oz ai/100 gal) alone and tank mixed with 0.25% NR oil, was compared to the standard miticide Vendex (2.0 oz ai/100 gal) in a full season trial during 1982. Miticide treatments were completely randomized and replicated four times on single tree plots in a 20-year-old 'Ruby Red' grapefruit orchard on 30 ft × 25 ft spacing. Treatment sprays were applied to foliage runoff (ca. 12-15 gal/tree) at 225 PSI by handgun mounted on a John Bean model 1010-MTBT Sprayer (FMC Corp. Agric. Machinery Div., Jonesboro, Ar.). The initial spray application was made on 3 June and reapplied on 20 August 1982. Average fruit diameter was ca. 5 cm at time of the initial application.

Pre- and post-treatment counts of CRM were made at ca. 14 day intervals throughout the trial. During each count, 12 fruit/tree were randomly selected and examined in situ with a 10X handlens fitted with a 1 cm<sup>2</sup> grid. All CRM were counted in two-1 cm<sup>2</sup> lens fields on the shaded side of each fruit. Counts are reported as average number of CRM per 1 cm<sup>2</sup> of fruit surface

CRM feeding injury (% russet) was assessed on fruit from test plot trees at harvest in November, 1982. Twenty-five fruit/tree (replicate) were randomly selected and rated for injury damage. Fruit with  $\geq$  50% surface injury due to CRM feeding was downgraded and would be marketable as US #2 fresh or usable for processing only.

All data were subjected to analysis of variance and means separated by Duncan's Multiple Range Test.

Evaluation of Agri-Mek Applied by Commercial Sprayer. 1983 Trial — Agri-Mek at rates of 0.0062 and 0.0125 lb ai (5 and 10 oz) / acre + 0.20% (0.5 gal/acre) NR oil were compared to the experimental miticides, SLJ-0312 and Advantage and to the standard miticides, Ethion, Morestan and Vendex. A 22-year-old 'Ruby Red' grapefruit orchard on 16 ft × 22 ft spacing was utilized with each test plot consisting of 2 rows of 13 trees. Treatments were completely randomized with 2 replicates. Each test plot was buffered by an adjacent row on either side and two trees on each row end left unsprayed to minimize any cross contamination of treatments. Spray applications were made on 17 May 1983 by a commercial Lockwood Hardie Super 40 air blast sprayer (Lockwood Corp. Gering, NE) with nozzling, pressure (140 PSI), and speed adjusted to apply 250 gal/acre. Pre- and post-treatment counts of CRM were made at ca. 14-day intervals on 50 randomly selected fruit/replicate. The mite counting method was as described previously. On culmination of the trial in the fall, 100 fruit/plot were randomly harvested from test trees and evaluated for CRM feeding injury (% russet) using the previously described method.

1988 Trial — Agri-Mek at 0.0125 lb (10 oz) ai/acre + 0.40% (1 gal/acre) NR oil was compared to Vendex and the experimental miticides, Nomolt and Diaract (separate formulations of teflubenzuron). The latter formulations were tested alone and also mixed with 1.0% (2.5 gal/acre) NR oil. The test was conducted in a 25-year-old orchard of 'Webb Redblush'

grapefruit on 24 ft  $\times$  24 ft spacing. Treatments were randomly assigned with 3 replicates on test plots of four trees (2  $\times$  2). Test plots were buffered on all sides by unsprayed trees to minimize cross contamination of treatments. Spray applications were made on 16 May and reapplied on 13 July by a Lockwood Hardie air blast sprayer with nozzeling, pressure, and speed adjusted to apply 250 gal/acre. Pre- and Post-treatment counts of CRM were made at 14-day-intervals on 25 randomly selected fruit/replicate. At the end of the trial, 100 fruit/replicate were randomly harvested from test trees and evaluated for CRM injury (% russet). The methods used for counting CRM and conducting CRM - fruit injury evaluations were as previously described.

#### RESULTS

Agri-Mek High Volume Spray Trial. Citrus rust mite (CRM) were allowed to build to high population levels on fruit in test trees prior to application of any spray treatments. All miticide treatments gave good initial knockdown of CRM, but the two Agri-Mek treatments (0.02 and 0.04 oz ai/100 gal) tank mixed with 0.25% NR oil provided longer residual CRM control than either the Agri-Mek without oil or standard Vendex treatments (Table 1).

CRM populations on fruit in unsprayed control trees declined rapidly in mid trial due to severe mite feeding injury on the fruit peel. After the second spray application, all treatments were still providing residual CRM control at 70 days post-treatment. The Agri-Mek + NR oil treatments and the Vendex treatment had significantly lower percentages of mite-damaged fruit at harvest.

Agri-Mek Commercial Sprayer Trials. 1983 Trial — Experimental SLJ-0312, Ethion, and Morestan treatments lost efficacy against CRM before 60 days post spray (Table 2). All other miticide spray treatments provided CRM control for 76 days or longer, with two treatments, Agri-Mek + NR oil (0.0125 lb ai/acre + 0.20%) and Advantage + Ethion tank mix, providing CRM control beyond 112 days. All Agri-Mek, Advantage, and Vendex (standard) treatment plots had ≤ 9% rust-mite-damaged fruit at harvest versus ≥ 40% damaged fruit from each of the SLJ-0312, Ethion, Morestan and control treatments.

1988 Trial — Agri-Mek 0.0125 lb/acre + 0.40% NR oil provided CRM knockdown and residual control comparable to the standard miticide, Vendex; both treatments gave superior CRM control compared to the Nomolt or Diaract treatments, whether applied alone or tank mixed with 1.0% NR oil (Table 3). The superiority in rust mite control was also shown by a lower percentage of CRM injured fruit at harvest from the Agri-Mek and Vendex treatments, i.e., ≤ 12% russeted fruit, versus 28-44% and 58% russeted fruit from the Nomolt or Diaract and control treatments, respectively (Table 3).

#### DISCUSSION

Included in citrus miticide screening trials for several seasons, Agri-Mek consistently gave citrus rust mite (CRM) control comparable, or superior, to other labelled and experimental chemicals tested. Tank mixing Agri-Mek with a low volume (0.20-0.40%) of Narrow Range petroleum spray oil improved residual (long-term) CRM control which generally exceeded 60 days. No foliar or fruit injury was observed at the Agri-Mek rates and methods of application used in these orchard trials. However, injury to 'Pineapple' and 'Temple' orange fruit was observed in tests elsewhere (McCoy et al., 1982) but at an Agri-Mek rate (0.08 oz ai/100 gal) twice that used in these trials. Moreover, no adverse effects were observed on beneficial larvae or adults of either the twice-stabbed lady beetle, *Chilocorus stigma*, (Say) or green lacewing, *Chrysopa carnea* Stephens. Both species were numerous in treated and control plots throughout these trials. Previously, French and Villarreal (1988) reported no observed mortality of several natural insect enemies of the citrus mealybug, *Planococcus citri* (Risso) following earlier Agri-Mek treatments.

In laboratory tests conducted by Hoy and Cave 1985, Agri-Mek at 3 ppm caused significant mortality and affected fecundity of female Metaseiulus occidentalis (Nesbitt) (Acarina:

Table 1. Citrus rust mite (CRM) counts on the fruit surface of 'Ruby Red' grapefruit sprayed with test miticides, Weslaco, TX 1982.

						CRM/1-cm <sup>2</sup> (f	ruit surface	)				
	Rate	Dec				Days post-t	st-treatment 2nd Spray 20 August					% russet <sup>y</sup>
Treatmentz	oz. ai/100 gal	Pre- Spray	14	28	40	56	14	28	42 42	56	70	Tusset
Agri-Mek Agri-Mek +	0.04	86.9b	2.8b <sup>x</sup>	2.6b	14.6a	12.1a	3.3a	0.3a	2.3a	0.1b	0.7b	17b
0.25% NR Oil	0.02	137.4a	0.1b	0.0b	0.9b	0.1c	0.0a	0.0a	0.0a	0.1b	0.0b	9¢
Agri-Mek + 0.25% NR Oil	0.04	65.4b	1.0b	0.1b	3.1b	0.8c	0.1a	0.7a	0.0a	0.0b	0.0b	4c
Vendex	2.00	80.8b	6.8b	6.1b	3.9b	8.5ab	0.1a	0.1a	0.2a	0.2b	0.0b	11bc
Control	-	114.1a	105.1a	70.6a	4.4b	2.7bc	0.4a	0.0a	2.2a	3.4a	8.3a	61a

<sup>&</sup>lt;sup>2</sup> Applied as high volume sprays by handgun sprayer.

y Percentage of fruit at harvest downgraded due to CRM feeding injury (russeting).

x Treatment means within a column followd by the same letter are not significantly different (P=0.05) by Duncan's Multiple Range Test.

Table 2. Citrus rust mite (CRM) counts on the fruit surface of 'Ruby Red' grapefruit sprayed with test miticides, Weslaco, TX 1983.

					CRM	/1-cm <sup>2</sup> (fruit s	urface)			
Treatment <sup>z</sup>					Da	ays post-treatn	nent:			10.17 - 12 11 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1
	Rate Lbs ai/acre	Pre Spray	14	30	48	60	76	90	112	% russet
Agri-Mek + 0.20% NR Oil	0.0062	0.1e <sup>x</sup>	0.0b	0.1a	0.2b	0.4c	5.9c	4.7d	7.5cd	6de
Agri-Mek + 0.20% NR Oil	0.0125	1.1cde	0.0b	0.1a	0.0b	0.1c	0.2c	0.0d	0.0d	2e
SLJ-0312	3.00	0.2de	0.0b	0.1a	0.1b	11.3b	32.4b	40.3b	27.5b	40c
Advantage	0.625	1.2cde	0.1b	0.2a	0.0b	0.4c	4.9c	2.9d	0.5d	4de
Advantage + Ethion	0.47 2.00	2.5bcd	0.0b	0.1a	0.0b	0.2c	0.1c	0.0d	0.0d	2e
Ethion	4.00	0.1e	0.0b	0.5a	1.9a	38.3a	48.9b	20.1c	21.8bc	44bc
Morestan	0.75	2.9bc	0.1b	0.1a	0.46	21.5b	78.8a	54.9a	25.1b	54ab
Vendex	0.625	4.1ab	0.0b	0.0a	0.4b	0.8c	3.6c	1.7d	16.4bc	9d
Control		5.8a	0.3a	0.7a	0.1b	13.5b	29.4b	35.4b	54.0a	59a

<sup>&</sup>lt;sup>2</sup> Applied as semi-dilute spray by commercial air blast sprayer on 9 May 1983.

y Percentage of fruit at harvest downgraded due to CRM feeding injury.

x Treatment means within a column followed by the same letter are not significantly different (P = 0.05) by Duncan's Multiple Range Test.

Table. 3 Citrus rust mite (CRM) counts on the fruit surface of 'Webb Redblush' grapefruit sprayed with test miticides, Weslaco, TX 1988.

						CRM/1-cm <sup>2</sup> (fruit surface)					
						Days post-t	reatment				
	Rate Lbs	Pre-		1st Spra	y 16 May			2nd Spra	ay 13 July		‰ russet <sup>y</sup>
Treatment <sup>z</sup>	ai/acre	Spray	10	18	32	48	14	28	42	60	
Agri-Mek + 0.40% NR Oil	0.0125	0.6ab <sup>x</sup>	0.1b	0.7b	0.4c	7.6b	0.1c	0.2c	0.2c	9.0b	11d
Nomolt	0.10	0.1b	0.0b	3.1b	2.1c	12.5b	1.4c	7.4b	10.8ab	21.2ab	28c
Nomolt + 1.0% NR Oil	0.10	0.1b	0.1b	5.2b	9.6bc	11.3b	9.8b	6.6b	15.6a	13.3b	41bc
Diaract	0.10	0.0b	0.4b	5.4b	19.3b	32.2a	6.7bc	7.8b	17.4a	19.7ab	44b
Diaract + 1.0% NR Oil	0.10	0.1b	0.3b	1.6b	5.7bc	13.4b	5.3bc	14.8a	13.6a	8.7b	43b
Vendex	0.50	0.9a	0.1b	0.1b	0.2c	3.9b	0.9c	0.2c	3.7bc	9.3b	12d
Control	-	0.2b	4.0a	35.4a	39.8a	27.5a	23.1a	16.2a	15.5a	30.9a	58a

<sup>&</sup>lt;sup>2</sup> Applied as semi-concentrate sprays by commercial air blast sprayer.

y Percentage of fruit downgraded due to CRM feeding injury.

x Treatment means within a column followed by the same letter are not significantly different (P = 0.05) by Duncan's Multiple Range Test.

Phytoseiidae), an important mite predator of the two spotted spider mite, *Tetranychus urticae* Koch. Any future trials should include determining Agri-Mek's activity on beneficial predatory mites, with several identified species active in LRGV orchards (Browning, 1983).

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## Incidence and Severity of Melanose Disease on Grapefruit trees in Texas, After the 1989 Freeze.

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Additional Index Words: Diaporthe citri, stem end rot.

#### ABSTRACT

Conditions during the first half of the year following the December 1989 freeze have resulted in a high infection of melanose disease caused by the fungus, Diaporthe citri, on the dead twigs and new leaves of grapefruit trees in Texas. The highest disease incidence in any one location was 43%, recorded in Mission, TX. The best control strategy is removal of all dead wood, and the timely application of copper spray(s).

The fungus *D. citri* (Fawc) Wolf causes two major diseases on citrus: melanose and stem end rot. On fruit, melanose results in a peel blemish which eliminates fruit from the fresh market. For up to 3-5 months after petal fall, the developing fruits are more likely to become infected by the fungus. Conditions that favor disease development are: the presence of dead wood bearing spores of *D. citri*, a wetting period of 100% relative humidity for 8-10 hours, and temperatures above 75°F. The same conditions lead to melanose infection of young leaves and twigs. The disease symptoms are partially characterized by brown to dark corky pustules (Fig. 2 and 3).

Stem end rot is a post-harvest decay caused by the spores of D. Citri (anamorph, Phomopsis citri Fawc.) germinating on the button of the fruit. Unlike melanose, the spores that cause stem end rot can become established on the fruit at any time.

While the December 1989 freeze killed thousands of citrus trees outright in the Lower Rio Grande Valley (LRGV), approximately 30% of the freeze-damaged trees have sprouted from the main trunk. Large amounts of dead wood above the new growth flushes together with spring showers that splashed spores on the tender leaf surfaces provided ideal conditions for causing an outbreak of melanose disease. As a high incidence of melanose in 1990 can result in economically damaging levels of melanose and post-harvest decay on the 1991 fruit crop, a survey was conducted to document the incidence and severity of melanose on grapefruit trees in the LRGV. Although melanose pustules were also found on sweet and sour orange flushes (Citrus sinensis L. and C. aurantium L., respectively), only grapefruit (C. paradisi Macf.) orchards were surveyed because the latter is a more suitable host for melanose.

#### MATERIALS AND METHODS

The LRGV was divided into 3 sampling areas, using two US Highways 281 and 77 as boundaries (Fig. 1). Fifty orchards were surveyed west of US 281 (section 1), seventy two between US 281 and US 77 (section 2), and eight orchards east of US 77 (section 3). The stars in Fig. 1 show the general area where the samples were taken. A small star represents 1 to 3 orchards and a large star represents 3 to 9 orchards.

Leaf samplings: Fifty leaves were collected at random from ten grapefruit trees in each orchard. The ten trees were randomly selected along the two diagonals of a 5 acre section. Two persons walked on the diagonals, collected 25 leaves from five stops, and placed them in plastic bags. Each person's collection from an orchard was considered a sub-sample. The samples were then brought to the laboratory for inspection.

Disease incidence and severity: The leaf surfaces were examined for the presence of at least one or more pustules caused by the melanose fungus. The leaves were examined visually, or under a microscope if definite confirmation was needed. Disease incidence was recorded as the percentage of total leaves that showed the presence of one or more pustules. The non-infected leaves were discarded, and the infected leaves were used for disease severity rating. The infected leaves from an orchard were grouped into four classes on a severity scale of one to four, where: 1 = leaves with one pustule or up to 25% of the total surface area covered with melanose pustules; 2 = 25 to 50%, 3 = 50 to 75%, and 4 = 75 to 100% of the total leaf surface covered with melanose pustules. The percentage of infected leaves that fell into each of the above groups was recorded to assess disease severity rating.

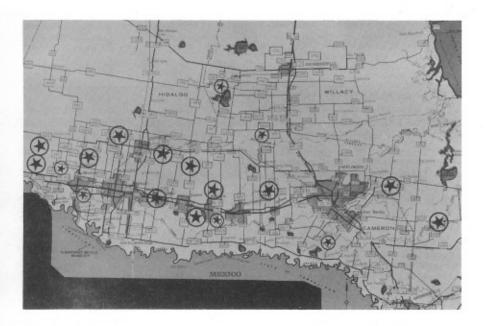


Fig. 1 Map of the Lower Rio Grande Valley. Small star shows the location(s) of 1-3 samples, and a large star shows the locations of up to 9 samples.

#### RESULTS AND DISCUSSION

Incidence and severity of melanose disease in the west, middle, and east sections of the Valley are shown in Table 1. As of July 1990, 26.2% of the trees across the Valley were infected with melanose. Among the infected leaf samples, 19.6% of the trees had a leaf severity rating of 1, 5.2% had a severity rating of 2, and 1.3% had a severity rating of 3, and none of the leaves had a rating of 4. Severe infections on twigs with or without die back symptoms were observed occasionally (Fig. 3). The highest incidence of melanose in any one location was 43%, recorded in Mission. Fig. 2 and 3 illustrate the symptoms observed on grapefruit leaves and twigs.

The melanose inoculum produced on the dead wood is washed onto the young leaves by rain. According to the National Weather Service, Brownsville, TX 78521, (telephone communication), between January and July 1990, Mission in Section 1, Weslaco in Section 2, and Brownsville in Section 3 received 8.05, 8.83, and 6.42 inches of rain, respectively. More important than the total inches of rain, however, is the frequency of small showers which are so important and conducive to melanose disease spread.

Table 1. Incidence and severity of melanose on grapefruit trees in the LRGV after the December 1989 freeze.

Number of leaves	Incidence (%)		Severi	ty class	
checked		1 .	2	3	4
2500	18.8	14.4	3.8	0.6	0.0
3600	27.5	21.5	5.1	0.9	0.0
400	32.3	23.0	6.8	2.5	0.0
6500	26.2	19.6	5.2	1.3	0.0
	2500 3600 400	leaves (%) checked  2500 18.8  3600 27.5  400 32.3	leaves (%) 1  2500 18.8 14.4  3600 27.5 21.5  400 32.3 23.0	leaves (%) Severii 1 2  2500 18.8 14.4 3.8  3600 27.5 21.5 5.1  400 32.3 23.0 6.8	leaves checked         (%)         Severity class           1         2         3           2500         18.8         14.4         3.8         0.6           3600         27.5         21.5         5.1         0.9           400         32.3         23.0         6.8         2.5

In a 5 year study on grapefruit orchards, Timmer and Fucik (1976) found that the total length of periods of environmental conditions favorable for fruit infection by *D. citri* were not well correlated with the incidence of melanose. Melanose in a given year would be more closely related to the amount of dead wood and/or the severity of melanose in the orchard in previous years. Based on this year's incidence and the abundance of dead wood, the 1991 fruit will be under high risk of melanose infection. Application of copper fungicides is the best available chemical control to protect fruit from melanose. Timing of chemical application(s) based on fruit maturity and rain fall is very critical (Timmer, 1974, Whiteside, 1975). This year's data on the incidence and severity of melanose should alert management to develop proper strategies to protect citrus fruit from infection by *D. citri* next year. Since there are no fruit this year, copper sprays were not generally applied. An important part of the control of melanose is removal of all dead wood from the trees.

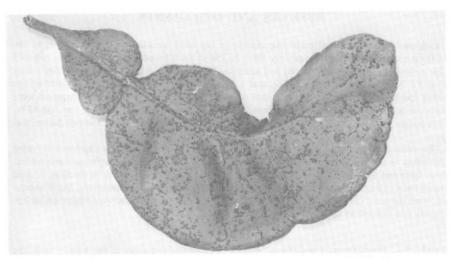


Fig. 2. Corky pustules of melanose developed on a grapefruit leaf.

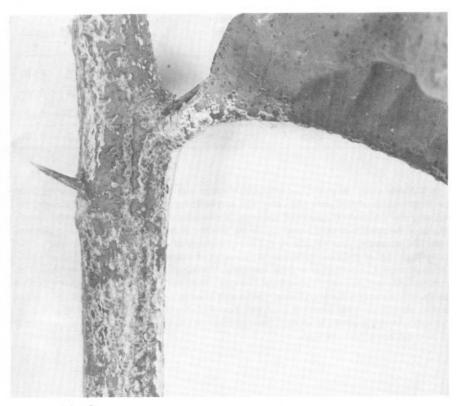


Fig. 3 Melanose pustules developed on the twig of a grapefruit tree.

