In all tests, no phytotoxicity was observed. Based on the overall pest reductions reported herein, Orthene and Vydate appear to hold good promise as broad spectrum insecticides for commercial greenhouse production of *A. squarrosa*.

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CHRYSANTHEMUM PRODUCTION SYSTEM VARIABLES AFFECT PEST POPULATION AND DAMAGE[1]

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Abstract. **Cultural variables of mulch, irrigation, cultivar, fertilization and chemical soil treatment were combined in a single factorial experiment to test their effects on insect pest populations and field growth of chrysanthemums.**

Data summed from weekly observations over the season indicate that larva-damaged plants were reduced in plots where mulch was used but mite frequency and density were increased. 'Manatee Iceberg' was more extensively damaged by larvae, mites, and leafminers than 'Albatross'; however, the latter cultivar was more readily attacked by aphids. Soil treatments by injection of oxamyl resulted in fewer leafmines but larger numbers of mites and aphids on foliage. The effects of fertilizer and irrigation variables on pest populations over the entire season were minimal. However, both had a significant initial and continued effect on plant growth in height.

Manipulation of agronomic and cultural practices to maximize their suppressant effect on crop pests is of much interest to crop protection scientists involved with crop management. Cultural practices augmented with resistant cultivars, biological control, and selective use of pesticides can result in more efficient and safe management of pests than reliance upon chemical toxicants alone. However, before manipulation of production variables can be integrated into the pest management scheme, their individual as well as interactive effects on pest populations must be described.

In Florida, production of chrysanthemum (*Chrysanthemum morifolium* Ram.) is accomplished in an intensively managed system that is dependent upon use of agrichemicals for pest control. Several variables in this system important as pest determinant factors were demonstrated for chrysanthemum grown under saran protection (1, 2, 3). Among the important variables were irrigation, fertilizer, mulch, chemical pesticide use and cultivar. Due to the high quality demand in cut flowers, the conventional damage threshold concepts have little application and consequently any cultural management practice that results in reduced pest potential or threat should gain ready acceptance.

This report summarizes data on the influence of production system variables on plant growth and pest populations and represents part of a series of experiments undertaken to determine the best cultural practices. Again, production practices—irrigation, use of bed covers, fertilization, cultivar, and pesticide use were treated as variables to determine how pest populations and plant growth respond.

Materials and Methods

The experimental plants were grown under a saran cover in 24 ground beds of Myakka fine sand, standard for chrysanthemum production. Land preparation included broadcast amendments of 1000 lbs/A dolomite,[3] 546 lbs/A triple superphosphate, 30 lbs/A FTE 503 fritted trace elements incorporated 4-6″ deep prior to forming the beds.

One-half of each 3′ x 72″ bed received 360 lbs/A KNO_3 and 71.6 lbs/A NH_4NO_3 broadcast and raked 1″ deep into the bed surface as a preplant fertilizer. Irrigation water was supplied once each hour throughout the crop season so that each day 0.46 in. water per bed-acre was distributed in each of four systems designed to vary the placement of water relative to bed width. The four systems were:

1. One Via-flo[R] type I micropore tube placed atop the center of the bed between positions of rows 3-4 of the 6-row bed.
2. Two tubes, placed between rows 2-3 and 4-5.
3. Three tubes, placed between rows 1-2, 3-4, and 5-6.
4. Two Anjac[R] biwall tubes with single emission parts 18″ apart, turned upward, between rows 2-3 and 4-5 of the 6-row bed.

One-half the beds were sealed with 40 lbs kraft paper with 0.25 mil clear polyethylene laminated to both sides. Liquid fertilizer at the rate of 30 lbs N/A/week for 10

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[3]For metric conversions, see Table near the front of this Volume. Ed.

weeks (formulated from NH_4-N and KNO_3) was introduced into all plots regardless of pre-plant fertilizer applications. Oxamyl (2L) at the rate of 4 gal/A distributed over a 9-week period was introduced into one-half the plots through the irrigation system. The plots were planted to 2 cultivars, 'Albatross' and 'Manatee Iceberg' on February 7, 1975.

