creasing the data base by continued routine sampling should enhance and refine the preliminary conclusions presented here.

Literature Cited

1. Alvarez, Jose, and K. D. Shuler. 1983. Economic importance of the Everglades Agricultural Area, 1982-83. Belle Glade Agr. Res. Educ. Center Res. Rpt. EV-1983-8.
2. Burdine, H. W. 1976. Plant analysis for vegetable crops grown on Everglades organic soil. Belle Glade Agr. Res. Educ. Center Res. Rpt. Ev-1976-9.
3. Caprio, J. M. 1971. The Solar-Thermal Unit theory in relation to plant development and potential evapotranspiration. Montana Agr. Exp. Sta. Cir. 251.
4. Forsee, W. T., Jr. 1950. The place of soil and tissue testing in evaluating fertility levels under Everglades conditions. Soil Sci. Soc. Amer. Proc. 15:297-299.
5. Geraldson, C. M., G. R. Klacan, and O. A. Lorenz. 1973. Plant analysis as an aid in fertilizing vegetable crops, p. 365-379. In: L. M. Walsh and J. D. Beaton (eds.) Soil testing and plant analysis. Soil Sci. Soc. Amer., Madison, WI.
6. Letzsch, W. S., and M. E. Sumner. 1984. Effect of population size and yield level in selection of Diagnosis and Recommendation Intergrated System (DRIS) norms. Commun. in Soil Sci. Plant Anal. 15:997-1006.
7. Lorenz, O. A., and K. B. Tyler. 1978. Plant tissue analysis of vegetable crops, p. 21-24, In: H. M. Reisenauer (ed.). Soil and plant-tissue testing in California. Univ. Calif. Div. Agr. Sci. Bul. 1879.
8. Lucas, R. E. Organic soils (Histosols) formation, distribution, physical and chemical properties and management for crop production. Michigan State Univ. Agr. Expt. Sta. Res. Rpt. 435.
9. Munson, R. D. and W. L. Nelson. 1973. Principles and practices in plant analysis, p. 223-248. In: L. M. Walsh and J. D. Beaton (eds.). Soil Sci. Soc. Amer., Madison, WI.
10. Wolf, Benjamin. 1982. A comprehensive system of leaf analyses and its use for diagnosing crop nutrient status. Commun. in Soil Sci. Plant Anal. 13:1035-1059.

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COMPATIBILITY OF FUNGICIDE-INSECTICIDE COMBINATIONS FOR DISEASE AND PICKLEWORM CONTROL ON HONEYDEW MELON[1]

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Abstract. **Three fungicide programs and 4 insecticides factorially combined were tested for efficacy and phytotoxic effects when evaluated for the control of diseases and pickleworm** (Diaphania nitidalis **(Stoll)) on honeydew-type melon** (Cucumis melo **var.** inodorus **cv. Morgan). Mancozeb (Manzate 200) and benomyl (Benlate), metalaxyl (Ridomil) and benomyl, and chlorothalonil (Bravo) were tank mixed with methomyl (Lannate), methamidophos (Monitor), acephate (Orthene), and** Bacillus thuringiensis **var.** kurstaki **(Dipel). The efficacy of all fungicides against downy mildew** (Pseudoperonospora cubensis **(Berk. & Curt.)), gummy stem blight** (Mycosphaerella citrullina **(C. O. Sm.) Gross), and scab** (Cladosporium cucumerimum **(Ell. and Arth.)) was not affected by the insecticides. Edge necrosis and slightly misshapen leaves were produced by the metalaxyl plus methomyl treatment. All 3 chemical insecticides significantly reduced the percentage of fruit damaged by pickleworm larvae. Chlorothalonil combined with** B. thuringiensis **resulted in a significantly higher percent (49%) of fruit damaged by pickleworm when compared with the bacterial insecticide alone.**

Honeydew melons are attacked by many diseases and insects including downy mildew, gummy stem blight, scab, and pickleworm. Tank mixed fungicide-insecticide combinations would be desirable for control of these pests because of reduced application costs.

The purpose of this investigation was to evaluate tank mix combinations of 3 fungicide programs with 4 insecticides for disease and insect control on honeydew melon. The experiment was conducted in the spring of 1978 at the Agricultural Research & Education Center in Immokalee.

Materials and Methods

Plots of *Cucumis melo* var. *inodorus* (cv. Morgan) were established by seeding into raised beds on 6 ft centers through holes spaced 3 ft apart in black plastic mulch. Plots, arranged in 3 randomized blocks, were 30 ft in length and contained 10 "hills" thinned to 2 plants each. Cold damaged plants were replaced with additional seed.