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#### Release of Two Parasitoid Species for Biological Control of Citrus Blackfly in South Texas

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Additional Index Words: Amitus hesperidum, Encarsia opulenta, releases

#### ABSTRACT

Disruption of the parasitoids, Amitus hesperidum, Silvestri and Encarsia opulenta Silvestri, resulted in a severe outbreak of citrus blackfly, Aleurocanthus wogfumi Ashby, in Lower Rio Grande Valley (LRGV) citrus orchards during the 1988 and 1989 seasons. In efforts to regain biological control of citrus blackfly, an estimated 702,400 parasitoids were released or redistributed in 40 infested mid-LRGV orchards between June and November, 1989. Releases included both insectary-reared and field-collected A. hesperidum and E. opulenta received from Florida and field-collected E. opulenta received from Mexico. To augment imported parasitoids, leaves with parasitized citrus blackfly from two Brownsville-area orchards were redistributed and accounted for 70% of all A. hesperidum and E. opulenta released.

The citrus blackfly (CBF), Aleurocanthus woglumi Ashby, is a citrus pest of South Asian origin, but infestations have occurred in the Lower Rio Grande Valley (LRGV) of Texas in 1955 and 1971 (Smith et al. 1964, Hart et al. 1973). The first outbreak was on residential citrus and was eradicated in 1956; the second outbreak also initiated on residential citrus but soon spread to commercial orchards. Insecticide applications failed to give adequate control, but release in 1974 of laboratory-reared and field collected parasitoids, Amitus hesperidum Silvestri (Platygasteridae) and Encarsia opulenta Silvestri (Aphelinidae) reduced population densities below economic damage levels (Summy et al. 1983). Citrus blackfly population densities had remained stabilized under biological control until the mid 1980's. Five years after a severe freeze in December 1983, CBF densities again surged in mid-LRGV orchards while concomitant parasitoid densities were low. This report describes the release and redistribution of A. hesperidum and E. opulenta during the 1989 season to regain biological control of CBF.

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#### MATERIALS AND METHODS

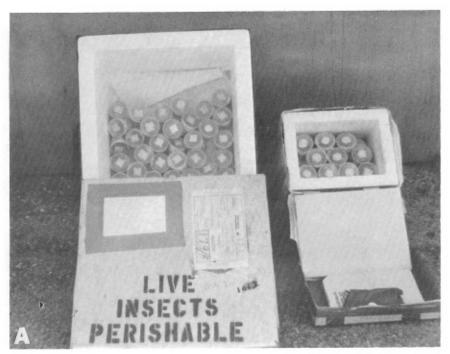
Several parasitoid sources were utilized during 1989. Beginning June 28, air shipments were sent from a beneficial insect rearing facility in Gainesville, Florida, which was maintained by the Florida Department of Agriculture, Division of Plant Industry. These insectary shipments consisted of A. hesperidum, which were placed in wax cups and contained honey and water (1:1) as a food source, and were shipped in styrofoam containers (Fig. 1 a,b) (Hart et al. 1978). E. opulenta were field collected in the Linares-Montemorelos area of Nuevo Leon, Mexico and transported to the border. After inspection by USDA-APHIS-PPQ (Plant Protection and Quarantine), parasitoids were brought into the U.S. under a special permit at Hidalgo, Texas. The collections in Mexico were conducted under the auspices of Secretaria de Agricultura y Recursos Hidraulicos (SARH). Beginning in mid September, most A. hesperidum and all E. opulenta shipments from Florida were field collections. Parasitoids were collected in Haines City, Florida from CBF-infested trees carefully inspected for citrus canker. Cups containing parasitoids were taped to tree branches with foliage supporting heavy blackfly infestations. Releases were usually made during the early morning hours in a total of 27 LRGV orchards from June 28 to November 4, 1989.

To augment the releases of Florida and Mexico parasitoids, leaves with parasitized CBF from two Brownsville orchards were collected and redistributed into mid-LRGV orchards during September. Since parasitoids emerge from 4th stage CBF (pupae), leaves with a preponderance of this stage were selected and put into paper bags (ca. 50 leaves/bag). The bags were stapled shut and each day's collection of about 150 bags were transported in large coolers to the Texas A&I University Citrus Center insectary. The bags were placed in CBF-infested orchards by stapling them atarms length inside the canopy of the northwest quadrant of the tree (Fig. 2). A hole cut near the top of each bag allowed the emerging parasitoids to escape. A subsample of leaves from each day's collection were held for a 2-week period in the insectary to estimate the number of parasitoids released.

#### RESULTS AND DISCUSSION

An estimated total of 702,400 parasitoids were released or redistributed from CBF-infested orchards to 40 mid-LRGV orchards between June and November 1989 (Table 1, Fig. 3). There was a total of 39 parasitoid shipments from Florida and 4 shipments from Mexico. Additionally, over 900 bags of parasitized CBF-infested leaves were redistributed to 20 mid-LRGV orchards. Cup releases from laboratory-reared colonies and field-collected orchards in Florida comprised 31% of all A. hesperidum released. Cup release numbers of E. opulenta were similar from Mexico and Florida (44.7% and 55.3%, respectively), although 76.5% of all E. opulenta and 70% of the total parasitoids released during 1989 were via parasitized CBF-infested leaves from Brownsville.

Indigenous populations of both A hesperidum and E. opulenta were identified in two Brownsville orchards during a survey in early January 1989. After several parasitoid generations had occurred, these orchards became the "nursery locations" from which parasitized CBF-infested leaves were obtained for redistribution. Although the leaf collection and distribution was time consuming and labor intensive, this method expedited relocation of high numbers of parasitoids with limited mortality. The redistribution procedure would have been expanded to other orchard locations if not disrupted by a severe freeze that occurred December 21-26, 1989.



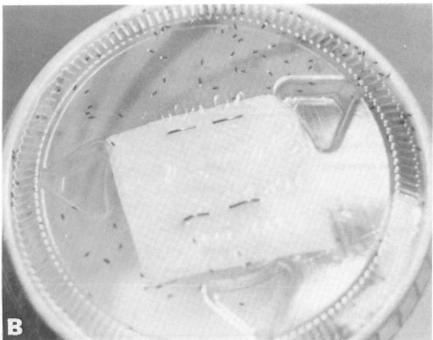


Fig. 1
 A. Styrofoam containers used to ship parasitoids by air from a beneficial rearing facility in Gainesville, FL.
 B. Wax cup containing the parasitoid A. hesperidum and paper pad with honey

B. Wax cup containing the parasitoid A. nesperidum and paper pad with honey and water as a food source.



Fig. 2 Paper bag stapled in citrus tree and containing leaves with parasitized CBF. Emerging parasitoids escape through a hole cut near top of the bag.

Table. 1 Number of releases and redistributions of two parasitoid species against citrus blackfly in South Texas, 1989.

Parasitoid Species	Source	Estimated No. Released
Amitus hesperidum	Florida	180,450
	Brownsville*	402,190
		582,640
Encarsia opulenta	Mexico	12,600
	Florida	15,600
	Brownsville*	91,560
		119,760
Total parasitoids		702,400

Parasitoids from Brownsville were redistributed by transferring parasitized-CBF leaves in paper bags.



Fig. 3 Citrus growing counties of the Lower Rio Grande Valley with arrows indicating blackfly parasitoid orchard release sites.

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#### Asparagus Harvest Duration, Storage Carbohydrates and Yield

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Additional Index Words: Asparagus officinalis L., cultural management, storage roots, fructans.

#### ABSTRACT

Asparagus (Asparagus officinalis L.) "decline" may decrease production acreage and may be associated with the depletion of storage root carbohydrate (SRC) reserves. Light, moderate or heavy harvest pressure within a season, gradually increasing in subsequent years and the response of SRC concentrations were evaluated. Marketable yields were significantly increased in subsequent years if asparagus was harvested for 2 or 4 weeks the first year of planting as opposed to not harvesting. Over a 4 year period there were no differences in the mean weight of spears in response to light, moderate or heavy cutting pressure, but there were significantly more marketable spears and spears per crown with increased harvest duration. SRC concentrations were not significantly different within years.

By 1989, asparagus (Asparagus officinalis L.) produced in the Yuma, Arizona area had surpassed broccoli as the third leading crop with over 3,700 acres in production. In 1990, almost 900 acres were taken out of production due to a physiological/pathological condition we will refer to as asparagus "decline". Observations of this condition were made in four and five-year-old fields which should have been at their peak productivity. Plants were small with few, thin, short shoots and generally non-vigorous; many storage roots were empty. Fields in this condition had been harvested in both fall and spring of the same season obviating suspicion of overharvesting and SRC depletion as causal. However, crowns were shallow, there was mechanical damage to storage roots and a prior year European asparagus aphid (Brachycorynella asparagi Mordvilko) infestation was evident. Any combination of the above factors may have put undue stress on the crop resulting in "decline".

Carbohydrates produced by the asparagus fern accumulate in the fleshy storage roots and are utilized in support of growth during subsequent seasons. Although several studies have considered the effects of harvest duration on yield, no studies in the southwest have considered gradually increasing harvest pressure or storage root carbohydrate (SRC) responses. Takatori et al (1970) reported increased second year production followed by decreased third year production if the harvest duration was extended from 60 to 90 or 120 days the first year. In Michigan, a 4 or 6 week harvest in the second year followed by 8 or 10 weeks the third year resulted in significant yield reductions and severely depleted SRC reserves (Shelton and Lacy, 1980). On the other hand, Jones and Robbins (1926) and Benson and Motes (1982) did not find harvesting the year following planting to have adverse effects on yield or quality of asparagus in succeeding years.

Our objectives were: 1) to establish the optimum harvest duration in the desert southwest and, 2) to determine whether SRC levels might be useful indicators of subsequent yield. This study may have additional relevance due to the current interest in fall-harvested asparagus in southern and western states.

#### MATERIALS AND METHODS

One-year old crowns of 'Mellowland Select' asparagus were planted 15 cm deep on 21 May 1986 at the Yuma Mesa Agricultural Center. The crowns were spaced 30 cm apart in a single row on 1.0 M beds to yield a population of 32,278 plants/ha. By April 1987 the population had been reduced by 25% across all treatments due to severe salt and heat stress during early stand establishment. The plots were furrow irrigated as needed with Colorado River water containing approximately 800 ppm total dissolved salts. The soil is a Superstition sand, and a soil test indicated adequate or high levels of all nutrient except nitrogen. Nitrogen was applied as UN-32 at 168 Kg N/ha in 1986 with 56 Kg N/ha increments each year so that 336 Kg N/ha in the 1989 fern growing season.

The fern was irrigated through October each year before the water was shut off to induce senescence and dormancy. After drying, the fern was either removed manually (1987 and 1988) or burned (1989). A heavy irrigation in late December or early January was the only irrigation until the completion of harvest with the exception of 1988 when an additional light irrigation to soften the soil surface for spear emergence was required. Generally, cutting commenced in early February; asparagus spears were harvested daily, trimmed to 23 cm and graded based on spear diameter and USDA quality standards (U.S.D.A., 1966). There were 6 grades of marketable spears ranging from 5-8 mm to >24 mm diameter. Yield is the combined weight of all the marketable spears after trimming.

The intensity of cutting pressure was classified as light, moderate or heavy depending of the duration of harvest each year. The first year (1987) the crop was harvested for 0 (light), 2 (moderate), or 4 (heavy) weeks. The length of harvest was increased each year by two weeks within each harvest regime and the two-week difference between harvest regimes was maintained; thus, in 1990 we harvested for 6, 8, or 10 weeks. There were six 15.3 m-long beds per treatment with the three treatments arranged in a randomized complete block replicated four times. Storage roots were sampled by inserting a 6.8 cm diameter steel core into the soil bed approximately 15 cm from the crown center at three random locations per plot. Only 2 randomly selected beds were used for root core samples each year and those same two beds were not used the following year. Samples were taken once a week during harvest, for three weeks following harvest and monthly thereafter. Storage root segments were dried at 98°C for 2h and an additional 46h at 70°C then ground in a Wiley Mill (40-mesh screen). Soluble carbohydrates were extracted from 250 mg tissue and total carbohydrates determined by a modified anthrone reagent method (Morris, 1948). Concentration was determined by comparison to a fructose standard curve (prepared daily) with optical density measured at 620 nm in a Bausch and Lomb Spectronic 20 spectrophotometer.

#### RESULTS AND DISCUSSION

There was no diference in the mean weight of spears for all 4 years of harvest in response to the harvest treatments (Table 1). However, in 1989 and 1990 the light and heavy cutting pressure regimes produced spears weighing less than those receiving moderate cutting pressure. For 1987, 1988 and 1990 there were significantly more spears harvested per crown in response to the extended harvest intervals (Table 1). This was similar, but not significant in 1989. Fewer spears were harvested early in the season when the plants had been subjected to either light or heavy cutting pressure the previous two years (McGrady and Tilt, 1990).

The moderate and heavy harvest regimes resulted in increased yields and greater production of marketable spears in the four years of the study (Table 1). There was also a steady yearly increase in yield and number of marketable spears in all three of the harvest regimes. Under Michigan conditions, Shelton and Lacy (1980) suggest that asparagus should not be harvested until 2 years after planting. Our results agree with those of Benson and Motes (1982), which indicate no adverse effects in response to light or moderate harvest during the first year after planting (Table 1). In fact, we found a significant decrease in yield in subsequent years if there was no harvest the first year (Table 1). Harvesting for 4 weeks the first year after planting one year old crowns and gradually increasing the harvest period by 2 weeks each succeeding year does not appear to deplete SRC to a level that reduces subsequent yields.

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Table 1. Mean weight of spears, number of spears per crown, marketable yield and spear production of 'Mellowland Select' asparagus harvested for 0, 2, or 4 weeks in 1987; 2, 4 or 6 weeks in 1988; 4, 6 or 8 weeks in 1989; and 6, 8 or 10 weeks in 1990.

Years					
after		Harvest Pressure		F	LSD
planting	Light	Moderate	Heavy	Value	
SPEAR WT (g)					
1		14.2	15.1	NS	
2	19.8	19.8	19.2	NS	****
3	17.0	19.5	17.5	NS	
4	18.3	19.6	18.5	NS	
SPEARS/CROWN					
1		0.35	0.59	**	0.15
2	0.47	1.20	1.86	***	0.42
3	1.10	2.18	2.47	NS	
4	1.90	3.06	3.93	***	0.62
YIELD (kg/ha)					
1		460	795	**	285
2	832	2217	3322	***	884
3	1804	4072	4336	NS	
4	3141	5515	6936	***	2366
NO. SPEARS (000/I	na)				
1	***	14.8	24.1	**	6.9
2	19.3	50.6	78.7	***	12.8
3	46.1	93.4	107.4	NS	
4	80.0	127.7	171.9	***	27.8

NS, \*, \*\*, \*\*\* Nonsignificant or significant at P = 5%, 1%, or 0.1%, respectively

Table 2. Yearly levels of soluble carbohydrates in storage roots of 'Mellowland Select' asparagus subjected to four successive years of increasing light, moderate or heavy cutting; harvest was for 0, 2 or 4 weeks in 1987 and increased by 2 weeks in each category in each subsequent year.

after				
planting	Light	Moderate	Heavy	Pr>F
	fructo	se equivalents mg/g o	iry wt	
1	453	476	479	NS
2	361	398	399	NS
3	403	438	407	NS
4	513	505	492	NS

There is a typical pattern of slowly declining levels of fructans prior to and during harvest that is shared by all three cutting regimes. After cessation of harvest there is a precipitious drop in the level of fructans for three to four weeks as shoots continue to elongate. After shoots have expanded into fern carbohydrate levels begin to increase. Like Shelton and Lacy (1980), we found significant differences in storage root fructan concentrations during that two to three week period of time immediately following cessation of a harvest regime (data not shown.) At that point we are comparing the carbohydrate status of plants at three distinct stages of growth: spear production, shoot elongation, and early fern growth, and that comparison, although valid, may not be relevant.

In areas with long growing seasons such as the desert southwest, temporary depletion of SRC reserves due to a gradually increasing, relatively heavy harvest alone does not appear to be detrimental to productivity. The ratio of root mass and carbohydrates to the number of buds and/or the number and maturity of buds at initiation of harvest may be more important than carbohydrate concentration or root mass alone. Low SRC levels may contribute to a physiologically stressful condition in which the asparagus plant is more susceptible to pathogens, insects and environmental and cultural management stresses. Pressure by one or more of these factors in combination with low SRC's may result in asparagus "decline".

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# Adaptation and Stability of Different Bean Materials in Eastern Mexico

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### ABSTRACT

During 1982 and 1983, 24 genotypes of beans (*Phaseolus vulgaris* L.) were evaluated to determine their adaptation and stability under a wide range of environments in the Mexican tropical region of the states of Tamaulipas, Veracruz, San Luis Potosi, and Hidalgo. The genotypes BAT7 and 1374 showed general environmental adaptability; Porrillo-Sintetico was consistently the best genotype in less favorable environments while P675-ICA-Pijao, and 1196 showed the best adaptability to good environments. All others genotypes could not be recommended for the tropical region of these states.

Dry beans *Phaseolus vulgaris* L. are the major protein source in the Mexican diet. In Eastern Mexico, dry bean production usually is confined to small farms, where inputs such as fertilizers, pesticides and improved cultivars, are seldom used. As a result, seed yields of dry beans are low, averaging 550 kg ha. <sup>-1</sup>. Most dry bean producers use the crop not only as a source of income, but also as a source of food. In Eastern Mexico, edaphic variation between localities and seasonal variation in any one locality is great. Therefore, farmers need dry bean cultivars that can perform predictably over a wide range of environmental conditions.

One common problem faced in genetic improvement programs is the evaluation and recommendation of new varieties based soley on the mean yield, without examination of genotype × environmental interactions, and performance stability when cultivated under a diversity of environments.

The regression approach, first suggested by Yates and Cochran (1938), employs regression of genotypic means upon an environmental index obtained by averaging the performance of all genotypes in each environment. The regression technique of measuring genotype × environmental interaction developed by Finlay and Wilkinson (1963) and later improved by Eberhart and Russell (1966) and Perkins and Jinks (1968) suggested statistical parameters for the assessment of cultivar stability in plant breeding programs. It has been extensively used in many crop plants to qualify the response of a set of genotypes to varying environments.

Many researchers have used this method to investigate genotype × environmental interactions in different species (Carballo, 1970; Jowett, 1972; Perkins and Jinks, 1971).

These regression techniques characterize genotypic adaptation, and identify unusual performance at specific locations. Regression techniques permit the genotype × environmental interactions to be divided into two parts: (1) the portion of the genotype × environmental interaction due to the response in performance of the genotype to environments of varying levels of productivity, and (2) the portion due to unexplained deviations from regression.

Eberhart and Russell (1986) defined a stable genotype as one having an average response in performance to environments of varying levels of productivity and minimum deviations from regression. Therefore, an ideal genotype would be the one which obtains a relatively high yield and stable performance in low yielding environments as well as the capacity to respond to favorable environments.

Marquez (1970) reviewed the stability concept proposed by Eberhart and Russell and defined genotype × environmental interactions as the relative differential behavior shown by genotypes when evaluated over different environments. He suggested the value of one in the regression coefficient indicates lack of genotype × environmental interaction. A regression from deviations equal to zero indicates a higher grade of predictability. Carballo (1970) defined this last characteristic as consistency. Carballo (1970), using the b and s<sup>2</sup>d values, proposed a classification table (Table 1), grouping the different combinations in six possible situations.

Table 1. Interpretation of the stability parameters according to Carballo (1970).

Type of genotype	Regression coefficient	Deviation from regression	Description
a	b = 1	$s^2d = 0$	Stable genotype.
b	b = 1	$s^2d > 0$	Inconsistent, good response in every environment.
с	b<1	$s^2d=0$	Consistent, best response in unfavorable environments.
d	b < 1	$s^2d > 0$	Inconsistent, best response in unfavorable environments.
e	b>1	$s^2d = 0$	Consistent, best response in good environments.
f	b>1	$s^2d > 0$	Inconsistent, best response in good environments.

The objective of this research is to determine the adaptation and stability of 24 genotypes, over a wide range of environmental conditions. Breeding cultivars with relative consistency of performance over a wide range of environments, or selection for a minimal degree of genotypic and environmental interaction has been a universal goal among plant breeders.

### MATERIALS AND METHODS

The studies were conducted during the fall-winter agricultural cycle in 1982 and 1983, under rainfall conditions in the following municipalities: Altamira, Tamaulipas; Huejutla, Hidalgo; Chicotepec, Veracruz; and Ebano, San Luis Potosi. In the last locality, the experiment was conducted under rainfall and irrigated conditions.

The trials were conducted in commercial dry bean fields following standard agronomic practices and recommended procedures for fertility and weed control. Seeds were drilled into four row plots between October 1 and October 15. Rows were 6 meters long and 70 cm apart. Spacing within rows was 5 cm. A randomized block design with four replications at each location was used.

Twenty four dry bean genotypes exhibiting an upright short vine habit were tested. They included:

- a) Ten CIAT lines from Colombia: BAT832, BAT804, BAT527, BAT304, BAT945, BAT7, BAT873, BAT58, BAT1057, and P675-ICA-Pijao.
- b) Eleven lines from Guatemala: ICTA-Tamazulapa, ICTA-Quetzal, ICTA-Jutiapan, D149, 1374, 1353, 1465, D150, 1196, 1234, and D143.
- c) Two Mexican genotypes: N.-Huasteco-81 and N.-Jamapa, which are the commercial varieties used in Eastern Mexico.
- d) One genotype from Salvador: Porrillo-Sintetico.