Fungicides, benomyl plus captan and benomyl plus manzate were applied on alternate weeks in tank mixes containing diazinon, *Bacillus thuringiensis,* oxydemeton methyl or azinphosmethyl plus methomyl also on alternate weeks. These materials were applied beginning Feb. 13 and continued until May 8. When spidermites became troublesome, Omite[R] or trihexyltin hydroxide was applied with the sprays. Only plots receiving no injections of oxamyl were sprayed with insecticides and acaricides.

The plant growth period was divided into transplant (0-4 weeks), vegetative (4-10 weeks), and flowering (10-12 weeks) phases and the upper most fully expanded leaf labeled with a string-tag bearing the date. Insect and mite populations and damage were measured weekly, from whole plant observations during the transplant phases, then from 5 leaf samples taken at random from plants in each plot. Density, number of individuals per leaf, frequency, and number of leaves (or plants) injured by, or hosting, pests were recorded.

Results and Discussion

Plant growth. The height of the two cultivars throughout the season is shown in Fig. 1. 'Albatross' was the taller plant initially and continued to be so regardless of the treatment variables. Pre-plant fertilization resulted in significantly better plant growth during establishment, vegetative and flowering phases (Table 1) for both cultivars.

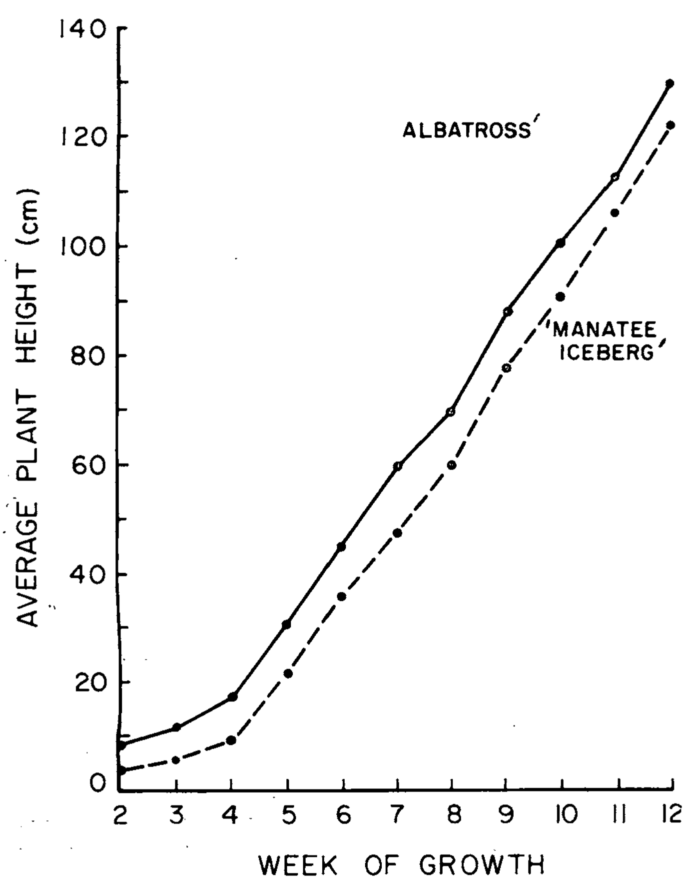

Fig. 1.

Table 1. Main effects of cultural variables on chrysanthemum growth, pest populations and damage, Spring 1975, Bradenton, Florida.

Dependent variables[z]	Independent variables and relationship[y]
Plant height (cm)	
Week 4	Var: Albatross (17.1 > Man. Iceberg (8.7) Fert: Preplant (16.4) > No preplant (9.4)
Weeks 4-10	Irr: Viaflo 3 (88.5) ≥ Viaflo 2 (85.1) ≥ Anjac (82.4) > Viaflo 1 (76.3) Fert: Preplant (88.1) > No preplant (78.0)
Week 12	Var: Albatross (128.2 > Man. Iceberg (123.2) Fert: Preplant (134.3) > No preplant (117.3) Trt: Spray (129.2) > Oxamyl (122.4)
Pests	
% plants damaged by larvae	Var: Man. Iceberg (3.75) > Albatross (1.82) Fert: Preplant (3.10) > No preplant (2.46)
% plants damaged by leafminer	Var: Man. Iceberg (6.18) > Albatross (1.09) Fert: Preplant (4.63) > No preplant (2.63) Trt: Oxamyl (4.13) > Spray (3.14)
Average number of plants damaged by leafhopper	Var: Man. Iceberg (0.34) > Albatross (0.08) Fert: Preplant (0.31) > No preplant (0.11)