The soil was an Immokalee fine sand (Arenic Haplaquod) with 27-32 inch deep hardpan which allowed open ditch seep irrigation. A starter fertilizer equivalent to 25-18-33 lb./acre N, P, and K, respectively, placed in the plant beds was supplemented by 180-0-207 lb./acre of N and K banded on the bed surface 9 inches to each side of the plant row and covered with 1.25 mil black polyethylene mulch. Paraquat dichloride was applied twice at 0.6 gal/acre between the mulched beds. Nu-Iron (Cities Service Co., Atlanta, GA) was applied twice at 3.1 lb./acre as a foliar spray to correct a nutritional deficiency.

Materials evaluated and rates of application listed below were factorially combined such that all combinations of letters and numbers occurred, thereby providing one fungicide and one insecticide in each application.

Fungicides used were: A) mancozeb 80W at 3.1 lb./acre as Manzate 200 plus benomyl 50W at 0.5 lb./acre as Benlate; B) chlorothalonil 6 lb./gal F at 3 pints/acre as Bravo 6F; C) metalaxyl 2EC at 1 pint/acre as Ridomil 2E plus benomyl 50W at 0.5 lb./acre.

Insecticides used were: 1) acephate 75S at 1.3 lb./acre as Orthene 75SP; 2) methamidophos 4EC at 1 qt/acre as Monitor 4E; 3) methomyl 1.8LC at 4.5 pints/acre as Lannate 1.8 LC; 4) *Bacillus thuringiensis* var. *kurstaki* Berliner at 1.0 lb./acre as Dipel.

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Materials were combined in 1-gallon jugs of water 3 to 5 hr before application. Sprays were applied at 100 gal/acre with a backpack mistblower. Eight applications were made on a weekly schedule. The melons were harvested 95 and 110 days after planting. No sprays were applied between the 2 harvest dates.

Foliar diseases were rated by the Horsfall-Barratt disease index scale using 1 = 0% disease and 12 = 100% (5). Downy mildew symptoms and foliar symptoms of gummy stem blight were rated together since they were difficult to separate. A decision was made not to rate the severity of gummy stem blight stem and petiole lesions because moving the canopy to rate these lesions would have caused considerable and unwanted dissemination of the pathogen.

Yield parameters recorded were number and weight of fruit, total fruit soluble solids, number of fruit damaged by lepidopterous larvae, identity of any lepidopterous larvae found in fruit, and number of fruit with scab lesions. Total soluble solids (chiefly sugar) were determined for 3 melons from each plot using a hand refractometer.

Significance of treatment effects was established using 2-way analysis of variance at P = 0.05 and then constructing 95% confidence intervals based on the Tukey HSD. Where coefficients of correlation (r) and determination (r^2) are included, they were significant and independent at P = 0.05.

Results

Through most of the season a low level of downy mildew was observed on foliage; no plot had more than 6% foliage damaged by downy mildew 45 days prior to harvest. Late in the season a mixture of downy mildew and gummy stem blight caused significant foliage damage (Table 1). All 3 fungicide programs reduced foliar damage and the insecticides did not affect fungicide efficacy. The number of melons harvested was not significantly affected by fungicide treatment (Table 2) but the yield as indicated by weight was (Table 3). The yield was also significantly correlated with disease ratings. The coefficient of correlation was —0.45 and the coefficient of determination was 0.21; 21% of the loss in yield weight was attributable to the increase in foliar disease damage.

Table 1. Foliar damage caused by mixed infection of downy mildew and gummy stem blight rated 18 days prior to first harvest by Horsfall-Barratt disease index.

Insecticides	Fungicides: Mancozeb + benomyl	Metalaxyl + benomyl	Chlorothalonil	None	Average (insecticide)
Acephate	1.7	1.3	2.0	6.0	2.8[z]
Methamidophos	1.0	1.7	2.0	7.0	2.9
Methomyl	2.0	1.7	2.3	7.0	3.0
B. thuringiensis	1.7	1.0	2.0	7.0	2.9
None	2.3	2.3	2.3	5.3	3.0
Average (fungicides)	1.7 a[y]	1.6 a	2.1 a	6.5 b	

[z]No significant difference (P = 0.05) among means.
[y]Confidence intervals established at P = 0.05 by Tukey HSD. Means with any letter in common are not significantly different. Individual HSD = 2.86, insecticide average HSD = 1.07, and fungicide average HSD = 0.81.