Two rows, 5 meters long were hand harvested at maturity and reported cleaned seed yield was adjusted to 14% moisture. Two methods of data analysis were used to investigate genotype × environment interactions for grain yield. The first was based on a standard model for a factorial with years, locations, and genotypes as the main, second, and third factors, respectively. Secondly, a simpler linear regression was used to estimate the regression coefficient (b) and the deviation mean square from regression (s<sup>2</sup>d). The model for stability proposed by Eberhart and Russell (1966) was applied.

### RESULTS AND DISCUSSION

Genotypes differed significantly (P < 0.01) for mean yield (Table 2). Mean genotype yields ranged from 852 to 1124 kg ha<sup>-1</sup>. The highest yielding genotype was BAT7. First and second order interactions were significant (P < 0.01) for all traits (Table 2). The significance of  $G \times L$  and  $G \times Y$  effects demonstrated that genotypes responded differently to variation in environmental conditions. This variation was attributed to different climatic conditions for the different years and locations and to different edaphic conditions among the different locations. The significant interaction of genotypes, locations and years indicated the necessity of testing at multiple locations over time for accurate characterization of genotypic performance over a divergent geographical region.

In the stability analysis, the regression of genotype mean yield on the environmental index resulted in regression coefficients ranging from 0.61 to 1.29. Ten genotypes had b values significantly (P 0.05) different from 1.0 (Table 3). Deviations from regression were significant P 0.05) for 54% of the genotypes.

Table 2. Three factor factorial analysis of variance combined over two years in five Eastern Mexican locations for grain yield of 24 bean genotypes.

Source	df	Mean Squares
Replicates	3	44181.83
Years (Y)	1	33780006.66
Locations (L)	4	14933978.74
$Y \times L$	4	5599135.37
Genotypes (G)	23	157084.63
$Y \times G$	23	149979.29
$L \times G$	92	129601.33
$Y \times L \times G$	92	83056.14
Error	717	56903.98

The ideal genotype as proposed by Eberhart and Russell (1966) would have a high mean performance over a range of environments, a regression coefficient of one, and deviation mean square from regression of zero. According to Carballo (1970) (Table 1), genotypes with regression coefficients greater than 1.0 would be adapted to more favorable environments, while those with coefficients less than one would be relatively better adapted to less favorable growing conditions. For grain yield, the superior genotypes were BAT7, 1374, Porrillo-Sintetico, 1196, N.-Huasteco-81, 1234, 1465, D149, BAT58, BAT832, and P675-ICA-Pijao. BAT7 and 1374 are very desirable genotypes because their performance is uniformly superior (b=1,  $s^2d=0$  and  $\overline{X}=115\%$  and 106% of  $\overline{X}$ , respectively), indicating (by the Eberhart and Russell, 1966 and the Carballo, 1970 definition) stability over environments and greater adaptability of these genotypes over all other cultivars tested.

**Table 3.** Mean yields (X) and stability parameter estimates (b, s<sup>2</sup>d) for grain yields of 24 bean genotypes tested in five Eastern Mexican locations 1982-83.

Genotype	X	b	s <sup>2</sup> d	Genotype **
	kg ha <sup>-1</sup>			Classification
BAT7	1124 a	0.99	1993	a
1374	1035 a	1.00	000	a
Porrillo-Sintetico	1032 a	0.80 *	294	c
1196	987 a	1.13 *	210	e
D143	958 b	0.97	5717	a
D150	954 b	1.07	000	a
ICTA-Tamazulapa	952 b	0.81 *	7115	c
ICTA-Jutiapan	946 b	1.02	8442	a
BAT304	942 b	1.00	1031	a
1353	935 b	1.08	5868	a
NHuasteco-81	1035 a	1.01	20815 *	b
1234	1030 a	1.17 *	15963 *	f
1465	1024 a	1.15 *	10654 *	f
D149	1000 a	0.78 *	13759 *	d
BAT58	996 a	1.09	15337 *	b
BAT832	974 a	0.92	40116 *	b
BAT873	956 b	0.91	15404 *	b
ICTA-Quetzal	955 b	1.06	14964 *	b
BAT1057	929 b	1.04	10661 *	b
NJamapa	918 b	0.79 *	19903 *	d
BAT804	910 b	1.16 *	31874 *	f
BAT527	890 b	1.03	14649 *	b
BAT945	852 b	0.61 *	42464 *	d
P675-ICA-Pijao	1053 a	1.29 *	9567	e
L.S.D. (.05)	150	0.12	_	

<sup>\*</sup>Significantly different from 1.0 for the regression coefficient and from 0.0 for the deviation mean squares at 0.05 level of probability.

Genotypes N.-Huasteco-81, BAT58 and BAT832 had b values of one and high deviations from regression indicating good response in every environment but inconsistent yields (over time) in any given environment.

There are also five stable low yielding genotypes: D143, D150, ICTA-Jutiapan, BAT304 and 1353. However, low yielding characteristics place them at a disadvantage compared to the previously identified desirable genotypes. According to evidence about high heritability of deviations from regression (Eberhart and Russell, 1966), the stable genotypes may be used in breeding programs to transmit their yield stability to their offspring. This may be exploited by crossing other genotypes possessing other desired characteristics (pest or disease resistance) which might contribute to increased yield over time.

The remaining genotypic groups possess values for b=1 and  $s^2d>0$  indicating good response in all environments but inconsistent yields (over time) in any given environment or b<1 and  $s^2d>0$  indicating inconsistently better in unfavorable environments and b>1 and  $s^2d>0$  indicating inconsistently better in good environments. Therefore, those genotypes are not to be recommended for this region.

<sup>\*\*</sup>Classification according to Carballo (1970).

### CONCLUSION

Using the regression coefficient and deviation from regression parameters helped in selecting genotypes with good general adaptability, capable of producing higher bean yields under conditions of widely fluctuating seasonal environments; those genotypes are: BAT7 and 1374. This germplasm is recommended for planting in Eastern Mexico.

We also can suggest that the genotypes P675-ICA-Pijao, and 1196 be planted in that region under favorable environments. However, planting must be conducted under irrigated conditions to prevent rainfall fluctuations which may produce undesirable yields.

Nevertheless, because Porrillo-Sintetico was the best of all studied genotypes under unfavorable environments, it can be recommended to be planted in this region under rainfall growing conditions.

This research provides valuable information for the bean breeding program in Eastern Mexico. This information, combined with data about reaction to field infection of the most prevalent diseases and pests, should enable researchers to better determine the most appropriate use of these genotypes in their breeding program.

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# Botryosphaeria dothidea From Muskmelon: In Vitro Growth

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#### ABSTRACT

The muskmelon isolate of Botryosphaeria dothidea grew best in liquid culture at pH 7.2 followed by 6.7, 5.7, and 4.6. The vitamins nicotinamide, calcium pantothenate, biotin, and para-aminobenzoic acid suppressed growth after four days of incubation at 25C. Significantly less growth occurred when pyridoxine hydrochloride, thinamine hydrochloride, and inositol were individually absent or when all vitamins were present as compared with the control. Based on growth parameters, peptone was the most readily utilized nitrogen source at the four day harvest. However, by the seventh day, growth was greatest on glutamic acid. Sucrose and starch supported the most rapid growth of B. dothidea; fructose, mannose, maltose, mannitol, and methyl cellulose supported intermediate growth; and galactose supported the least growth. The optimum temperature range for growth was 25 to 32C. The muskmelon isolate of B. dothidea demonstrated chromogenic activity in Czapek's solution at 10 to 15 days and was physiologically similar in many respects to previously reported apple and currant isolates.

The ascomycete fungus Botrysphaeria dothidea (Moug. ex Fr.) Ces. & de Not. (= B. ribis Gross & Dugi.) causes serious fruit rots and cankers on may plants worldwide (Anderson, 1956; Shear et al., 1925; Smith, 1934; Stevens, 1926; Stevens and Shear, 1929; Weaver, 1974; Brown and Britton, 1986). Few reports of the effects of pH (Drake, 1968; Drake and Moore, 1966), carbon (Drake and Moore, 1966), nitrogen (Drake and Moore, 1967), and vitamin (Grossenbacker and Dugger, 1911) supplements are available in the literature. Drake and Moore (1966) demonstrated, with an apple isolate of B dothidea, that the optimum pH varied with the individual carbon source suppled. Also, maximum fungal growth varied with incubation time for the individual carbon sources. However, maltose, sucrose, d-glucose, d-fructose, amylopectin, dextrin, sodium polypectate, galacturonic acid, polygalacturonic acid, pectin, and L-malic acid were found to support superior growth, while the medium supplemented with citric acid supported the least growth. All nitrogen sources tested by Drake and Moore (1967) supported good to moderate growth. Kohn and Hendrix (1982) found the optimum temperature for infection of Top Red Delicious apples occurred between 30 and 35C and optimum rot developed between 26 and 32C.

In 1985, muskmelon fruit rot was added to the list of diseases caused by *B. dothidea* (Bruton and Taber, 1985). Because muskmelon is a major horticultural crop in Texas along with the expanding commercial peach production, an investigation was initiated to characterize and compare the *B. dothidea* (Texas 33) isolate from muskmelon with isolates from other host plants.

## MATERIALS AND METHODS

Nutritional Study. The effects of various nutrient sources on growth of Texas Isolate 33 were examined. These parameters included carbon and nitrogen sources as well as pH effect and vitamin requirement. Growth on both liquid and solid nutrient media was tested. In general, these methods followed those described by Taber et al. (1968) and Taber and Vining (1959).

Inocula for liquid cultures. Inocula were grown in media described below, in 250 ml Erlenmeyer flasks on a rotary shaker (140 rpm) at 25C. After three days, the mycelial mat was washed three times in sterile double-distilled water, and homogenized in a Waring Blender, and aloquats introduced into secondary flasks containing the same sterile media. Inocula in all cases consisted of mycelial fragments in sterile, double-distilled water of 3-day-old mycelium. A 10-ml aliquot was dried to constant weight at 50C and inocula concentrations were calculated from this weight. Inocula for the pH study were grown in 50 ml of yeast glucose liquid medium (10 g of yeast extract: 10 g of glucose/liter, pH 6.5). Inocula for the vitamin study were grown in the basal synthetic medium (see below) with no stock vitamin solution added.

Basic synthetic medium. The liquid medium was a modification of one used previously by Taber and Vining (1959), in which the carbon source, basal nitrogen, salts and vitamins were sterilized separately then combined at the time of inoculation: Carbon source (Part 1): consists of 15 g glucose, in 100 ml of water, and autoclaved in 500 ml flasks. Ten ml were aseptically added to each 40 ml of basal nitrogen and salts medium. Basal nitrogen and salts (Part 2): 1.5 g ammonium succinate; 1.9 g K<sub>2</sub>HPO<sub>4</sub>; 1.5 g KH<sub>2</sub>PO<sub>4</sub>; 300 mg MgSO<sub>4</sub>\*7H<sub>2</sub>O; and 20 mg FeSO4.7H2O were brought up to 800 ml with double-distilled water. One ml of stock salt solution was added and autoclaved for 20 min at 120C in 250-ml Erlenmeyer flasks. Stock salt solutions (Part 3): the stock salt solution was prepared individually in 100-ml volumetric flasks (ground glass stoppers): 595 mg CaC12\*2H2O, 440 mg ZnSO4\*7H2\*O; 275 mg MnSO4\*H2O; 255 mg NaC1; 26.9 mg CuC1, 2H, O, and 182 mg (NH<sub>4</sub>)6MO<sub>7</sub>O<sub>24</sub>4H<sub>2</sub>O. Stock vitamin solutions (Part 4): 1 g inositol; 0.1 g thiamine hydrochloride; 0.1 g pyridoxine hydrochloride; 0.1 g calcium pantothenate; 0.05 g nicotinamide; 0.05 g PABA, and 0.0005 g biotin were added to 1 liter of deionized water. Vitamins were filter-sterilized through a Millipore ultrafine (UF) filter (0.22 um) and refrigerated until used. One ml/50 ml of medium was added at time of inoculation.

Liquid pH media. The basic synthetic medium (pH 6.8) was adjusted with K<sub>2</sub>HPO<sub>4</sub>, KH<sub>2</sub>PO<sub>4</sub>, or succinic acid to give the following pH values: pH 4.6, 1.5 g of KH<sub>2</sub>PH<sub>4</sub>, and 3.0 g of succinic acid; pH 5.6, 1.5 g of KH<sub>2</sub>PO<sub>4</sub>, and 0.85 g of succinic acid; pH 6.8, unadjusted basic synthetic medium; and pH 7.5, 6.5 g of K<sub>2</sub>HPO<sub>4</sub>.

Vitamin requirement media. The ammonium succinate concentration was increased in the basal synthetic medium to 3.3 g for the vitamin study. Four replicates of media having the following combinations were harvested at two harvest dates (4 and 7 days): all vitamins or growth factors (Part 3), none of them, and all other combinations each with one vitamin omitted.

Liquid nitrogen source media. Nine different nitrogen sources were tested. Ammonium succinate was used as the reference nitrogen source. Weights of asparagine, urea, potassium nitrate, glutamic acid, peptone, glycine, phenylalanine, and leucine were varied to equal the amount of nitrogen in the ammonium succinate reference medium. Urea was filter-sterilized through a Millipore ultrafine filter; other sources were autoclaved at 120 C for 15 min. Vitamins were added to all nitrogen media following ultra-filtration.

Liquid carbon source media. Glucose served as the reference carbon source. Amounts of sucrose, maltose, mannose, fructose, glactose, mannitol, starch, and methyl cellulose were adjusted so that each contributed carbon at the rate of 6 g per 100 ml of stock solution. One series of eight replicates was prepared with no carbon source other than that contained in the ammonium succinate nitrogen source. Sterile, double-distilled water was substituted for the zero carbon source solution.

Solid media. To observe cultural characteristics, the test fungus was transferred onto solid media having the same composition as the liquid media, i.e. aliquots of the same lots of liquid media were used to make up agar plates. The agar was prepared by adding 50 ml of sterile, liquid medium to 1 g of sterile, dry agar which previously had been extracted with aqueous alcohol and aqueous acetone of various proportions (Taber et. al., 1968) to remove impurities.

In addition to the above specialized media, growth on 8 routine laboratory media was evaluated. These included rose engal streptomycin agar (RBS) (Martin, 1950), Difco potato dextrose agar (PDA), fresh PDA agar (RPDA), V-8 juice agar (V-8) (Miller, 1955), Difco malt agar (MA), Difco Czapeks agar (CZ), and Difco cornmeal agar (CMA).

Effects of light. Cultures of Texas 33 isolate of B. dothidea were grown in total darkness, normal laboratory lighting or constant fluorescent light. Inocula consisted of 1 cm discs cut and inoculated onto corresponding routine laboratory media listed above. Cultures were incubated for four days. Colony diameter was measured at 2 and 4 days.

Effects of temperature. Preliminary studies indicated Texas 33 grew well between 20 and 35C. More critical temperature regimes were therefore implemented using 23, 25, 28, 30, 32, and 35C. Inocula were prepared according to the methods outlined under Effects of light. Colony diamters were measured at 5 days.

Chromogenic activity. To determine if the muskmelon isolate of B. dothidea had chromogenic activity, the fungus was grown on potato dextrose broth and Czapek's solution of pH 7.3 for 15 days. General Electric lights (F40-P1), 42 cm above the shaker, provided a 12 hr photoperiod at 24±1C. Erlenmeyer flasks containing 50 ml of nutrient solution and the test fungus were rotated at 140 rpm for 15 days. The fungus was filtered using #2 Whatman filter paper and the filtrate poured into 10 ml test tubes (16 mm OD, 100 mm L) and compared to Maerz and Paul (1930) color plate II.

#### RESULTS AND DISCUSSION

Effect of pH. The muskmelon isolate of B. dothidea grew best in liquid culture at an initial pH 7.2 followed by 6.7, 5.7, and 4.6 (Table 1). In general, the pH of the media changed toward pH 6.0 over time. Drake and Moore (1966) reported excellent growth over a pH range of 4.0 to 7.5, with sucrose as the carbon source with an optimum pH range of 6 to 7. Maximum growth varied with time for the individual carbon sources. In the present study, in which glucose was used as the carbon source, the results corresponded closely with those Drake and Moore (1966). On solid media, growth was superior at pH 6.7 compared to pH 5.7, 4.6, and 7.2 (Table 2).

Table 1. Effect of pH on growth of Botryosphaeria dothidea in liquid culture<sup>x</sup>

Initial	4 days		7 days		
pH	Growth (mg)	ΔpH	Growth (mg)	ΔpH	
7.2	321.7 a <sup>y</sup>	-0.4	870.7 a <sup>y</sup>	-0.2	
6.7	288.8 b	-1.3	750.0 b	-0.4	
5.7	208.0 c	-0.5	753.8 b	+0.2	
4.6	171.6 d	-0.7	569.9 c	+1.1	

x Data are mean values of three replicates of 4 samples each.

y Means followed by the same letter are not significantly different (P=0.05) according to Fisher's least significant difference test.

Table 2. Effect of pH on growth and pycnidia development of Botryosphaeria dothidea on solid media<sup>x</sup>

	Radial gro	Radial growth (mm)y		ycnidia <sup>z</sup>
pН	0-2 days	2-4 days	#/cm <sup>3</sup>	Size rating <sup>x</sup>
6.7	15.8 a	20.8 a	2264 b	3.4 b
5.7	15.6 a	20.4 a	2597 a	3.5 ab
4.6	14.6 b	19.4 b	2587 a	3.6 a
7.2	12.5 c	17.3 c	2652 a	3.1 c

Means followed by the same letter are not significantly different (P=0.05) according to Fisher's least significant difference test.

Mycelial growth characteristics on solid media ranged from fuzzy aerial mycelium at pH 5.7 and 6.7 to thick but appressed mycelium at pH 4.6 to thin and appressed mycelium at pH 7.2. Numbers of pycnidia/cm³, on solid media, at pH 5.7, 4.6, and 7.2 were significantly greater than at pH 6.7 (Table 2). Pycnidial sizes at pH 7.2 were significantly smaller as compared to those produced at a lower pH.

Effects of vitamins. B. dothidea grew better after four days in liquid culture to which all the vitamins had been omitted as compared to the all vitamin treatment (Table 3). In addition B. dothidea grew as well in the no vitamin medium as when nicotinamide, calcium panthothenate, biotin, and para-aminobenzoic acid had been individually excluded from the all vitamin treatment. Growth of the fungus, in the no vitamin treatment, was greater than in the all vitamin treatment from which pyridoxine hydrochloride, thiamine hydrochloride, or inositol had been excluded. By the seven day harvest, only the all vitamin treatment was associated with a significant reduction in growth. In general, these data support the work of Drake (1968), however, there are difficulties in comparison due to the difference in design of the two studies. He found that 19% more growth occurred in media (pH 4.0) with combinations of certain vitamins and that some vitamins, including inositol, pyridoxine, biotin, and thiamine combination suppressed growth. Esposito et al. (1962) studied growth factor requirements of fungi associated with banana decay. They studied six genera of fungi including Gloeosporium musarum, Botryodiplodia theobromae, Nigrospora sphaerica, Thielaviopsis paradoxa, Verticillium theobromae, and Fusarium roseum and found all required biotin for growth and some were inhibitied by thiamine. They provided an explanation for inhibition of growth of F. roseum by thiamine by documenting the stimulation of ethanol production and accumulation. Ethanol was postulated to be the actual inhibitor. Biotin was able to reverse the effect of thiamine and the involvement of biotin in the removal of a precursor (pyruvate) was suggested. The pH in all treatments declined with time.

The all vitamin and no vitamin treatments provided greatest radial growth on the solid medium from zero to two days (Table 4). Growth from two to four days on the no vitamin treatment was significantly less than the other treatments. Vitamin supplements had little effect on pycnidial size. The exclusion of para-aminobenzoic acid increased pycnidial production and

y Data are mean values of four replicates of 10 samples each.

Data are mean values of four replicates of 6 samples each.

xx Size rating based on mean of at least 100 pycnidia: 1 = no pycnidia; 2 = 250 um or less; 3 = 250-350 um; 4 = 350-450 um; and 5 = 450 um or greater.

Table 3. Effect of selected vitamins on growth of Botryosphaeria dothidea in liquid culturex

	Initial	4 da	tys	7 days	
Vitamin source	pH	Growth (mg)	ΔpH	Growth (mg)	△ pH
No vitamins	6.6	235.1 a <sup>y</sup>	-0.8	805.3 a <sup>y</sup>	-1.0
All vitamins	6.6	204.3 b	-0.7	675.3 b	-1.1
All vitamins minus:					
Nicotinamide	6.6	248.8 a	-1.0	792.7 a	-0.9
Calcium pantothenate	6.6	247.6 a	-0.9	834.6 a	-0.8
Biotin	6.6	240.8 a	-0.8	769.0 a	-1.0
Para-aminobenzoic acid	6.6	238.7 a	-0.8	788.0 a	-1.0
Pyridoxine hydrochloride	6.6	215.1 b	-0.8	801.0 a	-0.9
Thiamine hydrochloride	6.6	204.4 b	-0.7	767.3 a	-1.1
Inositol	6.6	204.0 b	-0.7	778.7 a	-0.

x Data are mean values of three replicates of 4 samples.

y Means followed by the same letter are not significantly different (P = 0.05) according to Fisher's least significant difference test.