[z]Larvae = *Pseudoplusia includens* and *Trichoplusia ni;* Leafminer = *Liriomyza sativae* Blanchard; and Leafhopper = Cicadellidae.
[y]Var = cultivar; Fert = fertilizer; Irr = irrigation; Trt = treatment; Man = Manatee; > = greater than; ( ) = mean values; and significant at P = 0.05.

Bed irrigation also significantly affected plant growth and in an interaction 'Albatross' responded best to Viaflo (2 tubes per bed) with preplant irrigation. Mulching had no influence on plant growth where preplant fertilizer was used; however, with no preplant fertilization the addition of a bed cover increased growth (117 to 129 cm). Fertilization also influenced the effect of treatment on growth since with no preplant fertilizer, plant height was reduced in oxamyl plots (124 to 112 cm). This difference appeared to be offset by the added nutrition when preplant fertilizer was applied. Plant height was increased by mulch when only 1 Viaflo tube per bed was used (132 to 117 cm) and a similar effect was noted with 3 Viaflo tubes per bed; however, the reverse was true with 2 tubes per bed regardless of the type of delivery, Viaflo or Anjac.

Pests. During the establishment phase of growth (wks. 0-4), variables affecting pest damage and presence included cultivar, fertilizer and treatment (Table 1). In all plots 'Albatross' showed less damage by insects than did 'Manatee Iceberg.' The addition of preplant fertilizer resulted in significant increases in damaged plants for all measured pest variables. The number of plants with leafmines and the percent of plants mined was decreased by the standard spray program compared to injected oxamyl.

The major pest species present and causing damage during the early stages of growth were caterpillars of *Trichoplusia ni* (Hubner) and *Pseudoplusia includens* Walker, cabbage and soybean loopers, respectively; *Liriomyza sativae* Blanchard, vegetable leafminer; and cicadellids. The latter organisms typically invade newly set beds where their feeding results in a stipple-like scar on plant foliage similar to leafminer punctures. During later stages of growth leafhoppers are usually not pests.

Populations of pests present in the vegtative and flowering phases of growth were similar and data of the two periods were pooled for presentation. In addition to the named caterpillars and leafminers, spidermites (*Tetranychus urticae* (Koch)), green peach aphid (*Myzus persicae* (Sulzer)), and *Frankliniella* spp flower thrips also attacked the older plants.

Caterpillars. The number and percent of leaves damaged by caterpillars was significantly reduced on plants grown in mulched beds; however, damage increased with an increase in Viaflo tubes per bed in the absence of mulch but was not influenced when mulch was present (Table 2). Because of transpiration, turgor of plants was often less in plots without mulch and fewer irrigation tubes, and the decrease in damage recorded for these plots suggests that larvae cause more damage to succulent turgid foliage.

The cultivar 'Manatee Iceberg' showed more damage by caterpillars than did 'Albatross,' regardless of the other variables (Table 2). Similar results were reported earlier (3).

Table 2. Main effects of cultural variables on pest populations during vegetative and flowering phases of chrysanthemum growth, Spring 1975, Bradenton, Florida.