Table 4. Effect of selected vitamins on growth and pycnidial development of Botryosphaeria dothidea on solid media<sup>x</sup>

	Radial gro	wth (mm) <sup>y</sup>	Pycnidia <sup>z</sup>		
Vitamin source	0-2 days	2-4 days	#/cm <sup>3</sup>	Size (rating) <sup>xx</sup>	
All vitamins	12.8 a	24.9 a	1302 bc	4.1 ab	
No vitamins	12.2 a	24.0 c	1262 bc	4.0 b	
All vitamins minus:					
Para-aminobenzoic acid	11.0 b	24.9 a	1603 a	4.0 b	
Nicotinamide	10.8 b	26.0 a	1044 e	4.2 a	
Calcium pantothenote	10.8 b	24.6 b	1136 de	4.1 ab	
Thiamine hydrochloride	10.6 bc	24.9 b	1295 bc	4.0 b	
Biotin	10.2 bcd	25.8 a	1168 cd	4.1 ab	
Pyridoxine hydrochloride	9.8 cd	25.0 b	1207 cd	4.1 ab	
Inositol	9.4 b	25.6 a	1322 b	4.2 a	

x Means followed by the same letter are not significantly different (P = 0.5) according to Fisher's least significant difference test.

y Data are mean values of three replicates of 10 samples each.

<sup>&</sup>lt;sup>z</sup> Data are mean values of three replicates of 6 samples each.

xx Size rating based on mean of at least 100 pycnidia: 1 = no pycnidia; 2 = 250 um or less; 3 = 250-350 um; 4 = 350-450 um; and 5 = 450 um or greater.

the exclusion of nicotinamide and calcium pantothenate inhibited production. Mycelial characteristics were similar in all treatments. Hyphae were appressed with little aerial mycelium.

Effects of nitrogen source. By four days, B. dothidea grew on all nitrogen sources tested with the exception of glycine (Table 5), with the best growth on the medium augmented with peptone. By the seventh day growth was greatest on glutamic acid and urea and all out performed the no nitrogen control. Glycine supported growth the least. The final pH of all media was lower than the initial pH except for the media containing glutamate or potassium nitrate. The final pH of the latter two media would be expected to increase with time as utilization of the nitrogen-containing anions in the presence of excess sodium or potassium would result in the production of Na or K bicarbonate. The result of a study by Drake and Moore (1967) concerning utilization of various nitrogen sources by B. ribis is somewhat at variance with others. However, as was the case in the carbon study, there are several key differences between the studies, i.e., initial pH, incubation periods, and use of different carbon sources in the basic media.

On solid media, early growth was dependent upon added nitrogen source (Table 6). Radial growth from two to four days was best on asparagine and urea. Pycnidial production was better on all nitrogen sources tested than on the no nitrogen control. Overall these results seem to agree with Klebs Laws (1900) regarding fungal development which states that nutritional conditions which favor mycelial growth often do not favor reproduction and vice versa. Nitrogen source has much less affect on pycnidial size than does carbon source. Mycelial characteristics for the nitrogen sources were essentially the same, being more or less fuzzy and appressed.

Effect of carbon source. Sucrose and starch supported the most rapid growth of B. dothidea in liquid culture through seven days; fructose, mannose, glucose, maltose, mannitol, and methyl cellulose were intermediate and galactose the least growth (Table 7). These data are somewhat in contrast to that for B. ribis (Drake and Moore, 1966) in which maltose, sucrose, D-glucose and D-fructose supported superior growth with starch and cellulose supporting intermediate growth. There are three principal differences between this study and that of Drake and Moore (1966). Firstly, we used ammonium succinate as the nitrogen source; they used ammonium nitrate; secondly, our initial pH was adjusted to approximately 6.7; they used 4.0; and thirdly, our harvests were at 4 and 7 days; they harvested at 2 day intervals for 24 days. In general, there appeared to be a direct relationship between growth and a pH reduction in the media as compared to the initial pH.

On solid media, sucrose provided the best growth (Table 8). Starch in solid agar appears to be less supportive of growth when compared to liquid media. Methyl cellulose and galactose were poor carbon sources for *B. dothidea*. Aerial mycelium ranged from moderately fuzzy to very fuzzy on all carbon sources except for methyl cellulose and galactose. Pycnidial production was poor on methyl cellulose, galactose, and no carbon. Pycnidial size rating ranged from 3.0 for sucrose to 5.0 for galactose, with the average rating, excluding galactose being 3.4. It appears that galactose as a carbon source has a large effect on pycnidial size.

Effect of light. B. dothidea grew best on V-8 agar and poorest on CMA under all three light conditions tested (Table 9). Light conditions influenced the rate of radial growth. Aerial tufts of gray hyphae formed on V-8, RBS, and MA. Pycnidia formed under all three conditions; however, production was stimulated under constant fluorescent light. Darkest pigment formation occurred in MA, although hypae were dark gray on all media.

Effect of temperature and common laboratory media on growth. Growth of B. dothidea was most rapid on V-8 agar at all temperatures (Talble 10). Between 25 and 32C best growth occurred on MA, PDA, and RPDA. With the exception of growth on V-8 agar, growth was slower above 32C on all media and also below 25C. Abundance and size of pycnidia varied with the medium composition. In general, pycnidia formed in decreasing order of occurrence, on MA, PDA, RPDA, CZ, RBS, V-8, and CMA. Largest pycnidia formed on MA and the pattern of

Table 5. Effect of nitrogen source on growth of Botryosphaeria dothidea in liquid culturex

	Initial	4 days		7 days	
Nitrogen source	pH	Growth (mg)	Δ рН	Growth (mg)	∆ рН
Peptone	6.8	393.5 a	-0.2	734.4 c	-0.4
L-Asparagine	6.8	350.5 b	0.0	788.0 b	-0.3
Urea	6.8	321.6 c	-0.1	805.9 a	-0.5
Ammonium succinate	6.7	273.2 d	-1.3	641.8 d	-0.5
L-Glutamic acid	5.4	206.9 e	+1.0	829.6 a	+1.4
L-Phenylalanine	6.8	154.6 f	-0.2	738.9 c	-0.6
Potassium nitrate	6.8	119.5 g	+0.3	472.3 f	+0.8
L-Leucine	6.8	115.7 g	-0.3	514.5 e	-0.9
Glycine	6.8	32.8 h	0.0	129.5 g	-0.1
No nitrogen	6.8	18.6 h	0.0	16.2 h	-0.0

<sup>x</sup> Data are mean values of three replicates of 4 samples each.

y Means followed by the same letter are not significantly different (P = 0.05) according to Fisher's least significant difference test.

Table 6. Effect of nitrogen source on growth and pycnidial development of Botryosphaeria dothidea on solid media<sup>x</sup>

	Radial gro	wth (mm) <sup>y</sup>	P	ycnidia <sup>z</sup>
Nitrogen source	0-2 days	2-4 days	#/cm <sup>3</sup>	Size rating <sup>xx</sup>
No Nitrogen	9.5 a	21.0 f	182 h	3.0 b
Ammonium succinate	9.4 a	27.1 b	1973 c	3.0 b
L-Asparagine	9.2 a	28.6 a	2407 b	2.7 c
Peptone	9.1 a	27.4 b	1328 g	3.3 a
Urea	8.4 b	28.6 a	1867 f	3.0 b
L-Glutamic acid	7.4 c	20.5 g	2617 a	2.6 cd
Potassium nitrate	6.9 c	25.1 c	2444 b	2.5 d
L-Phenylalanine	5.5 d	23.3 c	1757 e	3.1 b
L-Leucine	5.3 d	22.0 e	1969 с	3.0 b
Glycine	3.0 e	20.8 fg	1399 f	3.3 a

Means followed by the same letter are not significantly different (P = 0.5) according to Fisher's least significant difference test.

y Data are mean values of three replicates of 10 samples each.

<sup>&</sup>lt;sup>2</sup> Data are mean values of three replicates of 6 samples each.

xx Size rating based on mean of at least 100 pycnidia: 1 = no pycnidia; 2 = 250 um or less; 3 = 250-350 um; 4 = 350-450 um; and 5 = 450 um or greater.

Table 7. Effect of carbon source on growth of Botryosphaeria dothidea in liquid culturex

	Initial	4 days		7 days	
Carbon source	pH	Growth (mg)	ΔpH	Growth (mg)	ΔpH
No carbon	6.7	16.3 g <sup>y</sup>	+0.5	32.0 h <sup>y</sup>	+1.4
Sucrose	6.7	491.8 a	-1.4	661.5 ab	-0.4
Starch	6.7	398.9 b	-1.1	697.7 a	-0.2
D-Fructose	6.6	281.1 c	-1.1	625.8 b	-0.2
D(+) Mannose	6.7	249.0 d	-0.9	573.3 c	-0.2
D-(+)-Maltose	6.7	240.8 d	-1.1	523.1 d	-0.8
-D(+)-Glucose	6.5	201.2 e	-0.9	507.8 d	-0.2
D-Mannitol	6.6	141.4 f	-0.4	415.0 e	-0.1
Methyl cellulose	6.7	128.5 f	+0.6	147.0 f	+1.3
D-Galactose	6.6	17.1 g	+0.1	80.0 g	+0.9

x Data are mean values of three replicates of 4 samples each.

y Means followed by the same letter are not significantly different (P = 0.05) according to Fisher's least significant difference test.

Table 8. Effect of carbon source on growth and pycnidial development of Botryosphaeria dothidea on solid media<sup>x</sup>

	Radial gro	wth (mm) <sup>y</sup>	Py	renidia <sup>z</sup>
Carbon source	0-2 days	2-4 days	#/cm <sup>3</sup>	Size rating <sup>x</sup>
No carbon	5.4 f	12.4 g	92 e	3.8 b
Sucrose	14.0 a	25.3 b	1964 b	3.0 d
D-Fructose	10.5 b	25.9 ab	1617 c	3.7 b
D(+) Mannose	9.2 c	26.1 a	1652 c	3.8 b
-D(+)-Glucose	8.3 d	21.1 d	2033 b	3.3 cd
D-Mannitol	8.2 d	19.4 e	1803 bc	4.0 b
Starch	8.2 d	23.9 с	1911 в	3.3 c
D-(+)-Maltose	6.6 e	24.2 c	2695 a	3.3 c
Methyl cellulose	5.0 f	15.2 f	100 e	3.0 d
D-Galactose	3.2 g	2.7 h	792 d	5.0 a

Means followed by the same letter are not significantly different (P = 0.5) according to Fisher's least significant difference test.

y Data are mean values of three replicates of 10 samples each.

<sup>&</sup>lt;sup>2</sup> Data are mean values of three replicates of 6 samples each.

 $<sup>^{</sup>xx}$  Size rating based on mean of at least 100 pycnidia: 1 = no pycnidia; 2 = 250 um or less; 3 = 250-350 um; 4 = 350-450 um; and 5 = 450 um or greater.

Table 9. Growth of Botryosphaeria dothidea on media under three light regimes<sup>x</sup>

	Growth (cm) on various media <sup>y</sup>						
Light regime	MA	RPDA	PDA	CZ	RBS	V-8	СМА
Constant fluorescent	4.5	6.6	7.0	7.1	6.9	7.8	3.9
Constant darknesss	6.2	6.6	5.9	4.0	4.8	8.0	3.4
Room light	6.3	7.3	6.7	4.4	7.2	8.0	4.4

x Four day old agar cultures at 25C.

Table 10. Effect of temperature and media on growth of Botryosphaeria dothidea from muskmelon<sup>x</sup>

Temp.	MA <sup>y</sup>	RPDA	PDA	CZ	RBS	V-8	CMA
23	5.5	7.5	7.5	5.3	4.5	8.5	4.8
25	8.0	8.5	8.4	6.1	4.8	8.5	6.0
28	8.3	8.5	8.5	8.1	4.1	8.5	6.0
30	7.9	8.4	8.5	8.0	5.6	8.5	6.6
32	7.8	8.5	8.5	8.0	6.1	8.5	6.0
35	4.0	3.0	3.0	3.0	2.3	5.5	4.5

x Growth after 5 days (cm).

formation was distinctive in that they developed in radial lines from the center of the colony. Smallest pycnidia formed on V-8 agar where they formed irregularly over the colony and appeared randomly distributed. Although growth on CMA was sparse, the few pycnidia that formed were almost as large as those on MA.

Chromogenic activity. The muskmelon isolate of B. dothidea demonstrated chromogenic activity in Czapek's solution after 10 days with optimum production at 15 days. The pigment color was yellow with very slight orange or red-orange tint. Using the Dictionary of Color

y MA = malt agar; RPDA = fresh potato dextrose agar; PDA = potato dextrose agar; CZ = Difco Czapeks agar; RBS = rose bengal streptomycin agar; V-8 = V-8 juice agar; CMA = Difco cornmeal agar.

y MA = malt agar; RPDS = fresh potato dextrose agar; PDA = Difco potato dextrose agar; CZ = Difco Czapeks agar; RBS = rose bengal streptomycin agar; V-8 = V-8 juice agar; CMA = Difco cornmeal agar.

(Maerz and Paul, 1930), the pigment was rated (Color plate 11) after 15 days as follows: G-5, I-6, J-5, J-6, J-7, and K-6. Chromogenic activity was not observed on PDA. Grossenbacher and Duggar (1911) reported a purplish-pink coloration when certain *B. dothidea* isolates were grown on a starch medium. They named the chromogenic isolates *B. ribis f. chromogena* and the nonchromogenic isolates *B. ribis f. achromogena*. They reported that the chromogenic form was parasitic on currant and that the non-pigmented form was parasitic on currant and that the non-pigmented form was saprophytic. Shear et. al. (1925) stated that the *B. ribis* commonly found on apples in the U.S. was nonchromogenic. Stevens (1926) stated that the occurrence of *B. ribis f. chromogena* was reported on host other than currant in 1924 (Stevens and Jenkins, 1924) and that it occurred on host south of the limit of cultivation of the currant. Cooley and Fenner (1926) reported both forms of the fungus produced a similar rot on apples. Ting (*Aleurites montana*) isolates growing on starch medium produced a yellow pigment (Wiehe, 1952). Witcher and Clayton (1963) and Weaver (1974) demonstrated that chromogenic activity is not correlated with pathogenicity but is affected by pH and light.

Since fruits of many plants are attacked by B. dothidea, it is conceivable that several strains of the fungus also exist and that they may be recognizable by differences in nutrition, pigment production, responses to various environmental conditions, or to various combinations of these parameters. This study of the isolate present on muskmelon was conducted to characterize it and to provide information that would allow eventual comparison with isolates from other fruits.

Our muskmelon isolate (Texas 33) of *B. dothidea* resembles the isolate studies by Drake (1968) from apple. With exception of poorer utilization of glucose by the muskmelon isolate, this strain and that of Drake and Moore (1967) did not differ strikingly; both can utilize a variety of carbon sources for vegetative growth and pycnidium formation. An absolute requirement for an external source of B vitamins was not demonstrable. Both isolates utilize a wide variety of nitrogen sources and utilization influenced the culture medium pH in a predictable manner, that is, residual cation of nitrogen source containing anionic nitrogen caused an eventual increase in pH toward alkalinity (NaNo<sub>3</sub> and salts of amino acids). Utilization of ammonium succinate caused a decrease in pH, indicating the cationic nitrogen was used more rapidly than the organic anion.

Maximum growth occurred above neutrality in liquid but not solid media. Growth was markedly less at pH 4.6 in liquid but not solid media. It is interesting that other workers (Drake and Moore, 1966; Drake and Moore, 1967; Moore and Drake, 1966) used initial pH of 4.0 in their studies because this is the pH of apple juice. Based on our study, pH near 4.0 is suboptimal for fungal growth.

No consistent effect of light upon mycelial growth was noted. There was interactions between light regimes and media which affected relative mycelial growth. Constant fluorescent light favored growth on Czapeks-Dox and PDA but not on other media. Vegetative growth occurred over a wide temperature range, the relative amount varying with the medium composition. Best growth occurred between 25 and 32C with growth uniformly less at 35C.

Pycnidia were formed under all light regimes and media. Pycnidial sizes and distribution patterns were greatly influenced by temperature. Pigment formation by *B. dothidea* appears to vary with the isolate and medium composition, although various environmental conditions may account for these differences. Pigment formation may be characteristic of individual strains and further comparative studies will be required to correlate these factors.

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# Seed Coat-Mediation of Lettuce Germination Responses to Heat and Sodium Chloride

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Additional Index Words: thermodormancy, Lactuca sativa L., ACC, ethylene, kinetin.

## ABSTRACT

Seeds from 'Val-Tex 39' and 'Floricos' lettuce (Lactura sativa L.) were tested for tolerance to both heat and sodium chloride (NaCl) stress. Germination was measured using intact seeds and embryos with seed coats removed. 'Val-Tex 39' seed became dormant at 30°C, while 'Floricos' germination was 10% at 34°C. 'Val-Tex 39' was more susceptible to NaCl stress imposed by increasing concentrations of NaCl. 'Floricos' seed were tolerant to NaCl concentrations as high as 6000 ppm. Tolerance to stress in both cultivars was increased by removing the seed coat. The pattern of stress tolerance was unique to each cultivar and suggested that the stress response was controlled primarily in the embryo and not by the seed coat. Cultivar differences in the response of embryos to stress also were reflected in the sensitivity of 'Val-Tex 39' to 1-aminocyclopropane-1-carboxylic acid and kinetin treatments. These results imply that the increased tolerance to heat and salt stress associated with 'Floricos' may be the consequence of amplified hormone metabolism in the embryo.

Lettuce as a species has evolved germination requirements for low temperatures. These requirements apparently provide the advantage of delaying germination until the environment has become favorable for seedling establishment and growth (Vidaver, 1977). The loss of germination at high temperatures or thermodormancy continues to be expressed by most commercial producers in warm climates. Increasing concentrations of salt or NaCl found in irrigation water also delay or inhibit lettuce seed germination (Khan & Huang, 1988). Poor germination of lettuce exposed to heat and salt have been attributed to a reduction in the capacity for embryo expansion (Abeles, 1986; Dunlap & Morgan, 1976a; Khan & Huang, 1988). However, mechanically rupturing the seed coat overcomes dormancy and increases the capacity for germination at high temperatures and low water potentials (Prusinski & Khan, 1990).

Ethylene and kinetin are proposed to overcome heat and salt stress by increasing the expansion force of the lettuce embryo which ruptures the seed coat barrier to radical growth (Dunlap & Morgan, 1974; Dunlap & Morgan, 1977b; Khan & Huang, 1988; Prusinski & Khan, 1990). Prusinski & Khan (1990) showed that cultivar tolerance to stress was related to the inherited capacity for ethylene production. Despite the vast amount of research conducted with lettuce seed germination, no clear mechanistic relationship between ethylene synthesis, ethylene action, and the reduced capacity for embryo expansion at high temperatures is apparent (Dunlap & Morgan, 1976b; Dunlap & Morgan, 1977a). Understanding the individual functions of the seed coat and embryo during stress conditions is critical to the development of new strategies for the breeding of stress tolerant lettuce. In the present research, the germination of a thermosensitive and thermo-tolerant lettuce cultivar was determined with heat and NaCl stress in the presence of 1-aminocyclopropane-1-carboxylic acid (ACC) and kinetin. Comparisons of the germination response for each treatment were determined with intact seeds and isolated embryos.

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#### MATERIALS AND METHODS

Lettuce seed (Lactuca sativa L.) of the cultivars 'Val-Tex 39' and 'Floricos' were germinated on four layers of paper toweling placed in 9 cm plastic weigh boats and sealed in 1-pint plastic freezer bags after wetting with 6 ml of the appropriate chemical solution. Each test was repeated at least three times with 20 intact seed or 20 embryos from which the seed coat had been removed after soaking in water for 2-4 hours. The "seed coat" as defined within the context of these experiments includes the pericarp, seed coat and endosperm. The "embryo" then consists of embryonic axis and attached cotyledons. Although anatomically incorrect, "seed coat" and "embryo" are defined in this manner to maintain compatibility with terms commonly used in the existing literature on lettuce seed germination. Using a binocular microscope, each embryo was forced from the moistened seed coat by gently pressing on the cotyledonary end with a pair of forceps. The intact seed and embryos were germinated in the light provided by two, 20-W cool, white fluorescent tubes (46 uE 5-1m-2) at temperatures ranging from 28°C to 38°C in 2°C increments and exposed to 0 to 16,000 ppm of NaCl at intervals of 1000 to 2000 ppm. Seeds and embryos were incubated in solutions of ACC (1.0 mM) and kinetin (0.1 mM) containing NaCl and exposed to supraoptimal temperatures. Tests were scored for germination at 24 h by counting seeds and embryos exhibiting geotropic curvature of the radical.

#### RESULTS

At least 90% of the seed from both 'Val-Tex 39' and 'Floricos' germinated at ambient air temperature near 28°C. 'Val-Tex 39' failed to germinate at 30°C while 'Floricos' exhibited the capacity for limited germination even at 34°C (Fig. 1). However 'Val-Tex 39' embryos were capable of germination from 30°C to 34°C after removal of the seed coat. Removing the seed coat from 'Floricos' embryos permitted complete germination at temperatures as high as 36°C which normally inhibit the intact seed.

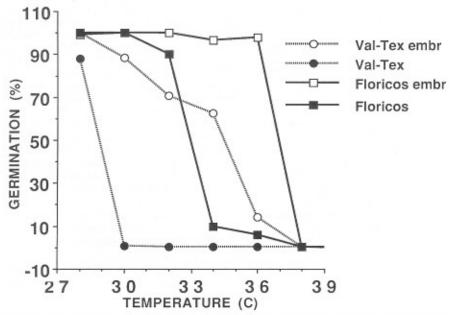


Fig. 1 Percent germination of intact seeds and embryos from 'Val-Tex 39' and 'Floricos' lettuce incubated at 28°C to 38°C.

The germination of 'Val-Tex 39' seed at 28°C decreased from 90% at 2000 ppm to less than 30% at 4000 ppm of NaCl (Fig. 2). Embryos were capable of nearly 100% germination at 4000 ppm but declined abruptly to approximately 10% at 6000 ppm of NaCl. Intact 'Floricos' seed showed no inhibition at 6000 ppm and only 40% germination at concentrations as high as 10,000 ppm of NaCl. The germination of 'Floricos' embryos was inhibited to approximately the same level as the intact seed by NaCl concentrations greater than or equal to 12,000 ppm.

At temperatures above 28°C, 'Val-Tex 39' and 'Floricos' seed became more sensitive to salt as indicated by 50% inhibition of germination at lower concentrations of NaCl (Fig. 3). Only 1000 ppm NaCl was required to inhibit the germination of 'Val-Tex 39' embryos by 50% at 30°C to 32°C while 5000 ppm was required at 28°C. The inhibition of intact 'Floricos' seed by the combination of heat and NaCl stress was similar to the response of 'Val-Tex 39' while the embryos expressed a much greater tolerance to the same treatments.

The cumulative effects of heat and NaCl on germination were overcome in 'Val-Tex 39' embryos by treating with ACC and/or kinetin (Fig. 4). As the NaCl concentrations increased at a constant temperature, only the combination of ACC and kinetin was capable of promoting germination. Although generally more stress tolerant than 'Val-Tex 39', 'Floricos' embryos were responsive to the same treatments (Fig. 5). The germination of 'Floricos' embryos was stimulated equally well by all hormone treatments across a broad concentration range but abruptly became unresponsive at 10,000 ppm of NaCl.

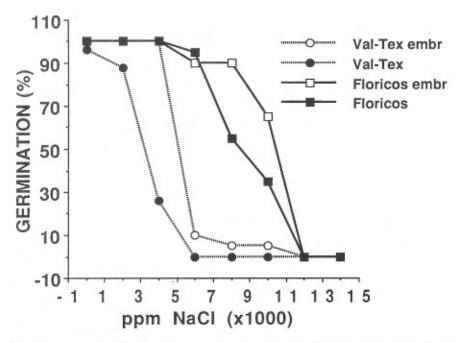


Fig. 2 Percent germination of intact seeds and embryos from 'Val-Tex 39' and 'Floricos' lettuce incubated at 28°C in 0 to 14,000 ppm sodium chloride.

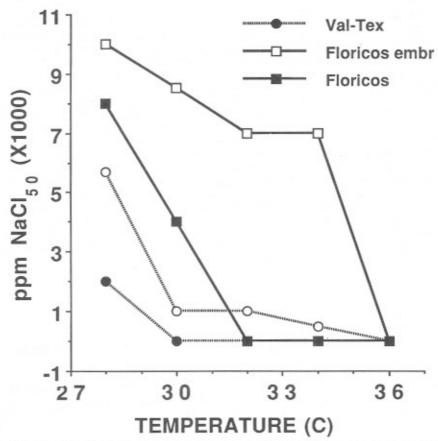


Fig. 3 Concentrations of sodium chloride required to inhibit the germination of intact seeds and embryos from 'Val-Tex 39' and 'Floricos' lettuce by 50% (NaCl<sub>50</sub>) at incubation temperatures between 28°C and 36°C.

### DISCUSSION

The difference in germination between seed and embryos subjected to increasing temperatures indicate that both the structural features of the seed coat and physiologic properties of the embryo are controlling thermodormancy. The same conclusion applies to germination in the presence of increasing NaCl concentrations. These data suggest that the physiological makeup of the embryo determines the thermodormancy characteristics of a cultivar. The germination of 'Val-Tex 39' and 'Floricos' embryos were inhibited 50% at  $34.5^{\circ}$ C and  $37^{\circ}$ C, respectively. The seed coat had the additive effect of lowering the upper temperature limit for germination to  $28.5^{\circ}$  ( $-6.5^{\circ}$ C) and  $33^{\circ}$ C ( $-6.0^{\circ}$ C) in 'Val-Tex 39' and 'Floricos', respectively. It appears that thermodormancy is controlled primarily in the embryo and the result of cultivar differences between the seed coats.

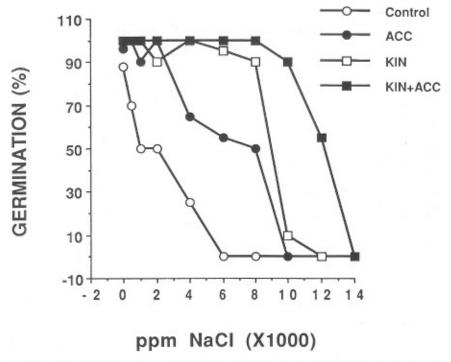


Fig. 4 Percent germination of 'Val-Tex 39' lettuce embryos treated with water (Control), 1-aminocyclopropane-1-carboxylic acid (ACC) and kinetin (KIN) at 30°C in 0 to 14,000 ppm sodium chloride.

Heat and NaCl interacted to suppress the germination of lettuce. Treatments such as ACC and/or kinetin that improved the germination of seed subjected to heat stress also improved the germination of seed exposed to NaCl stress. A similar mechanism appears to be responsible for both heat and NaCl tolerance in lettuce. However, a closer look at the cultivars response reveals very different trends with respect to germination in the presence of heat and NaCl. With the exception of 'Val-Tex 39' embryos, the response to increasing temperatures is characterized by a very abrupt loss of germination implying a sharp threshold for the response. The response trend to NaCl was more gradual and typical of a quantitative change in tolerance to stress. 'Val-Tex 39' embryos were the exception, displaying a more abrupt loss of tolerance between 4000 and 6000 ppm of NaCl. The behavior of 'Val-Tex 39' embryos subjected to heat or NaCl stress is quite different from the 'Floricos' embryos exposed to the same series of treatments. Therefore, different genetic mechanisms may account for the difference in stress responses between 'Val-Tex 39' and 'Floricos' rather than just a quantitative difference in the same physiological mechanism.

An apparent qualitative difference also was reflected in the hormonal response of embryos subjected to increasing concentrations of NaCl at a constant temperature. Operating at the threshold temperature for inhibition of embryo germination (36°C), 'Floricos' responded equally well to ACC, kinetin, or ACC+kinetin as the NaCl concentration increased to 8000 ppm. The resonse of 'Val-Tex 39' embryos to the same series of treatments was quite different. At the comparable temperature threshold for germination (30°C), the combination of

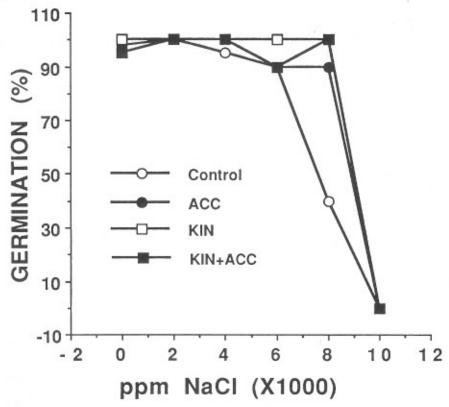


Fig. 5 Percent germination of 'Floricos' lettuce embryos treated with water (Control), 1-aminocyclopropane-1-carboxylic acid (ACC) and kinetin (KIN) at 36°C in 0 to 14,000 ppm sodium chloride.

ACC+ kinetin was the most effective treatment with ACC or kinetin becoming ineffective at 10,000 ppm while germination in the presence of ACC+ kinetin remained near 90%. 'Val-Tex 39' appears to suffer from interference with the operation of two critical metabolic steps while the more tolerant 'Floricos' contains only a single stress-sensitive step.

The more heat tolerant cultivar, 'Floricos', is also the more tolerant to NaCl stress. The difference in tolerance seems to reside primarily in the embryo and not the seed coat. The genetic regulation of thermodormancy and NaCl stress appear to be controlled by similar genetic mechanisms. Treatments such as "seed priming" and hormones used to overcome thermodormancy in lettuce may confer additional tolerance to NaCl stress. Short-term solutions can include transplants to avoid early stresses or commercial priming and chemical seed treatments. The longer effort will require breeding programs designed to incorporate the biological processes responsible for tolerance to heat and salt stress in 'Floricos' into the more sensitive commercial cultivars such as 'Val-Tex 39'. Our results suggest that breeding for high-cytokinin (kinetin) and ethylene producing seed will improve germination under stress. Breeding efforts directed at increasing embryo tolerance will result in greater gains from selection, with secondary emphasis on the seed coat.

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# The Effects of Discrete Wavelengths of Light on Sporulation of Colletotrichum dematium

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Additional Index Words: fungal pathogen, fungal development, onion

# ABSTRACT

The fungal pathogen of onion, Colletotrichum dematium (Berk.) Sacc., was exposed to multiband and discrete band light sources, alone for 20 min or in sequential, paired, combinations to determine the effects on sporulation with comparison made to continuous dark treatment. Fewest spores were produced in the dark while the most were produced by exposure to continuous fluorescent light. Differences in energy levels of the discrete light sources did not affect sporulation. The reversal of sequenced 450 and 750 nm and 650 and 750 nm light produced significant differences in sporulation. All other combinations of light sources did not. When used in sequential combinations light in the 550 nm band may have inhibited sporulation of this fungus.

The fungus *C. dematium* is the causal organism of an onion disease termed smudge. Initial infection normally occurs in the field but symptoms are most noticeable in transit and storage (Walker, 1969). Storage conditions can inhibit or enhance disease development. Fungal morphogenesis can be controlled by light quality and quantity in ways analagous to higher plants which are governed by photoreceptors. Several reports hypothesized the presence in fungi of a photoreceptor termed "mycochrome" which is active in the near-ultraviolet (NUV) and blue light range (Honda, 1969; Kumagai and Oda, 1969; Tan, 1974a, 1975; Tan and Epton, 1974). Tan (1974b, 1975) and Osman and Valadon (1979) proposed a photoreceptor for fungi which appears to be active in the portion of the electromagnetic spectrum similar to that for phytochrome in plants (Fredericq and De Greef, 1972). Photoreceptors in fungi have not been isolated.

Although the extremes of the visible light portion of the electromagnetic spectrum have received the most attention regarding fungal sporulation, there is evidence that other sectors of the spectrum affect this activity. Sometimes the reported responses are contradictory, even when the same fungus is used. Thomas (1964) stated that species of *Leptosphaerulina* responded positively when exposed to green light but Leach (1972) could not duplicate this response.

Germination of *C. dematium* spores was increased by greater than 100% following exposure to 500, 550, 700, and 750 nm wavelengths as compared to spores exposed to 400, 450, 600 and 650 nm wavelengths (Russo and Pappelis, 1981b). Light in the 520 nm band controls stomatal opening in onion (Meidner, 1968), which can be used as a port of entry by this fungus (Russo and Pappelis, 1981a). This project was designed to determine the effects of selected wavelengths of the visible portion of the electromagnetic spectrum, either alone or in sequence, on sporulation of *C. dematium*.

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#### MATERIALS AND METHODS

Colonies of C. dematium were incubated under continuous cool-white fluorescent light (FL, energy level described in Table 1). Spores from 14-day old cultures were transferred to the middle of 6 cm diameter plastic petri-dishes containing 10 ml of sterile 1.5% V-8 juice agar. Spore placement was important so that the entire developing colonies would be illuminated by the light cone of the discrete wavelengths. Transfers were made under cool-white fluorescent light at one hour intervals. The inoculated petri-dishes were wrapped in aluminum foil and incubated for 72 hr at  $24\pm1C$ .

After the 72 hr incubation colonies were exposed to discrete wavelengths, as described by Russo and Pappelis (1981a), using an interference wedge monochromator mounted below the condensor on a Zeiss Universal microscope stand. The aluminum foil was removed from the colonies in a darkened room and the petri-dishes were placed in the light path created by the condensor. Two irradiation regimes were used. In the first, the colonies were exposed to 450, 550, 650 or 750 nm wavelengths of light for 20 min. Controls consisted of 20 min exposure of colonies to multiband light from the microscope tungsten source (TL, energy level described in Table 1), or exposure to FL approximately 48 cm above the cultures on the laboratory bench, or no light. In the second regime, the colonies were exposed to 450, 550, 650 or 750 nm wavelengths of light for 20 min followed immediately by a 20 min exposure to one of the other three wavelengths as listed in Table 3. Multiband controls were a 20 min exposure to the TL followed by a 20 min exposure to FL, or the reverse irradiation sequence, or continuous dark. Light energies for discrete wavelength treatments and TL and FL controls were determined with a radiometer (VSI-Kettering Model 65A, Yellow Springs Instruments, Yellow Springs, Ohio). All twelve possible irradiation combinations with discrete wavelengths, two combinations for multiband light controls, and dark controls were replicated three times. Between exposures and during the 72 hr incubation period following irradiation, petri-dishes were rewrapped with aluminum foil to prevent exposure to unwanted wavelengths.

Cultures were removed at one hour intervals after the second dark incubation, flooded with 10 ml of distilled water, and agitated with a camel hair brush to dislodge spores. Five ml of the suspension were removed by pipet and transferred to a clean glass vial. The vial was vigorously shaken for several seconds and a 0.1 ml droplet was transferred to a Howard Mould Counting Chamber. Numbers of spores in each of three randomly chosen fields were counted and values expressed as spores per ml of suspension. Linear fit was tested, and where appropriate, Duncan's Multiple Range and Least Squares Means (LSM) analysis procedures of SAS (SAS, Inc., Cary, N.C.) were employed for post-hoc means separation.

#### RESULTS

Immature stromata were scattered throughout the colony by the end of the first 72 hr dark incubation but no spores were produced. Sporulation rates for the initial 20 min treatments, of dark and multiband controls and discrete wavelengths, are presented in Table 1. Dark controls produced the smallest number of spores (8700 spores/ml) and Fl controls the highest (44,300 spores/ml). Taken together the treatments may describe incremental steps in a progression from 0-54000 ergs. Spore production was analyzed with linear and quadratic regression methods but not cubic, fits were indicated regardless of whether dark controls (0 ergs) were included in the analysis (Table 2). Spore production, induced by discrete wavelengths in the 800-2600 erg range (450-750 nm), was not linearly related (Table 2). For these wavelengths, analyzed with post-hoc methods for means separation, there were no significant differences in sporulation rates (Table 1).

The two-step irradiation treatments, by their nature, did not represent an incremental continuum and were analyzed by post-hoc means separation methods. Mean numbers of spores for each two-step irradiation treatment (symbols in the text; first treatment symbol followed by the second treatment symbol) are presented in Table 3. The number of spores produced in the two multiband control combinations were significantly different from, by up to 6.4 fold,to

those produced in the dark. The result for the multiband controls were not significantly different when treatments were reversed (FL + TL sequence; TL + FL sequence). When treatments with discrete wavelengths were compared to multiband controls the treatment with the greatest improved sporulation, of the 12 possible combinations, was 450 + 750 nm with spore counts of 76×10 spores/ml, which was almost 1.5 fold greater than the multiband controls. The next best treatments were 450 + 650 and 650 + 450 irradiation regimes. The least productive irradiation treatments were 550 + 650 and 650 + 550 regimes which were about 36% of the multiband controls. All other treatments were intermediate between these and ranged to 43-88% of the multiband controls. A hypothetical cumulative mean sporulation rate of 51,400 spores/ml was computed by multiplying the mean for individual 20 min exposures for all treatments from Table I by two. This would represent the cumulative 40 min exposure of the two-step irradiations. Most predicted values for two-step irradiation treatments approximated the hypothetical cumulative mean. The exceptions were the multiband controls, which exceeded the hypothetical mean, and the dark control, which was below the mean (Table 3). All but three observed values for irradiation combinations had sporulation rates below the hypothetical mean (Table 3).

The two-step irradiation regimes could be grouped into those which produced significant differences in the spore production when the sequence was reversed and those which did not. Five combinations (FL+TL vs. TL+FL; 450+550 vs. 550+450 nm; 450+650 vs. 650+450 nm; 550+650 vs. 650+550 nm; and 550+750 vs. 750+550 nm) had no differences in spore production associated with the order of irradiation. The means for these non-significant differences ranged from 600 to 9200 spores/ml. For the two irradiation combinations (750+650 vs. 650+750 nm; and 450+750 vs. 750+450 nm) there were significant differences in spore production when the irradiation sequence was reversed. Those differences were 14,600 and 44,000 spores/ml representing a 1.45 fold and 2.38 fold increase in spore production and were accompanied by LSM probability values of 0.0158 and 0.0004 respectively.

Table 1. Light energies and mean spore production after 20 min exposure of colonies to continuous dark, discrete wavelengths and multiband controls.

Treatment	Ergs/cm <sup>-2</sup> /s <sup>-1</sup>	Spores/ml $\times$ 10	
Dark Control	0	8.7 a <sup>x</sup>	
450 <sup>z</sup>	800	24.6 a	
550	1300	23.7 a	
650	1600	24.7 a	
750	2600	21.0 a	
FL Control (400-1100 <sup>z</sup> )	8800	44.3	
TL Control (300-750 <sup>2</sup> )	54000	33.3	
Average		25.7	

zin nm

xmeans followed by the same letter are not significantly different, Duncan's Multiple Range (p=0.05), for those wavelengths judged not be linearly related, see Table 2.

Table. 2 Curve fitting of spore production for all irradiation energies.

Treatment	Curve Fit $(P_r > F)$			
$(ergs/cm^{-2}/s^{-1})$	Linear	Quadratic	Cubic	
0 (Dark) to 54000 <sup>z</sup>	0.0001	0.0001	0.3797	
800 to 54000 <sup>z</sup>	0.0001	0.0001	0.3832	
800 to 2600 <sup>x</sup>	0.2573	0.3869	0.8238	

<sup>&</sup>lt;sup>2</sup>includes FL and TL controls

### DISCUSSION

Irradiation with multiband TL or FL, or discrete wavelengths used alone or in combinations, greatly stimulated *C. dematium* sporulation when compared to dark controls. Since this fungus also produces spores in the dark it can be classifed as a light variable rather than light dependent organism as defined by Osman and Valadon (1979).

The 20 min exposures to the multiband controls resulted in more spore production than 20 min exposures to discrete wavelengths. This might be explained by the greater light energies produced by the multiband controls, or the combination of wavelengths in the multiband light sources. The differences between the energies of the TL and FL controls, and their similar ability to stimulate sporulation do not support the first inference. Since there was no linear relationship, and no significant difference in sporulation between the individual discrete wavelengths, (after a 20 min exposure) it can be inferred that light quality may be more important than light source energy levels. The following observations support this inference. Only the two-step multiband control treatments approximated the hypothetical cumulative sporulation mean. Three of the two-step discrete wavelength treatments exceeded the hypothetical mean while the remainder of the treatments were below the hypothetical mean. In one case, the same sequence, with and without reversal, produced values above and below the hypothetical cumulative mean. Furthermore, the observed values for the multiband controls not approaching the predicted values may be explained by competition for receptor sites from the various wavelengths within the light source. When sporulation rates for the two-step discrete irradiation regimes were compared to multiband controls, the result could be classified as being beneficial, detrimental or having no effect on spore production. This further emphasizes the inhibitory or stimulatory effects of some wavelengths over others.

Obvious beneficial and detrimental responses tend to attract attention and are generally interpreted as evidence of the stimulation or inhibition of a biological reaction. In at least one combination of the paired treatments involving 450 or 650 nm light with the other three discrete wavelengths, a significant difference in sporulation was exhibited when the irradiation sequence was reversed. This was not the case when 550 nm light was paired with all others. It may be that 550 nm light has a modifying effect which either supercedes or nullifies the effect of the other component of the irradiation pair. This would suggest that if a protein photoreceptor is present, similar to the type conjectured by Leach (1972), its configuration could be governed by the presence of 550 nm light. Thomas (1964) and Thomas and Halpin (1964)

xincludes only 450, 550, 650, and 750 nm discrete wavelengths.

Table 3. Predicted and observed numbers of spores produced for treatment combinations.

Treatment	Predicted Value <sup>z</sup>	Observed Value
Dark	8.7	8.7 i <sup>x</sup>
FL+TL	77.6	54.9 bc
TL + FL		47.0 cd
450 + 550	48.3	38.0 de
550 + 450		47.0 cd
450 + 650	49.3	62.4 b
650 + 450		60.4 b
450 + 750	45.6	32.0 ef
750 + 450		76.0 a
550 + 650	48.4	17.1 h
650 + 550		20.1 gh
550 + 750	44.7	24.0 fgh
750 + 550		33.2 ef
650 + 750	45.7	45.3 cd
750 + 650		30.8 efg
Hypothetical		
Cumulative Mean	$2 \times 25.7 = 51.4^{9}$	

<sup>&</sup>lt;sup>z</sup>Predicted value was arrived at by addition of observed values for 20 min exposure of individual components from Table 1.

reported that green light (550-550) nm), benefitted sporulation in species of Leptosphaerulina. However, Leach (1972) could not duplicate that effect with the same fungus. Tan and Epton (1973) reported that green light might inhibit the induction of sporulation in Botrytis cinerea Pers. ex Fr. This same wavelength affects germination and appressoria production for C. dematium (Russo and Pappelis, 1981b) and the opening of onion stomata (Meidner, 1968), thus, providing a port of entry which this fungus can exploit (Russo and Pappelis, 1981a).