Dependent variables[z]		Independent variables and relationship[y]
% leaves damaged by larvae	Mulch:	No mulch (0.35) > Mulch (0.27)
	Var:	Man. Iceberg (0.42) > Albatross (0.20)
% leaves mined	Var:	Man. Iceberg (14.1) > Albatross (3.1)
	Trt:	Spray (10.5) > Oxamyl (6.7)
Average number mines per leaf	Var:	Man. Iceberg (0.60) > Albatross (0.15)
	Trt:	Spray (0.52) > Oxamyl (0.33)
% leaves with mites	Mulch:	Mulch (15.0) > No mulch (10.6)
	Var:	Man. Iceberg (19.8) > Albatross (5.8)
	Trt:	Oxamyl (17.6) > Spray (7.9)
Average number mites per leaf	Mulch:	Mulch (4.6) > No mulch (2.1)
	Irr:	Viaflo 2 (5.3) > Anjac (3.5) ≧ Viaflo 1 (2.5) = Viaflo 3 (1.9)
	Var:	Man. Iceberg (5.9) > Albatross (0.74)
	Trt:	Oxamyl (4.7) > Spray (1.9)
% leaves with aphids	Irr:	Anjac (4.4) ≧ Viaflo 3 (4.1) > Viaflo 2 (2.9) ≧ Viaflo 1 (2.6)
	Var:	Albatross (5.8) > Man. Iceberg (1.2)
	Trt:	Oxamyl (4.6) > Spray (2.3)
Average number aphids per leaf	Var:	Albatross (0.68) > Man. Iceberg (0.09)
	Trt:	Oxamyl (0.53) > Spray (0.23)

[z]Larvae: loopers, *Trichoplusia ni* (Hubner) and *Pseudoplusia includens* Walker; Miner: *Liriomyza sativae* Blanchard; Mite: *Tetranychus urticae* (Koch); and Aphid: *Myzus persicae* (Sulzer).
[y]Var = cultivar; Trt = treatment; Irr = irrigation; Fert = fertilizer; Man = Manatee; and significant at P = 0.05.

Leafminer. Density and frequency of mines given as percent of leaves damaged by leafminers was significantly dependent upon cultivar and treatment (Table 2). Plots that received regular sprays showed reduced mining activity compared to the plots that received injected oxamyl. 'Manatee Iceberg' was again the favored cultivar as host to leafminer. Several interactions among main variables occurred which had a significant effect on leafmining activity. Use of preplant fertilizer resulted in fewer leaves damaged only when beds were not mulched; otherwise leafminers responded positively to increases in fertilizer. Further, when preplant fertilizer was used, leafminer populations decreased in plots irrigated with 3 Viaflo tubes and Anjac biwall tubes but activity was increased with 1 and 2-tube Viaflo irrigation. In the absence of preplant fertilization, no such effects were noted. There was, however, a general increase in leafmines and damage with increases of Viaflo tubes per bed. Leafmining activity decreased in the Anjac irrigated plots when the beds were mulched, but increased where no mulch was used. The lowest average number of leaves mined (0.26) was in plots with one Viaflo tube and no preplant fertilizer as was the lowest percentage of leaves mined (5.2%). The highest average number of leaves mined (0.52) and percent mined (10.4) was found in plots with Anjac irrigation and no preplant fertilizer. Oxamyl *injected* was better (50-60% fewer mines) than the spray when irrigation was by Viaflo tubes.

Mites. The percent of leaves with mites and average number of mites per leaf were affected by cultivar, mulch and treatment; the latter was also affected by method of irrigation (Table 2). 'Manatee Iceberg' plants grown on mulched beds and oxamyl injected plots showed increased populations of mites compared to 'Albatross,' unmulched beds and spray treatment (Table 2). When mulch was used with 2-tube Viaflo irrigation, the average number of mites per leaf increased but the number of leaves with mites was reduced. That is, the density but not the frequency, was increased. In every case the addition of mulch resulted in an increase in mite presence and numbers except in plots with 3-tube Viaflo irrigation, which showed the lowest number of mites per leaf (Table 2). When the irrigation was provided by 2-tube Viaflo, preplant fertilization resulted in a decrease in mite numbers; in all other plots preplant fertilization increased mite numbers, but not significantly. The difference in density and frequency of mites in sprayed plots compared to oxamyl-injected plots was less when mulch was used than when no mulch was used, or mulch increased mite incidence in oxamyl-treated but not in sprayed plots (21-30%).