Stromata were formed during the dark period prior to irradiation and there was some spore production on cultures maintained in continuous dark. All two-step irradiation treatments increased sporulation rates over dark controls indicating that light caused a change in the non-sporulating stromata and/or the mycelia that give rise to conidiophores. The experimental conditions described here make it possible to study morphological changes associated with sporulation in very small colonies.

There have been several reports concerning the existence of "mycochrome", the postulated photoreceptor, active in the blue and NUV, which controls several light-induced responses in fungi (Honda, 1969; Kumagai and Oda, 1969; Tan, 1974a; Tan and Epton, 1974). It also appears that something analagous to phytochrome (Fredericq and De Greef, 1972) in plants is active in fungi (Tan 1974b, 1975). Based on responses reported here C. dematium should be

<sup>\*</sup>Values followed by the same letter are not significantly different, Duncan's Multiple Range (p = 0.05)

<sup>&</sup>lt;sup>y</sup>Twice the average of all treatments from Table 1.

included in the latter group. Tan (1974a) found that when *B. cinerea* was exposed to blue light followed by far-red light sporulation decreased. For *C. dematium* when 450 nm light followed 750 mn light the result was opposite indicating that either *C. dematium* uses the photoreceptor system hypothesized by Tan (1974b) in a reverse manner, or it uses a different photoreceptor system. Tan (1975) indicated that red light suppressed sporulation and that far-red light is repromotive. Here the only combination of two-step irradiation treatments with discrete wavelengths that supports that observation was when 650 nm light followed 750 nm light. When 750 nm light followed 650 nm light, the sporulation was repromoted in the classical expression of phytochrome activity. The complex series of events regulating sporulation is *C. dematium* warrants further examination.

Honda and Aragaki (1978) indicated that sporulation equal to, or greater, than that produced in the dark occurred below 335 and above 544 nm for Exserohilum rostratum (Drechs.) Leonard & Suggs, but from 341 to 500 nm there was no sporulation. There was no difference in sporulation due to irradiation with light in the visible range for Verticillium agaricinum (LK) Cda (Osman and Valadon, 1979). They did not pair any wavelengths to determine if sporulation activity changed. The findings reported here for C. dematium are like those reported by Osman and Valadon (1979) but not like those reported by Honda and Aragaki (1978). Portions of the visible range of the electromagnetic spectrum, other than those in the red and far-red, that affect sporulation of C. dematium are in the 450 and 550 nm range.

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# Chemical, Physical and Sensory Comparisons of Netted Muskmelon Fruit Cultivars and Breeding Lines at Harvest

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Additional Index Words: appearance, beta-carotene, flesh color, firmness, flavor, fresh weight, odor, soluble solids, texture, total free sugars, Cucumis melo L.

#### ABSTRACT

Analyses of sensory attributes of 19 netted muskmelon (Cucumis melo L.) cultivars and breeding lines showed that flavor, (r=0.92) had the highest significant correlation with overall fruit acceptance, while appearance (r=0.72), odor (r=0.71), and flesh color (r=0.68) were secondary, and texture (r=0.41) was not significantly correlated with overall fruit acceptance. Total sugars per gram fresh weight was highly correlated (r=0.65) with overall fruit acceptance, while percent soluble solids (r=0.59) was somewhat less correlated with overall acceptance. Total sugars per gram fresh weight were also significantly correlated with flavor (r=0.65). Other significant correlations were color with appearance (r=0.80), and odor with flavor (r=0.77). Although, sugars were correlated with flavor, sugars were less important than flavor in determination of overall muskmelon fruit acceptance.

Variations in the sensory quality of freshly harvested muskmelon fruits has been determined using "shipper" (Yamaguchi et al., 1977), and "fresh market" (Evenson, 1983) commercial cultivars. Acceptable sensory quality for both types is associated with sweetness or fruit sugars as the primary attributes (Currence and Larson, 1941; and Evenson, 1983) with aroma and flesh color as secondary and texture as tertiary attributes (Yamaguchi et al., 1977). Sweetness is correlated highly with soluble solids content (Gilbart and Dedolph, 1963), but soluble solids content does not correlate well with overall acceptability (Yamaguchi et al., 1977). It would be helpful to plant breeders in screening new varieties for fruit quality if they had a standard measurement correlated highly with muskmelon fruit quality and consumer preference. Our study considered the sensory attributes in association with the chemical composition at harvest of 19 netted musmelon cultivars/breeding lines to determine the chemical, physical, and sensory factors involved in taste panel preference of netted muskmelon fruits.

#### MATERIALS AND METHODS

Plant material. Full-slip, netted muskmelon fruits (Cucumis melo L. var. reticulatus Naud.) from 19 cultivars/breeding lines (Table 1) were obtained from Sharyland Plantation, a commercial grower located near McAllen, Texas. Fruits were washed in distilled water (21C) and sorted for uniformity and freedom from defects, then stored at 4±1C and 90% ±5% RH for up to 48 h before evaluation. Six fruits, from each cultivar/breeding line, (one fruit per replicate), were used for each sensory evaluation and six fruits for evaluation of chemical and physical properties.

Sensory Evaluations. A panel of 22 judges, screened for a preference for netted muskmelon fruit and trained for sensory evaluations of netted muskmelon fruit was used to assess appearance, flesh color, flavor, odor, texture, and overall fruit acceptance. Each judge was served a plate containing one-half fruit cut longitudinally for appearance, flesh color, and odor evaluation, and 4-1cm³ middle mesocarp tissue segments from the equatorial region of the second fruit half, for flavor and texture evaluations. The judges were asked to assess each fruit for the sensory attributes based on a nine point hedonic scale as follows: 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither dislike or like, 6 = like slightly, 7 = like moderately, 8 = like very much, 9 = like extremely.

Chemical and Physical Evaluations. The soluble sugars fructose, glucose and sucrose concentrations were determined using high performance liquid chromatography according to the method of Lester and Dunlap, (1985), and beta-carotene was determined using 25 g of fresh mesocarp homogenate according to the method of Lime et al., (1957) and expressed in International Units (I.U.). Soluble solids were determined using a refractometer on juice from a subsample of homogenized fresh mesocarp tissue and expressed as a percent. Dry weight determination was according to AOAC, (1984) on a subsample of homogenized mesocarp tissue. Fruit firmness expressed as {force newtons (N)} resistance of the whole fruit mesocarp tissue less rind to puncture with a 4.5 cm × 3mm diameter tip using a Chatillion Force gauge (Lindy Electric, Glen Head, NY 11545). Ten punctures were made on each fruit at evenly spaced locations along the equatorial region.

Statistics. Statistical analyses for mean separation were performed by analysis of variance. Sensory evaluations from the nine point hedonic scale were grouped into three frequency distribution categories: "dislike" = dislike extremely, dislike very much, and dislike moderately; "slight or no opinion" = dislike slightly, neither dislike or like, and like slightly; and "like" = like moderately, like very much, and like extremely.

### RESULTS AND DISCUSSION

Three muskmelon cultivars ('Caravelle', 'Magnum 45', and 'Mission') were highest in the 
"like" category for appearance, flesh color, flavor, odor, texture, and overall fruit acceptance 
(Table 1); and two muskmelon cultivars ('All Star' and 'Explorer') and one breeding line 
(Sunre 7003) were ranked highest in the "dislike" distribution for the same sensory attributes.

Comparison of these muskmelon cultivars and breeding lines for chemical attributes found that on average the highly "liked" fruit from the sensory analyses were also significantly higher in fruit firmness, beta-carotene, percent dry weight, and percent soluble solids than were the highly sensory "disliked" fruits (Table 2). Conversely, the highly sensory "liked" fruits were on average significantly lower in fresh weight per fruit than were the highly sensory "disliked" fruits. Comparisons of the highly sensory "liked" and "disliked" fruits for fructose and glucose on a dry weight or fresh weight basis (data not shown) demonstrated that there was no consistent difference between them or for the other 13 cultivars and breeding lines assayed. However, comparison of the highly sensory "liked" and "disliked" fruits for sucrose (data not shown) and total sugars revealed that on average the "liked" fruits had significantly higher concentrations of sucrose and total sugars on both a dry weight (data not shown) and fresh weight basis (Table 2) compared with the average for the "disliked" fruits.

Table 1. Frequency distribution of appearance, flesh color, flavor, odor, and texture sensory responses and overall fruit quality preference for nineteen netted muskmelon fruit cultivars and breeding lines.

	Appear	ance	Flesh C	olor	Flav	or	Odo	16	Textu	ire	Over	all
	9/0	0/0	0/0	0/0	9/0	9/0	970	$q_{0}$	970	970	970	$07_{0}$
Name	dislike	like	dislike	like	dislike	like	dislike	like	dislike	like	dislike	like
All Star	13	48	17	35	35	20	4	17	13	22	26	22
Caravelle	0	96	4	65	0	91	0	52	0	83	0	78
Durango	4	83	0	61	9	52	9	39	4	74	4	57
Easy Rider	9	74	13	52	9	65	9	35	4	56	4	35
Explorer	13	30	13	61	39	44	17	39	22	39	13	43
Grande Gold	9	57	13	57	0	65	4	48	0	65	0	52
HMX-6596	13	30	9	48	43	14	9	21	4	35	4	26
Laguna	0	83	4	78	17	26	5	30	9	52	4	43
Magnum 45	9	82	0	78	8	83	4	62	8	71	0	74
Mission	0	96	0	87	0	65	4	48	4	70	0	78
NVH-890	4	78	4	70	13	48	0	57	9	57	4	52
Producer	17	48	13	39	22	39	0	39	13	35	4	35
Sunex 7018	9	78	9	69	9	26	13	30	4	48	4	39
Sunre 7003	26	48	30	40	13	52	13	22	4	48	13	44
Super 45	0	74	4	57	13	52	4	44	4	52	0	61
Sweet Surprise	4	70	4	65	9	48	13	43	17	48	0	61
Tekos	9	74	9	48	13	39	9	30	0	43	9	48
Top Flight	4	65	4	52	13	26	4	26	9	56	4	30
Laguna	0	83	4	74	9	34	0	26	0	57	0	48

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Table 2. Fresh weight, firmness, Beta-carotene, dry weight, and soluble solids of cultivars and breeding lines of netted muskmelon fruits.

Name	Fresh weight per fruit (kg)	Firmness (Newton = M/kg/s²)	Beta- carotene (I.U.)	Dry Weight	Soluble solids	Total Sugar mg/ g fresh weight
All Star	1.8 d <sup>z</sup>	18.7 a	3302 j	11.5 bc	11.0 b	40.8 c
Caravelle	1.5 ef	19.2 a	3941 fgh	11.1 cd	11.0 b	44.6 b
Durango	1.8 d	9.9 fg	4728 b	9.6 de	10.7 bc	38.0 efg
Easy Rider	1.5 fg	8.3 gh	3629 i	10.5 de	10.0 cd	37.0 fgh
Explorer	1.4 gh	12.3 cde	3989 f	9.3 h	8.7 f	36.0 ghi
Grande Gold	1.2 i	12.0 cde	4413 cd	10.5 de	9.4 e	35.8 hi
HMX-6596	2.1 b	14.5 b	3747 hi	9.3 h	8.5 f	33.7 j
Laguna	1.9 c	6.9 c	4218 de	8.1 i	8.1 g	29.0 k
Magnum 45	1.5 fg	11.5 def	4490 c	10.8 de	11.0 b	38.5 def
Mission	1.6 ef	20.4 a	4097 ef	13.5 a	12.4 a	48.2 a
NVH-890	1.9 c	14.5 b	4733 b	10.4 ef	10.0 cd	39.2 cde
Producer	1.0 j	20.6 a	5000 a	12.0 b	11.0 b	38.3 ef
Sunex 7018	1.4 gh	11.8 def	3974 fg	9.8 fgh	9.6 de	33.4 j
Sunre 7003	2.4 a	13.5 bcd	3203 j	8.1 i	8.1 g	29.4 k
Super 45	1.8 cd	13.6 bcd	4371 cd	11.9 b	11.0 b	38.0 efg
Sweet Surprise	1.2 hi	13.3 bcd	3583 i	11.9 b	10.5 bc	40.4 cd
Tekos	1.7 de	6.8 h	3349 ј	8.5 i	7.5 h	30.8 k
Top Flight	1.5 fg	8.9 gh	4426 c	10.2 efg	8.7 f	34.1 ij
XPH-5363	1.6 ef	14.1 bc	3775 ghi	9.6 gh	8.6 f	33.7 j
LSD = 0.05%	0.1	2.1	204	0.6	0.5	2.0

<sup>&</sup>lt;sup>2</sup>Data are means of 6 melon fruits with mean separation within columns.

Correlation analyses of sensory and physical attributes (Table 3) from 19 muskmelon cultivars and breeding lines showed that flavor had the highest significant correlation with overall fruit acceptance (r=0.92) followed by appearance (r=0.72), odor (r=0.71), and flesh color (r = 0.68), while texture (r = 0.41) was not significantly correlated with overall fruit acceptance. Correlation analyses of chemical and physical characteristics versus sensory evaluations (Table 4) showed that the most significant correlation was between firmness and texture (r = 0.88), however, firmness was not correlated significantly with any other sensory or chemical attribute. Beta-carotene was significantly correlated with flesh color (r = 0.86), and with odor (r = 0.70), but was not significantly correlated with any other sensory attribute. Total sugars per gram fresh weight, however, were significantly correlated with flavor (r = 0.65), odor (r = 0.52) and when compared to all other chemical attributes, had the highest significant correlation with overall fruit acceptance (r = 0.68). Correlations of soluble solids, fresh weight, dry weight, beta-carotene and firmness with all other chemical and physical attributes (Table showed soluble solids was correlated with dry weight (r = 0.95), with sucrose (r = 0.94), and total sugars per gram fresh weight (r = 0.90), while fresh weight was negatively correlated with sucrose (r = -0.89), and total sugars per gram fresh weight (r = -0.88).

Table 3. Correlation coefficient analyses of sensory evaluations from 19 cultivars or breeding lines of netted muskmelon fruits.

Variable	Appear- ance	Flesh Color	Flavor	Odor	Text- ure	Over- all
Appearance		-			100	0.71*
Flesh Color	0.80*	-	2	_	82	0.68*
Flavor	0.50	0.50	(4)	-		0.92*
Odor	0.45	0.66	0.77*	-	0.7	0.71*
Texture	0.46	0.24	0.40	0.31	-	0.41

significant at the 0.05 level of probability.

Table 4. Correlation coefficient analyses of chemical, physical and sensory evaluations from 19 cultivars or breeding lines of netted muskmelon fruits.

Variable	Appear- ance	Flesh Color	Flavor	Odor	Text- ure	Over- all
Turiuore						
% sol. solids	0.20	0.32	0.59*	0.49	0.29	0.57
Fresh wt. (g)	0.10	-0.14	-0.39	-0.40	0.15	0.59
% dry wt.	0.24	0.30	0.47	0.49	0.27	0.54
Beta-carotene	0.24	0.86*	0.27	0.70*	0.15	0.24
Firmness	0.04	0.09	0.08	0.15	0.88*	0.13
Fru/g dry wt.	-0.24	-0.35	-0.23	-0.27	-0.03	-0.26
Fru/g fresh wt.	0.06	-0.14	0.13	0.12	0.24	0.07
Glc/g dry wt.	0.14	-0.08	0.12	0.01	0.19	0.13
Glc/g fresh wt.	0.29	-0.09	0.40	0.28	0.37	0.39
Suc/g dry wt.	0.35	0.49	0.47	0.48	0.16	0.61
Suc/g fresh wt.	0.32	0.40	0.49	0.48	0.21	0.63
T Sug/g dry wt.	0.30	0.26	0.39	0.36	0.28	0.40
T Sug/g fresh wt.	0.34	0.35	0.65*	0.52*	0.34	0.68

<sup>\* =</sup> significant at the 0.05 level of probability

Flavor was correlated with overall fruit acceptance (r=0.92) which was the single most important sensory attribute in determining overall acceptance of freshly harvested netted muskmelon fruit (Table 4). Other important attributes appear to be appearance (r=0.72), odor (r=0.71), and flesh color (r=0.68). Texture does not appear to be important in determining overall fruit acceptance. These data agree with the findings of Yamaguchi et al., (1977) in that odor, appearance, and flesh color are of primary importance in overall muskmelon fruit acceptance. But, these data disagree with Yamaguchi et al., (1977) on the importance of texture. Part of the explanation for the apparent non-importance of fruit firmness with overall fruit acceptability is that most of the cultivars and breeding line fruits were acceptably firm.

Sweetness is considered the primary attribute responsible for overall muskmelon fruit acceptance. However, our data showed that sweetness alone as determined by either individual or total sugars does not correlate as well with overall fruit acceptance as does flavor (Table 4 & 5). A correlation of individual and total fruit sugars showed that only total sugars on a fresh weight basis is significantly correlated with overall acceptability, but the coefficient is only r = 0.65. Soluble solids, which have a high correlation with sucrose (r = 0.94) and with total sugars (r = 0.90), had only a correlation with flavor of r = 0.57 and a correlation with overall acceptability of r = 0.59. These data help explain Aulembach and Worthingtons, (1974) findings as to why soluble solids are not a superior assay for overall fruit acceptability. Although, soluble solids were significantly correlated with fruit sugars, fruit sugars or sweetness had an inferior correlation with overall fruit acceptability when compared to flavor.

Table 5. Correlation coefficient analyses of chemical and physical evaluations from 19 cultivars or breeding lines of muskmelon fruits.

	9/0	Fresh	070		
	Soluble	wt.	dry	Beta-	Firm-
Variable	solids	(g)	wt.	carotene	ness
Fresh wt. (g)	-0.43		-	15	
% dry wt.	0.95*	0.63*	-	7.	2
Beta-carotene	0.30	-0.32	0.30	-	-
Firmness	0.63*	-0.10	0.76*	0.06	-
Fru/g dry wt.	-0.65*	0.10	-0.55	-0.18	-0.07
Fru/g fresh wt.	0.08	-0.26	0.23	-0.42	0.45
Glc/g dry wt.	-0.23	0.07	-0.69*	-0.09	0.22
Glc/g fresh wt.	0.35	-0.17	-0.42	-0.30	0.57
Suc/g dry wt.	0.82*	0.10	0.91*	0.31	0.40
Sug/g fresh wt.	0.94*	-0.89*	0.72*	0.34	0.53
Tot sug/g dry wt.	0.38	0.06	0.31	0.10	0.45
Tot sug/g fresh wt.	0.90*	-0.88*	0.93*	0.24	0.64

<sup>\* =</sup> significant at the 0.05 level of probability

#### SUMMARY

Selection of netted muskmelon fruits cultivars and breeding lines for consumer acceptance using sweetness or total sugars as the selection criteria may not result in a variety with overall acceptability. However, selection of netted muskmelon fruit cultivars and breeding lines based mainly on flavor, which is influenced by total sugars and the netted muskmelon fruit flavor component cis-6-nonenal (Kemp et al., 1972) may result in a cultivar with overall favorable acceptance.

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# Chemical, Physical and Sensory Comparisons of Shrink-wrapped and Non-wrapped Netted Muskmelon Fruits During Storage

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Additional Index Words: appearance, beta-carotene, flesh color, firmness, flavor, odor, shrink-film-wrap, soluble solids, texture, total sugars, Cucumis melo L.

#### ABSTRACT

Netted muskmelon fruits were treated with 1000 ppm imazalil and individually wrapped with a heat shrinkable polyethylene/polypropylene film or not wrapped, then stored at 4C and 90% ±5% RH for 0, 14, or 28 days. Following storage, beta-carotene, firmness, and total sugars were measured and the sensory attributes of appearance, flesh color, flavor, odor, texture, and overall fruit acceptance evaluated. After 14 days of storage, shrink-film-wrapped fruits and non-wrapped fruits were equally well liked for all sensory attributes and were similar in beta-carotene and total sugars concentration. However, wrapped fruits were significantly firmer than non-wrapped fruits after 14 or 28 days of storage. After 28 days of storage, shrink-film-wrapped fruits had higher concentrations of sugars than non-wrapped fruits, and were better liked than non-wrapped fruits for appearance, flesh color, flavor, texture, and overall fruit acceptance, but not for odor.

Full-slip netted muskmelon fruit treated with the fungicide imazalis and enclosed in shrink-film-wrap will maintain postharvest market quality for up to 60 days, at 4C (Lester, 1989) as compared with non-wrapped fruit which has a storage life of less than 14 days (Lester, 1988). High density (5 to 20, um thick) polyethylene/polypropylene film (shrink-wrap) aids in maintaining fresh appearance (Lester, 1989) and delays senescence of netted muskmelon fruit (Lester and Bruton, 1988). The extended postharvest life of shrink-film-wrapped muskmelon fruits has provided new markets, both foreign and domestic, which require high quality fruits to be exploited.

Flavor is the single most important sensory attribute in determining the acceptablity of muskmelon fruits (Lester and Turley, 1990). This study investigated the effects of wrapping two highly sensory "liked" muskmelon cultivars on the sensory attributes, beta-carotene content, total free sugars content, and fruit firmness, following 0 to 28 days of 4C storage.

#### MATERIALS AND METHODS

Plant Material. Full-slip fruits of 'Caravelle' and 'Mission', (Cucumis melo L. var. reticulatus Naud.) with a mean fruit weight of 1.5 kg and free from defects, were obtained from Sharyland Plantation, a commercial grower located near McAllen, Texas. Fruits were washed in distilled water (21C), then dipped in 1000 ppm 1-[2, (2,4, dichloro phenyl)-2-2(2-propenyloxy)-ethyl]-1 H-imidzole (imazalil) solution (Janssen Pharmaceutica, Beerse, Belgium) at 20C for 1 min. and air dried.

Shrink-film-wrapping. Fruits were randomized into lots for the wrapping treatments. Fruits were wrapped individually in 1.27, um thick Clysar 50 EHCF film (E.I. duPont de Nemours and Co. Wilmington, DE.). The procedure for shrinking the film around each melon and film characteristics were as previously described (Lester and Bruton, 1986.)

Storage. Wrapped and non-wrapped fruits were placed into ventilated, waxed, muskmelon shipping boxes and stored in rooms maintained at  $4\pm1$ C with 90%  $\pm5$ % RH for 0, 14, and 28 days. Ten wrapped and 10 non-wrapped fruits of each cultivar were used for chemical and physical evaluations per each storage time.

Sensory Evaluation. A panel of 22 judges, screened for a preference for netted muskmelon fruit and trained to detect the sensory attributes for one year prior to this evaluation was used to assess appearance, flesh color, flavor, odor, texture, and overall acceptance. Each judge was served a plate containing one-half fruit cut longitudinally for appearance, flesh color, and odor evaluation and four-1cm<sup>3</sup> middle mesocarp tissue segments from the equatorial region of the second fruit half for flavor and texture evaluation. The judges were asked to assess each fruit for the sensory attributes based on a nine point hedonic scale as follows: 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither dislike or like, 6 = like slightly, 7 = like moderately, 8 = like very much, 9 = like extremely.

Chemical and Physical Evaluations. The soluble sugars fructose, glucose and sucrose were extracted and analyzed as previously described (Lester and Dunlap, 1985). Analysis of beta-carotene required 25 g of fresh mesocarp homogenate. Beta-carotene was determined according to (Lime et al., 1957). Dry weight determination was according to AOAC (1984) on a subsample of the total homogenized mesocarp tissue. Soluble solids were determined using a refractometer on juice from a subsample of homogenized fresh mesocarp tissue and expressed as a percent. Fruit firmness expressed as [newtons (N)] resistance of the whole fruit mesocarp tissue (less rind) to puncture with a 4.5 cm long × 3 mm diameter tip using a Chatillon Force gauge (Lundy Electric, Glen Head, NY 11545). Ten punctures were made on each fruit at evenly spaced locations along the equatorial region.

Statistics. Statistical analyses for mean separation were performed by analysis of variance. Sensory evaluations from the nine point hedonic scale were grouped into three frequency distributions categories: "dislike" = dislike extremely, dislike very much, and dislike moderately; "slightly or no opinion" = dislike slightly, neither dislike or like, and like slightly; and "like" = like moderately, like very much, and like extremely.

#### RESULTS

Beta-carotene, firmness and total sugars in 'Caravelle' and 'Mission' cultivars were not different during 28 days of storage (data not shown). Therefore, data for both cultivars were combined for statistical comparison of film-wrapped and non-wrapped fruits.

The levels of beta-carotene in shrink-film-wrapped and non-wrapped fruits after 14 and 28 days of storage were not significantly different (Table 1). However, beta-carotene declined after 28 days of storage in all fruits regardless of wrap treatment.

Shrink-film-wrapped fruits were firmer than non-wrapped fruits in the "like" category and were significantly firmer than non-wrapped fruits after 14 or 28 days of storage (Table 1). Also, fruit firmness of wrapped fruits did not decline until after 28 days of storage, whereas, non-wrapped fruits decreased in firmness after 14 days.

Table 1. Beta-carotene, firmness and total sugars of shrink-film-wrapped or non-wrapped fruits stored for 0, 14, or 28 days at 4C and 90% ±5% RH.

Treat- ment	Beta- carotene (I.U.)	Firmness (Newtons)	Total Sugars mg/g dry weight	Total Sugars mg/g fresh weight
		0 days storage		
Wrapped	4176 <sup>z</sup>	20.4	728	42.6
No wrap	4176	20.4	728	42.6
		14 days storage	•	
Wrapped	4112	19.5	690	40.4
No wrap	4213	14.0	733	37.9
		28 days storage		
Wrapped	3798	16.3	661	38.3
No wrap	3718	10.2	578	34.3
LSD = 0.05%	222	2.1	49	3.1

<sup>&</sup>lt;sup>z</sup>Data are means of 20 melon fruits with mean separation within columns by Fisher's protected LSD.

Total sugars expressed on a dry weight or fresh weight basis decreased after 28 days of storage compared to 0 days, in both wrapped and non-wrapped fruits (Table 1). Non-wrapped fruits had significantly less total sugars than wrapped fruits after 28 days of storage.

Shrink-film-wrapped fruits always had a greater percentage of responses than non-wrapped fruits in the "like" category of appearance, flesh color, flavor, texture and overall fruit acceptance throughout 28 days of storage (Tables 2 and 3). However, wrapped fruits, were probably not significantly different than non-wrapped fruits in the "like" distribution for odor throughout 28 days of storage. Shrink-film-wrapped fruits never received more than 8% "dislike" responses for any sensory attributes regardless of storage duration, whereas, non-wrapped fruits received from 11 to 23% "dislike" responses for all sensory attributes by 28 days of storage.

Analysis of variance indicated that cultivars were not significantly different (Table 3). However, shrink-film-wrapping had a significant effect on fruit appearance and storage duration and significantly influenced all sensory attributes, including overall fruit acceptance. Interactions of (cultivars X shrink-film-wrapping), and (cultivars X wrapping X storage duration) were not significant with any sensory attributes. However, (cultivars X storage duration) had a significant interaction with flavor and (wrap X storage duration) had a significant interaction with texture and overall fruit acceptance.

Table 2. Frequency distribution of sensory responses or appearance, flesh color, flavor, odor, and texture sensory responses and overall fruit quality preference with shrink-film-wrapped and non-wrapped netted muskmelon fruits stored 0, 14, or 28 days at 4C and 90% ±5% RH.

	Appear	ance	Flesh C	Color	Flav	or	Odo	r	Textu	ire	Over	all
	970	070	970	9/0	9/0	9/0	970	970	970	0/0	070	070
Treatment	dislike	like	dislike	like	dislike	like	dislike	like	dislike	like	dislike	like
					0 days sto	orage						
Wrapped								-		-		
No wrap	2	92	1	78	0	84	2	55	4	74	0	78
					14 days st	orage						
Wrapped	0	78	0	80	1	69	0	55	3	67	0	70
No wrap	2	71	0	73	12	55	0	68	3	65	0	65
					28 days st	orage						
Wrapped	8	57	6	63	8	58	8	42	8	54	0	60
No wrap	23	40	11	41	21	46	12	46	15	46	11	43

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Table 3. Analysis of variance of taste panelists' hedonic scale responses for evaluating cultivars, shrink-film-wrap and days storage on appearance, flesh color, flavor, odor, texture, and overall acceptance of netted muskmelon fruits.

			F val	lues		
Source of Variation	Appearance	Flesh Color	Flavor	Odor	Texture	Overal
Cultivars (C)	1.4 ns	1.0 ns	1.1 ns	1.0 ns	1.3 ns	1.2 n
Wrap (W)	10.0 *	0.1 ns	3.2 *	0.1 ns	1.6 ns	1.6 n
Days Storage (D)	27.5 *	16.3 *	9.5 *	8.9 *	7.3 *	12.8 *
CXW	0.7 ns	1.1 ns	1.2 ns	0.4 ns	0.2 ns	0.1 n
CXD	0.5 ns	1.2 ns	3.1 *	0.4 ns	0.8 ns	0.3 n
WXD	1.5 ns	2.4 ns	1.0 ns	1.2 ns	8.2 *	9.4 *
CXWXD	0.5 ns	1.3 ns	0.1 ns	0.6 ns	0.2 ns	0.4 n
Error	2.7	2.1	3.5	2.4	3.1	2.1

ns = not significant and \* = Significant at the 0.05 level of probability.

#### DISCUSSION

The results indicating maintenance of beta-carotene, firmness, and total sugar levels in shrink-film-wrapped netted muskmelon fruits (Table 1), confirms previous reports (Lester, 1988; and Lester and Bruton, 1986). Sensory responses corroborated the chemical data findings, ie. that shrink-film-wrapping retarded the decline of netted muskmelon fruit quality during 28 days of cold storage (Tables 2 and 3).

All fruit treatments regardless of wrap or no wrap declined in the percent of fruits placed in the "like" category for all sensory quality attributes following 14 and 28 days of storage at 4C, but wrapped fruits were better liked overall. The difference in all sensory and chemical attributes between wrapped and non-wrapped netted muskmelon fruits was not as great at 14 days as it was at 28 days of cold storage. These data show that shrink-film-wrapping of highly sensory "liked" netted muskmelon fruits is beneficial in retarding the decline in fruit quality during cold storage, but film-wrapping is not a significant benefit to fruits stored 14 days or less. Therefore, shrink-film-wrapping of highly sensory "liked" netted muskmelon fruits is recommended if fruits are scheduled for greater than 14 days of cold storage.

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# A Pictorial Analysis of the Growth and Development of Ganoderma Rot on Young Citrus in Texas

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Additional Index Words: wood rot, grapefruit (Citrus paradisi Macf.) sweet orange (C. sinensis L.), sour orange (C. aurantium L.) cleopatra mandarin (C. reshni Kort. ex Tan), Swingle citrumelo (Poncirus trifoliata x C. parasidi), G. lucidum.

#### ABSTRACT

Four year old grapefruit and orange trees grown on sour orange rootstock were found infected by the fungus, Ganoderma lucidum. Following the 1983 freeze, in some orchards, the frezen trees were removed by a chain saw cut made at soil level and the stumps of old trees were left intact. Young trees were then planted next to the old stumps. Excellent growth of Ganoderma on and around the dead stumps increased inoculum pressure on the young trees making the sour orange rootstock vulnerable to Ganoderma rot.

Disease characteristics: G. lucidum (W. Curt.:Fr.) Karst is a basidiomycete fungus found in many countries, including North America (Hepting, 1971). While some species of Ganoderma are saprophytic, several are pathogens that cause decay of root and stem. Ganoderma grows on the dead or declining heartwood of trees. Usually, Ganoderma is not a serious problem on citrus, however, Reichert (1932) reported a root rot of citrus from Palestine caused by a Ganoderma spp. He found the disease, only on sweet lime root, and not on sour orange. There, the disease was associated with the presence of wooden stakes which supported the young trees.

Occurence in the Lower Rio Grande Valley: Fungus G. lucidum has been found pathogenic on young citrus in the Lower Rio Grande Valley (Skaria and Ferrald, 1989; Skaria et al, 1990). The infected trees were planted next to the dead stumps of older citrus trees that were killed in the 1983 freeze. Infection by Ganoderma has caused the death of several four-year-old Rio Red grapefruit trees grown on sour orange rootstock. In another orchard, 'Marrs' sweet orange trees on sour orange rootstock, were either killed or had reduced vigor. A hedge row of young Cleopatra mandarin, on its own root, not near any remains of older citrus wood has been found infected with Ganoderma. The pathogenicity of the citrus isolate of G. lucidum has been proved on two rootstocks: Swingle citrummelo and Cleopatra mandarin.

**Pictorial history and discussion:** The growth and development of Ganoderma on young citrus replants was observed in two orchards and a hedge row. Following is a pictorial analysis of the growth, development, and infection of *G. lucidum* on young grapefruit trees.



Fig. 1 Growth and development of G. lucidum on young grapefruit trees. Frame 1. Newly developed basidiocarps growing on the remains of an old citrus tree. Immature basidiocarps are white and soft textured. Frame 2. A maturing basidiocarp. The color changes from white to brown with maturity. Frame 3. Mycelial mat spreading from an old citrus stump toward a young tree planted close to the stump. Frame 4. Mycelial mat at the base of a young tree planted next to an old stump. The fungal mat on the young tree covers the cold-protecting wrap made of polyurethane. Frame 5. Mature brown basidiocarps at the base of a young tree. Upper white arrow shows a mature basidiocarp on the polyurethane wrap that has been removed from the tree. Frame 6. Underground, a white mycelial mat surrounds the base of a young tree. Frame 7. Remains of a decayed young tree. Decayed wood and root are soft and spongy with a characteristic mushroomy smell. Frame 8. A portion of a cross section of a young stem surrounded by hard basidiocarp. The white arrow shows gum exudation from inside. The stem is surrounded by the basidiocarp. Frame 9. Cross section of the object in Frame no. 7. The young stem (S) is completely surrounded by the basidiocarp. The white part is the remains of the winter wrap. The rest of the structure in the picture is part of the basidiocarp.

This is the first evidence of Ganoderma rot on sour orange rootstock in Texas. The presence of large old stumps of freeze-killed trees appears contributory to the reduced vigor and/or death of the replants. Excellent growth of Ganoderma on the dead wood increases the inoculum pressure sufficiently to make sour orange vulnerable to Ganoderma. Apart from the presence of Ganoderma, there were no damaging levels of other soil-borne fungi or nematode populations found in the above orchards. The cultural practice of cutting freeze-killed trees at the soil line, and replanting next to the old stump should be avoided to prevent Ganoderma rot.

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# Parasitoids of the Diamondback Moth, Plutella xylostella (L.) in the Lower Rio Grande Valley, Texas

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#### ABSTRACT

Two parasitoids of the diamondback moth, Plutella xylostella (L.), were recovered from three commercial cabbage fields in the Lower Rio Grande Valley, Texas. These parasitoids were found to parasitize 18,6% out of 623 sampled pupae in one field. Biological/natural control by these parasitoids provides suppression of insecticide-resistant diamondback moth populations and a valuable component useful in IPM programs in cruciferous crops.

The diamondback moth (DBM), Plutella xylostella (L.), has become the key pest of cruciferous crops in many parts of the world including the Lower Rio Grande Valley, Texas (Cartwright et al., 1987). This species has demonstrated an ability to rapidly develop resistance under field conditions to all classes of broad-spectrum chemcials insecticides around the world (Magaro and Edelson, 1990, Liu et al., 1981; and Sun et al., 1978). This has led to the breakdown of insecticide-based control systems and resulted in uncontrollable DBM populations causing millions of dollars in lost cole crop production in many parts of the world.

It is believed that the DBM originated in the Mediterranean along with its hosts (Hardy, 1938) because indigenous brassicas may be found throughout western Europe (Garris and Wolfe, 1949). The DBM was first reported in North America in Illinois in 1854 (Fitch, 1855) and from western Canada in 1885 (Fletcher, 1891). There are no reports of parasitoids introductions into mainland U.S. for the DBM, however, introductions of a parasitoid 2Diadegma sp., was made into Hawaii in 1953 from Kenya (Oatman, 1972). Native parasitoids for the DBM that have been recovered commonly throughout the U.S. include Diadegma insulare (Cresson), Diadromus subtilicornis (Gravenhorst), and Microplitus plutellae (Muesebeck) (Pimentel, 1961; Harding, 1976; and Quick, 1984).

In a systematic survey during 1969-73, Harding recovered seven different parasitoids of the DBM in the Lower Rio Grande Valley, Texas (Harding, 1976). These parasitoids represented four different families of parasitic Hymonopterans including one ichneumonid, *Diadegma insularis* (Cress.); three braconids, *Apanteles epinotiae* (View.), *Apanteles marginiventris* (Cress.), and *Apanteles* sp.; two chalcids, *Haltichella xanticles* (Walker), and *Spilochalis side* (Walker); and one pteromalid, *Calolaccus aeneoviridis* (Girault).

Parasitoids of two families were found on 5 April, 1990 in a commercial cabbage field in the Lower Rio Grande Valley, Texas (south Alamo area). They were an ichneumonid, *D. insulare*, and a braconid, *M. plutellae*. The sampled field has sustained 100% plant damage with no marketable head production. This field had received 15 pesticide applications from representatives of four classes of insecticides: organo-phosphate (Monitor and Methy-Parathion), synthetic pyrethroid (Asana), organo-chlorine (Thiodan), and *Bacillus thuringiensis* (Javelin). Percent parasitization on the sampling date was 18.6% out of 623 pupal nets observed on 10 plants. Although the percent parasitization was low, it is likely that the high number of insecticide applications had a detrimental effect on the parasitoid population. The primary parasitoid recovered was *D. insulare* while a few *M. plutellae* were also collected. These same parasitoids were recovered in two other commercial cabbage fields in the Lower Rio Grande Valley, Texas (Santa Maria area and Donna area) but were not evaluated for percent parasitization.

The presence of these parasitoids in heavily sprayed commercial cabbage is significant. Biological/natural control of DBM by parasitoids is an important component of an IPM program for cruciferous crops (Quick, 1984). These biocontrol agents need to be conserved through the use of the pest selective insecticides, such as *Bacillus thuringiensis*, which do not harm the beneficial parasitoid populations (Quick, 1984). The detection and identification of the impact of biocontrol of DBM should be further studied to allow for the development of an effective IPM program in cruciferous crops in the Lower Rio Grande Valley, Texas.

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# Egg Parasitoid of a Carrot Weevil, Listronotus texanus (Stockton), in the Lower Rio Grande Valley, Texas

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#### ABSTRACT

A field survey of carrots and parsley was conducted in the Lower Rio Grande Valley of Texas to detect egg parasitization of Listronoius texanus (Stockton). A mymarid parasitoid was found to parasitize 70.3% and 69.7% of sampled weevil eggs in carrots and parsley, respectively. This isthe first report of an egg parasitoid attacking L. texanus in Texas. This egg parasitoid provides a valuable biological/natural control component useful in IPM programs in umbelliferous crops.

A carrot weevil, Listronotus texanus (Stockton), attacks umbelliferous plants (carrots, parsley, and celery) in the Lower Rio Grande Valley (LRGV) (Edelson, 1985). Current control practices target adult weevil control with foliar applications of broad-spectrum insecticides (Edelson and Woodson, 1986). Although these materials are generally effective, inconsistent control has resulted in product (carrots) rejection at processing plants. As broad-spectrum standard insecticide programs begin to fail, integrated pest management (IPM) programs must be developed to insure production of high quality umbelliferous crops while reducing insecticide usage. If IPM programs are to be applied to crops attacked by carrot weevils, additional control methods are needed (Boivin, 1986). In order to achieve this control and maintain high quality production, a program should consist of scouting, economic thresholds, judicious use of the most pest selective insecticides, and utilization of biological/natural control present in the fields.

In order to determine the presence of biological/natural control by parasitoids in umbelliferous crops in the LRGV, a survey was conducted in fields known to have high populations of *L. texanus* and no insecticide usage. A carrot field (Weslaco area) was sampled on 18-19 April while a parsley field (Santa Maria area) was sampled on 20-21 April 1990. Plant samples were taken to the lab and dissected to remove carrot weevil eggs. Eggs were placed individually in Beem embedding capsules (size 3). The capsules were then placed in Petri plates with a moistened (distilled water) filter paper and sealed with Parafilm and held for weevil/parasitoid emergence.

A mymarid egg parasitoid, Anaphes sp., was found in both carrot and parsley fields. This is the first report of an Anaphes sp. attacking L. texanus in Texas. This species is an undescribed species different from Anaphes sordidatus (Girault) and is currently undergoing taxonomic review (J.T. Huber, personal communication). A. sordidatus has been reported to attack another carrot weevil, Listronotus oregonensis (Le Conte), which is native to the northern United States (Collins and Grafius, 1986a) and Canada (Boivin, 1986).

Percent parasitization by Anaphes sp. was 70.3% (n=75) in the carrot field and 69.7% (n=75) in the parsley field. Percent parasitization reaching 60 to 90% is considered high and suggests that this parasitoid may contribute significantly to carrot weevil mortality (Collins and Grafius, 1986b). A. sordidatus is the major biotic mortality factor for L. oregonensis eggs in Quebec, Canada (Zhao et al. 1989). However, an appropriate interpretation of such estimates depends on knowledge of the life cycles of both host and parasitoid (Collins and Grafius, 1986a).

L. lexanus has a rather low reproductive potential, long developmental cycle; and is the only economic pest in carrots and parsley in the LRGV. These factors greatly improve the potential of managing L. texanus through biological means. Since it is the only economic pest in these crops, the potential for disrupting the parasitoid populations by spraying for other insect pests is kept to a minimum. Similar reasons were mentioned for considering biological/natural control of L. oregonensis in Canada (Boivin and Belair, 1989). The presence of Anaphes sp. in both carrots and parsley increases the chances of effective suppression of L. texanus when integrated into an IPM program. Factors that influence the effectiveness of a parasitoid as a biological/natural control agent include host searching, host specificity, reproductive potential, and ability to occupy all of the host's niches (Doutt and DeBach, 1964). The recognition of Anaphes sp. in the Lower Rio Grande Valley is an advantage for further developement of an IPM program.