Aphids. Only during a short period of time beginning about week 8 did aphid invasion and population development occur. The frequency of aphids, percent of leaves infested, and average number per leaf were highly dependent upon cultivar ('Albatross' greater than 'Manatee Iceberg') and treatment (oxamyl greater than spray) (Table 2). More leaves (ca 40%) were infested with aphids in plots irrigated with Anjac and 3-tube Viaflo than 1 or 2-tube Viaflo. The reason for this might again be in the turgor of plants grown on the different water delivery systems, the more turgid plant providing a more desirable host for invading insects. Larger numbers of aphids were present on leaves in oxamyl-injected plots than in sprayed plots except when 2-tube Viaflo irrigation was used; however, the percent of leaves infested was not affected in the same manner. This result suggests that aphid reproduction was curtailed less in the oxamyl-injected plots.

Thrips. None of the independent variables had a significant main effect on trips damage. However, interactions between irrigation and fertilizer suggested that where preplant fertilizer was used the amount of thrips injury was reduced by the addition of mulch (11%) and by single-tube irrigation. Without preplant fertilization less damage was evident in 3-tube Viaflo and Anjac irrigated plots.

In this experiment 'Albatross' was found to be a more robust growing cultivar and to be a poorer host than 'Manatee Iceberg' for all pests encountered except for green peach aphid. The addition of mulch to beds resulted in a slight reduction in caterpillar damage but a substantial increase in mite populations. Treatment of plants by weekly sprays gave superior control of mites and aphids but generally poorer control of leafminers. Injected oxamyl appeared to influence these pests systematically. Use of preplant fertilizer resulted in faster initial and continued plant growth but also resulted in greater percent of damage caused by caterpillars, leafminers, and leafhoppers early in the establishment phase. Later, populations of pests appeared unaffected by fertilizer. Irrigation was important to plant growth during the vegetative phase (wks 4-10), 1 Viaflo tube per bed being significantly poorer than other delivery systems. Irrigation had a significant effect on mites per leaf, 2-tube

Viaflo resulting in the largest number of mites per leaf (5.3) and 1 or 3-tube Viaflo the least (1.9). Aphids on leaves were adversely affected by irrigation applied with 1 or 2 Viaflo tubes.

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EFFECT OF INSECTICIDES ON POINSETTIA AND ERINNYIS ELLO[1]

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Additional index words. Ello sphinx, poinsettia hornworm, phytotoxicity, chemical control.

Abstract. **No chemical injury to foliage or bracts of 3 cultivars of poinsettia grown in 6-inch pots outside under saran was noted after 8 applications of 4 insecticides. Methomyl (Lannate$^{(R)}$, Nudrin$^{(R)}$), endosulfan (Thiodan$^{(R)}$), and acephate (Orthene$^{(R)}$) gave 100% control of** Erinnyis ello **(L.) (a hornworm) after 1 application while 3 sprays were necessary to achieve this level of control with** Bacillus thuringiensis **var.** kurstaki **Berliner (Dipel WP$^{(R)}$).**

Two additional tests were completed to further evaluate phytotoxicity. In the first test, 8 insecticides were applied 12 times to 'Annette Hegg Diva' and 'Annette Hegg Supreme' grown in 6-inch pots outside under saran. The foliage of both cultivars was uninjured while the bracts exhibited slight to moderate necrotic spotting from diazinon and slight tip marginal necrosis by trichlorfon (Dylox$^{(R)}$, Proxol$^{(R)}$) sprays. No injury was observed with B. thuringiensis, **acephate, azinphosmethyl (Guthion$^{(R)}$), carbaryl (Sevin$^{(R)}$), endosulfan, or methomyl. In the second test, acephate and methomyl were applied 12 times to 27 poinsettia cultivars grown as above with no phytotoxicity observed. When the plants were moved to a greenhouse and treated 2 additional times, slight to moderate tip necrosis of foliage was evident on all cultivars. Slight to moderate tip and marginal necrosis of bracts was noted for 'Eckespoint Professor Laurie Pink' and 'Mikkel Dawn Rochford' (both insecticides), 'Paul Mikkelson' (methomyl only), and 'Mikkel Fantastic' (acephate only).**

Erinnyis ello (L.), sometimes called the Ello sphinx or poinsettia hornworm, is a major pest of poinsettia grown in Florida. It is particularly prevalent under saran, glass and fiberglass covered structures with open sides and on homeowner's plants. Larvae consume the foliage, leaving mid veins. Small plants can be completely destroyed. No work to control this pest has been reported in Florida.