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#### REVIEW

## Understanding and Controlling Ethylene in Horticulture Production

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#### ABSTRACT

Ethylene gas is capable of damaging nursery production stock, vegetables, and fruits at concentrations well below 0.0001%. Large quantities of ethylene are produced naturally by ripening fruit. However, ethylene also can be produced during the burning of natural gas, gasoline, wood, rubber, coal, and tar. Air can be contaminated by accumulating ethylene from these various sources in poorly ventilated areas. Ethylene contamination can cause extreme leaf drop, leaf yellowing, petal drop, petal fade, downward leaf growth (epinasty), flower closure, and floral wilting. The sensitivity to ethylene can be reduced by storage at cool temperatures, decreasing the available oxygen, increasing the carbon dioxide level, and treatment with silver thiosulphate. Plants also can be protected by expensive controlled atmosphere storage facilities that chemically remove ethylene while controlling the concentration of oxygen and carbon dioxide. The most cost-effective method for the control of ethylene in nursery production systems is to remove ethylene sources and maintain adequate ventilation to minimize accumulation.

#### HISTORICAL BACKGROUND

Ethylene is a gas and a natural hormone produced by plants. The earliest use of ethylene was probably in the ripening of figs about 300 BC (Blanpied, 1985). In 1901 a Russian scientist, Neljubow, described the effects of fumes from burning kerosene on pea seedlings. Neljubow was actually describing a plant response to ethylene gas produced during the burning of a petroleum fuel. Denny showed in 1924 that ethylene was produced during the burning of kerosene and represented the agent responsible for degreening lemons (Sherman, 1985). Crocker, Hitchcock, and Zimmerman proposed in 1935 that ethylene was naturally produced by ripening fruit. The real breakthrough in ethylene research surfaced in 1959 with the advent of simple gas chromatographic procedures for ethylene analysis. In 1979 Yang and Adams identified 1-aminocyclopropane-1-carboxylic acid (ACC) as the biochemical precursor to ethylene (Yang and Hoffman, 1984).

The Texas nursery industry has experienced periodic losses due to ethylene-induced defoliation, loss of color, and leaf epinasty in poinsettia (personal observation) and *R. sinica* ('China Doll') during the production of winter crops (Wang and Dunlap, 1989). Floral crops including carnations and roses are devalued or destroyed by ethylene-induced changes in bud and petal development. Although not easily identified, ethylene contamination can result in significant annual losses to the Texas nursery industry. Air samples from a heated greenhouse monitored during the first wave of cool winter temperatures in the LRGV contained nearly 5 ppm of ethylene (personal observation). However, the problem associated with an improperly adjusted heater was not detected until after the nursery stock was damaged. Despite the last 90 years of work with ethylene, there is still no clear understanding of how it is produced or acts in plants. Biological techniques currently becoming available will present new opportunities for major advances in the application of ethylene technology during the next decade.

#### NATURAL PRODUCTION AND EFFECTS

Ethylene is produced naturally in great abundance by ripening fruit as shown by the following examples (Dunlap, Lingle, and Lester, 1990; Paull and Chen, 1989; Rhodes, 1980). These horticulture products can be major sources of ethylene in poorly ventilated storage areas.

Table 1. Typical ethylene production of various ripening fruits.

Fruit	Ethylene (ppm)
Apple	100
Avocado	300-700
Banana	25
Cantaloupe	30-70
Mango	2-3
Papaya	4
Tomato	20-30

Ethylene production also is stimulated in a variety of plants and immature fruits by any form of physical injury such as bruising, cutting, severe chilling, and water stress. Once ethylene production is triggered in a tissue, it becomes self-sustaining (autocatalytic) and reaches relatively high levels of production (Dunlap and Andersen, 1985). The ethylene production resulting from an injury to one plant can be sufficient to damage other nearby plants.

The plant response to ethylene is quite variable and becomes a useful analytical tool, in some situations if managed properly. A few of the most notable ethylene plant responses are shown in Table 2 (Dunlap and Wang, 1989; Kader, 1985; Moore, 1989; Reid, 1985; Rhodes, 1980; Sherman, 1985; Wang and Dunlap, 1990).

Table 2. Physiological responses of some plants to ethylene.

Plant	Response			
Apple, melons, banana, papaya, tomato, pear, peach, avocado	Ripening (color change, fruit softening), flower abscission, and fruit abscission			
R. sinica, poinsettia, Schefflera	Leaf abscission, chlorosis			
Rose, geranium	Petal abscission			
Iris, tulip, gladiolus, potato, onion	Accelerated sprouting			
Rose, poinsettia	Petal or bract fade			
Pineapple, cucurbits	Flowering			
Tomato	Adventitious roots			
Carnation, orchids	Petal wilt			

### TABLE 2. CONTD.

Rose, carnation, Kalanchoe Inhibition of flower opening

Lettuce, peanut Stimulated germination

Pea, bean Hypocotyl swelling, hook closure

Citrus Degreening

Syngonium, tomatos, poinsettia Leaf epinasty

Broccoli Yellowing, leaf abscission

Lettuce Russet spotting

The sensitivity of each response will vary somewhat according to plant species but usually can be elicited at 0.0001% (1 ppm) or less of ethylene over a specified time of exposure. Brief exposures to ethylene require higher concentrations to trigger a response. Conversely, longer exposures can result in responses to lower concentrations. The initiation of certain plant responses become less likely as the surrounding temperature is lowered.

Ethylene is produced by the incomplete burning of carbon-based fuels such as those shown in Table 3. Each of these sources can produce sufficient ethylene to initiate a wide range of

Table 3. Potential sources of ethylene contamination.

Burning wood Propane heaters

Diesel exhaust Oil burning heaters

Gasoline exhaust Burning rubber

Heated tar Stack smoke

plant responses (personal observation; Blanpied, 1985; Sherman, 1985). However, none are of any consequence unless allowed to accumulate in a closed environment.

### METHODS OF DETECTION

The detection of ethylene was a laborious and difficult laboratory procedure until 1959 (Blanpied, 1985). It required that ethylene be removed from air samples and assayed chemically, manometrically, or biologically. One of the more historically popular bioassays for ethylene has been the "triple response" in pea seedlings (Moore, 1989). Pea seedlings exposed to ethylene undergo three very typical changes in growth: 1) shortened stem, 2) thickened stem, and 3) loss of upright growth. Properly managed tomato seedlings grown in a greenhouse production system may represent a potential system for detecting ethylene. Leaf epinasty or root growth along the lower stem are indicators of ethylene contamination. However, the response time for a bioassay is relatively slow and does not provide sufficient warning to avoid crop damage.

Procedures developed in 1959 for ethylene analysis by gas chromatography revolutionized the field of ethylene research. Gas chromatography made possible the direct analysis of an air sample for its ethylene content within only minutes. The sensitivity and precision are extremely high. The minimum cost for a gas chromatography system used in the detection of ethylene in 1990 dollars is approximately \$2,500. An alternative to gas chromatography is a hand-held gas analyzer produced by Drager and distributed by Lab Safety Supply for around \$300. This apparatus draws a measured volume of air through tubes packed with an ethylene indicator. The system claims a sensitivityof 0.00005 to 0.0001% (0.5-10 ppm) ethylene.

#### BIOLOGY OF PRODUCTION

Ethylene is a very small molecule closely related to carbon dioxide. It is colorless but does have an odor resembling natural gas. Ethylene is highly explosive at concentrations between 3% and 32% in air (Sherman, 1985). The ability of plants to produce ethylene becomes limited as the concentration of oxygen drops below 10%, which impairs the utilization of ethylene precursors. Commercial preparations of ethylene can be obtained in the form of a compressed gas or 2-chloroethylphosphonic acid (Ethrel<sup>R</sup>) which degrades to release ethylene.

Ethylene is produced in plants through a series of steps involving three major chemicals (Lieberman, 1979; Yang and Hofmann, 1984). Methionine, an amino acid which is also a building block for proteins, is converted to S-adenosyl methionine (SAM). SAM is then converted to 1-aminocylopropane-1-carboxylic acid (ACC). The ACC produced by SAM is converted to ethylene in the plant cell. The only known use of ACC in plants is for the production of ethylene.

The production of ACC from SAM for ethylene synthesis can be blocked in plants with the microbial toxin, aminoethoxyvinylglycine (AVG). Inhibition of ethylene production with AVG has become one of the tests to confirm the synthesis of ethylene in plants (Yang and Hofmann, 1984). Cobalt salts and salicylic acid (found in aspirin) also prevent ethylene production (Dunlap, 1988; Woltering and Van Doorn, 1988).

Inhibiting ethylene production is only one way to eliminate an ethylene response in plant tissue. Blocking the plant's ability to respond to ethylene will yield the same ultimate result despite the presence of ethylene production or high concentrations of ethylene in the air. Carbon dioxide (5%-10%), silver thiosulfate (STS), and norbornadiene (NBD) will prevent plant tissue from responding to ethylene by blocking access to the ethylene receptors (Lieberman, 1979; Dunlap and Wang, 1989; Yang, 1985). There is still very little information about the nature of plant ethylene receptors and the production mechanism in the cell. However, scientists have recently isolated and duplicated the gene responsible for production of ACC in mung bean (Arteca, 1988). If the gene can be altered and introduced into other plant species, it will be possible to selectively control production and manage for the desirable responses to ethylene.

#### PROTECTING PLANTS FROM ETHYLENE

The action of ethylene on plants can be prevented by avoiding exposure to active concentrations and blocking the plant response mechanism. Plants treated with silver thiosulfate (STS), cobalt chloride, or even salicylic acid are relatively insensitive to ethylene (Dunlap, 1988; Wang and Dunlap, 1990; Woltering and Van Doorn, 1988; Yang, 1985). AVG can be used to block the natural production of ethylene by plants and delay any adverse effects (Yang and Hofmann, 1984). However, the use of these chemicals can add expense and some risk to commercial operations if not handled in a skillful manner. Controlled atmospheres (CA) can be used to chemically remove accumulated ethylene from closed storage areas in addition to making adjustments of carbon dioxide and oxygen levels in the air (Sherman, 1985). Although commercially available, CA technology is expensive and requires a high degree of management. Refrigerated shipping and storage conditions are possible options for certain plant products that are not chilling sensitive. The most cost-effective protection can be achieved by eliminating the exposure to ethylene, by removing potential ethylene sources, and providing adequate ventilation. For example, mixed loads during shipping where one of the products may be an ethylene producer such as bananas or melons should be avoided (Lipton and Harvey, 1977). Particular care should be used to avoid inadvertant ethylene contamination

during the winter months when production and shipping facilities are heated and sealed against the outside air.

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## Status of Citrus Blackfly in Valley Orchards

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The citrus blackfly, Aleurocanthus woglumi Ashby, a relatively minor pest of Texas citrus for the past decade, escalated to ecomomically damaging levels during the 1988 and 1989 seasons. The current blackfly outbreak undoubtedly resulted from the disruption of the parasitoid, Amitus hesperidum Silvestri, and Encarsia opulenta Silvestri, which had effectively regulated blackfly since their introduction in 1974. To regain control of citrus blackfly an intensive parasitoid release program was conducted between June and September, 1989. An estimated 702,400 parasitoids were released in 40 mid-Valley orchards heavily infested with blackfly. Releases included both insectary-reared and field collected A. hesperidum and E. opulenta received from Florida and field collected E. opulenta from Mexico. To augment the parasitoids from these sources, leaves with parasitized blackfly from two Brownsville area orchards were collected and redistributed. The latter accounted for 70% of all A. hesperidum and E. opulenta released. Ten orchard release sites were intensively monitored via leaf examination and fluorescent yellow sticky traps. Parasitoid establishment was indicated by the increasing levels of parasitism, but significant declines in CBF populations had not yet occurred when a severe freeze struck the Valley in December 21-26, 1989. Parasitism levels in the orchards monitored ranged from 6.4% to 68.3% just prior to the freeze. Post-freeze parasitoid survival in these orchards was shown by the significant number of both A. hesperidum and E. opulenta captured on yellow sticky traps through February, 1990.

# The Effects of Transplanting, Plastic Mulch and Irrigation Level on Drip Irrigated Muskmelon Yield and Quality

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Melon growers are adopting several new cultural practices including transplanting and plastic mulches in an effort to improve earliness. Drip irrigation is necessary with plastic mulch and substantially reduces the amount of water needed to grow the crop. Data is needed on how much earliness can be expected due to such practices, what the optimum water application level is, and what adverse side effects such as salt accumulation in the soil might occur. Irrigation at .25, .50, .75, 1.0 and 1.25 times pan evaporation had little effect on soil moisture in yield, with all water application levels keeping the soil close to field capacity. Transplanting vs. direct seeding enhanced early vine growth and caused earlier yield, although direct-seeded plants later caught up and had final cumulative yields slightly higher than the transplants. Black polyethylene much also improved earliness and reduced the number of culls compared to bare soil, but at the lowest watering level total yields were reduced by mulch due to deflection of the rainfall received. The combined practices of transplanting and polyethylene mulch caused approximately a 9-day earliness advantage over the treatment that was direct-seeded without mulch, although final yields were unaffected. Slight salt buildup was observed in the surface 15 cm (6 inches) of soil for all but the lowest irrigation level. Soil salinity increases were between .2 and .4 mmhos/cm which should not be detrimental, but could result in buildup over time and may affect placement of the dripline.

# The Effect of Plastic Mulch and Drip Irrigation on Muskmelon Yield and Quality

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Various modifications in melon cultural practices offer the potential to improve yield, quality and earliness, as well as lower costs and reduce susceptibility to disease and insect pests. This study was conducted in the lower Rio Grande Valley of Texas in 1989 to determine the effects of planting methods, polyethylene mulch, and rate of drip irrigation on muskmelon growth, yield and quality. The first planting made on February 16 was lost due to high winds and cold temperatures, therefore the study was replanted on March 14. Irrigation at .25, .50, .75, 1.0, or 1.25 times pan evaporation had very little effect on soil moisture or yield, with all water application levels keeping the soil close to field capacity. Transplanting vs. direct seeding enhanced early vine growth and caused earlier yield, although direct seeded plants later caught up and had final cumulative yields slightly higher than the transplants. Black polyethylene mulch also improved earliness and reduced the number of culls compared to bare soil, but at the lowest watering level total yields were reduced by the mulch due to deflection of the rainfall received. The combined practices of transplanting and polyethylene mulch caused approximately a 9 day earliness advantage over the treatment that was direct seeded on bare soil, although final yield was unaffected. Soil salinity build up may cause problems and would affect the position of the drip line and frequency and amount of water applied.

# Postharvest Storage Evaluations of Muskmelon Relative to Taste and Quality Criteria

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Sensory analyses comparison of 19 netted muskmelon (Cucumis melo L.) cultivars and breeding lines at harvest revealed that 'Caravelle' and 'Mission' cultivars were highest in the 'like'' category for appearance, flesh color, odor, texture, and overal fruit acceptance. Analyses of sensory attributes showed that flavor (r = 0.92) had the highest significant correlation with overall fruit acceptance and that total sugars per gram fresh weight was highly correlated (r = 0.65) with overall fruit acceptance. These cultivars treated with 1000 ppm imazalil and individually wrapped in shrink-film wrap or not wrapped then stored 0, 14, or 28 days at 4C and 90% ±5% RH showed that after 14 days storage both wrapped and non-wrapped fruit were equally well liked for all sensory attributes. After 28 days of storage wrapped fruits were better liked than non-wrapped fruits for appearance, flesh color, flavor, texture, and overall acceptance, but were similar for odor.

# Lettuce Infectious Yellows: Potential Problems for Vegetable Crop Production in South Texas

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Lettuce infectious yellows (aka doradilla) is potentially a serious disease in cucurbits, lettuce, and other vegetable crops grown in the winter production regions of Central America, Mexico and the United States. This disease is stimulated by the lettuce infectious yellows virus (LIYV), a long, flexous rod in the closteovirus group, with a wide host range. It can only be transmitted by the sweet potato whitefly (Bemisia tabaci Genn.), which transmits a number of other viral diseases. Symptoms of LIYV were first reported in Southern California in 1982, and include leaf stunting, brittleness, yellowing with view clearing in lettuce (Lactuca sativa L.) In Latin America and California infection can reach 100% in certain vegetable fields, which is primarily a function of whitefly infestation. Whitefly populations build up on alfalfa and cotton crops, which are not susceptible to LIYV. Cotton defoliation in South Texas may induce migration of the whitefly to vegetable crops. LIYV has not been reported in South Texas, although squash silverleaf disease (SSD) of cucurbits, and Texas pepper gemini viruses (TPGV) of solanceous crops are common throughout the region in the summer and fall, Control of whiteflies and the diseases that they vector will reduce market variability for crops such as cucurbits, lettuce, tomatoes, and peppers. Reduced yields have increased unit prices up to six times, destroying market stability and altering farm receipts.

## Biological Functions of Plant Growth Retardants

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Growth retardants represent a group of chemicals which, upon applying to plants, drastically reduce the biosynthesis of gibberellins. They inhibit the oxidation of ent-kaurene to ent-kaurenol. As a result, internodes become short, reducing the total plant height. Water soluble retardants, such as daminozide and chlormoquat, move bidirectionally in plants. Whereas water insoluble plant growth retardants, such as ancymidol, paclobutrazol and uniconazole, moves acropetally through the transpirational water stream in the xylem. In many species, retardants reduce leaf size and increase chlorophyll concentrations in the leaf. The reduced transpiration rate of retarded plants is accomplished by the reduction of total leaf area. The rate of dark respiration of hibiscus leaves is not affected by uniconazole. Experiments have show that uniconazole reduces cell activity in the apical meristem and slows cell division and cell differentiation. It restricts shoot elongation mainly by allowing fewer cells per internode, rather than reducing cell length.

# Growth Rates and Care of the Texas A&I Thornless Mesquite

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In July 1989 Texas A&I entered into an agreement with Plantclone Inc. of Kingsville whereby Plantclone Inc. could use the name "Texas A&I Thornless Mesquite" in return for a percent of the gross sales of the tree. The clone was originally selected in U.S. Dept. of Energy supported field trials in the California Imperial Valley for rapid growth under high heat loads. In non-irrigated, clean cultivated field trials, this clone attained a height 6 m at the end of 3 growing seasons. At least one yard tree has grown 8 inches in diameter in less than 5 years. Under these rapid growth conditions the tree has a strong tendency to lean. Initially it had been suspected that since the tree was reproduced by cuttings that it would not develop a tap root. However a 3/8 inch diameter tap root is often observed leaving the 5 gallon pot and rooting into the ground (through roofing paper) after the clones are a year old. Management practices have not yet been developed to fully eliminate this leaning tendency, but it is clear that pruning to reduce canopy size and good staking will be necessary to take full advantage of the rapid growth of this clone.

# ABSTRACT The Easy Care Xeriscape Garden

Mardi Eggars Eggar's Acres 2 1/2 N. Shary Road Mission, Texas 78572

The principles of XERISCAPING are: IMPROVE THE SOIL with soil conditioners, peat moss, cotton burrs, decomposed manure or compost for better root growth and water retention. USE A WEED MAT AND MULCH to cover the soil and inhibit weed growth, reduce soil drying and keep the soil cooler. REDUCE LAWN AREAS as grass uses more water than most shrubs or ground covers. WATER EFFICIENTLY and early in the morning or as plants need water. Most plants will do well with 1 inch of water per week. GOOD MAINTENANCE, remove weeds that appear. SELECT DROUGHT TOLERANT PLANTS, many Texas natives are especialy good as are some exotics. Remember, even drought tolerant plants must be kept watered through their first summer. XERISCAPE PLANTS FOR USE IN THE RIO GRANDE VALLEY: Texas Pistachio, native orchid tree, southern live oak, mesquite, sable palm, esperanza, assorted cactus, cedar elm, desert willow, lantana, purple sedge, Mexican buckeye, wild olive, Texas persimmon, truk's cap, aloe vera, Texas Mt. laurel, red yucca, yaupon holly, bougainvilla, nandia, liriope, Mexican oregano, monkey grass, yucca, cape honeysuckle, cassia, European olive, aniscanthis, asparagus fern, hamelia, Barbados cherry, plumbago, pampas grass, mealy sedge, verbina, periwinkles, rosemary, orchard trees, santolina, poinciana, oleanders, shrimp plant, coral vine, flame bush, Afghan pine.

## Call for Papers

Papers are requested for inclusion in Volume 44, 1991 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 44, 1991 is July 1991. Manuscripts for publication in the Journal may be sent to:

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# Guidelines for Authors Reviews and 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 \$15.00 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 and Notes

Submit in English 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.

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Manuscript preparation should follow the style used by the Journal of the American Society for Hortlcultural 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 separate 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 acknowledgments 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 specific 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.

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Statistics: When treatments are a set of unrelated materials such as chemicals or varieties, Duncan's multiple range test or other multiple comparisions 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 comparision 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 feature outstanding speakers from all parts of the world who present new developments in the field of horticulture. Panel discussions, social gettogethers, 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 memberships 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 Texas Citrus Exchange and served in may civic capacities.

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