Richman and Gentile (2) summarized reports of phytotoxicity of pesticides to ornamentals, including poinsettias. In Florida, Poe and Raulston (1) studied the effects of single applications of acaricides and insecticides on mature greenhouse-grown poinsettias. Acephate (Orthene$^{(R)}$), endosulfan (Thiodan$^{(R)}$), diazinon, azinphosmethyl (Guthion$^{(R)}$), tetradifon (Tedion$^{(R)}$), dimethoate (Cygon$^{(R)}$, Defend$^{(R)}$) and oxydemeton-methyl (Metasystox-R$^{(R)}$) were safe on all the poinsettia cultivars tested.

The purpose of this paper is to report the effects of weekly applications of insecticides on poinsettia foliage and bracts and on control of *E. ello.*

Materials and Methods

All tests were conducted outside under saran cloth (25% shade) at the Agricultural Research and Education Center, Bradenton, Florida. Plants were grown from rooted cuttings planted singly in 6-inch pots containing a sand, peat, perlite and vermiculite (2:2:1:1 by volume) soil mixture with 0.41 lb dolomite, 0.18 lb hydrated lime, 0.22 lb superphosphate, 0.57 lb 14-14-14 Osmocote$^{(R)}$, and 0.18 lb Perk$^{(R)}$ added per ft^3. Plants were pinched to 4 nodes about 3 weeks after transplanting.

In Test 1, 'Annette Hegg Dark Red,' 'Annette Hegg White,' and 'Annette Hegg Diva' were transplanted Aug. 14, 1975. Five pots per cultivar per treatment for each of 4 replications were arranged in a split plot design 5 across in a 6 x 72 ft polyethylene plastic lined trough filled with 2 inches of methyl bromide-fumigated Myakka fine sand. Plants were irrigated by 2 Via-flo$^{(R)}$ tubes running the length of the trough. Treatments were applied weekly, beginning Nov. 7, 1975, and terminating Jan. 2, 1976. Plants were inspected for *E. ello* larvae and phytotoxicity on Nov. 11, 17, 26, and Dec. 1. Data were combined for cultivars and transformed ($\sqrt{X + 0.5}$) for analysis.

In Test 2, 'Annette Hegg Diva' and 'Annette Hegg Supreme' were transplanted Aug. 25, 1976. Three pots per cultivar per treatment for each of 3 replicates were arranged in a split plot design 3 across on a Vattex$^{(R)}$ capillary mat covering a 4 ft x 72 ft x 4 in high sand bed covered with polyethylene. Water was supplied by 2 Via-flo tubes positioned under the mat the length of the bed. Eight insecticides were applied weekly from Sept. 14 to Dec. 16 and phytotoxicity evaluated Dec. 21 by comparisons with check plants sprayed with water.

In Test 3, the following cultivars were transplanted Aug. 27, 1976: 'Annette Hegg Diva,' 'Annette Hegg Supreme,' 'Annette Hegg Lady,' 'Annette Hegg Dark Red,' 'Annette Hegg Super Star,' 'Annette Hegg New Pink,' 'Annette Hegg Marble,' 'Annette Hegg White,' 'Annette Hegg Top Star,' 'Annette Hegg,' 'Eckespoint C-1,' 'Eckespoint C-1 White,' 'Eckespoint Reddy Light,' 'Eckespoint Professor Laurie Pink,' 'Small Winter Flame,' 'Paul Mikkelsen,' 'Mikkel Heritage,' 'Mikkel Improved Rochford,' 'Mikkel Super Rochford,' 'Mikkel Vivid Rochford,' 'Mikkel Triumph,' 'Mikkel Pink Rochford,' 'Mikkel Fantastic,' 'Mikkel Im-

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