Table 2. Thousands of 'Morgan' melons per acre from two harvests.

Insecticides	Fungicides: Mancozeb + benomyl	Metalaxyl + benomyl	Chlorothalonil	None	Average (insecticide)
Acephate	11.3	10.5	13.4	9.3	11.3 a[z]
Methamidophos	9.7	12.5	12.1	8.1	10.9 a
Methomyl	6.9	12.1	6.5	8.9	8.5 ab
B. thuringiensis	11.3	8.9	6.1	8.1	8.5 ab
None	10.5	5.7	4.5	5.7	6.5 b
Average (fungicides)[y]	10.1	10.1	8.5	8.1	

[z]Confidence intervals established at P = 0.05 by Tukey HSD. Means with any letter in common are not significantly different. Individual HSD = 7.9, insecticide average HSD = 3.0, and fungicide average HSD = 2.3(not significant).
[y]No significant difference (P = 0.05) among means.

Table 3. Yield of 'Morgan' melons in tons per acre.

Insecticides	Fungicides: Mancozeb + benomyl	Metalaxyl + benomyl	Chlorothalonil	None	Average (insecticide)
Acephate	19.2	16.5	21.9	14.3	17.8 a[z]
Methamidophos	17.8	21.0	20.5	11.1	17.4 a
Methomyl	12.5	21.0	10.7	12.0	14.3 ab
B. thuringiensis	18 7	15.2	9.8	11.6	13.8 ab
None	17.4	9.4	8.0	8.5	10.7 b
Average (fungicides)	16.9 a[z]	16.5 a	14.3 ab	11.6 b	

[z]Confidence intervals established at P = 0.05 by Tukey HSD. Means with any letter in common are not significantly different. Individual HSD = 12.5, insecticide average HSD = 4.6, and fungicide average HSD = 3.6.

Scab lesions on fruit were significantly reduced by all fungicides (Table 4). Scab was not mentioned as being among the important disease and insect pests of muskmelon production in a previous Florida summary (8), and this occurrence of scab does not follow the weather relationships reported from New York (2). Epidemics there follow cool (58°F for 9 hr) nights or greater than average rainfall. In the 3 weeks preceding the appearance of scab in Immokalee the weather averages were 81°F/59°F and 2.65 inches rain, 85°F/60°F and 0.05 inches rain, and 88°F/69°F and 1.42 inches rain for 3, 2, and 1 week prior, respectively. The rainfall came as 2.65 inches 18 days prior, 0.94 inches 7 days prior, and 0.48 inches 5 days prior to the first scab observations. Three days in the 50's occurred 3 weeks before, and 1 night in the 40's and 1 in the 50's occurred 2 weeks before the scab appeared. Six hours of leaf wetness occurred during 4 of the 12 nights preceding first evaluation of scab. The weather was not especially cool or wet preceding the first week when scab was noticed.

Pickleworm larvae were found inside 94 of the 301 fruit damaged by lepidopterous larvae. No other lepidopterous larvae were found inside damaged fruit. In the first harvest, acephate and methamidophos gave significantly better control of pickleworm than either *B. thuringiensis* or no insecticide (Table 5). Significantly less pickleworm damage occurred where methomyl, acephate, or methamidophos were applied than when no insecticide was used. The same 3 insecticides significantly reduced damaged fruit compared to no insecticide in the combined harvest results (Table 6). In addition to reducing the percentage of fruit damaged by pickleworm, acephate and methamidophos also increased the total number and weight of fruit harvested (Tables 2 and 3, respectively). There was no negative impact of any of the fungicide programs upon the efficacy of acephate, methamidophos or methomyl.

The percent of pickleworm damaged fruit was greatest in the treatments receiving chlorothalonil or a tank mix of chlorothalonil plus *B. thuringiensis* (Tables 5 and 6). The possibilities of interference between chlorothalonil and the bacterial insecticide or of increased attractiveness of these plots to pickleworm bears further investigation considering the economic losses which 50% fruit infestation would bring.

Phytotoxicity was observed in only one combination,

Table 4. Percentage of 'Morgan' melons with scab.

Insecticides	Fungicides: Mancozeb + benomyl	Metalaxyl + benomyl	Chlorothalonil	None	Average (insecticide)
Acephate	3.7	0.0	0	13.2	4.2[z]
Methamidophos	0.0	0.0	0	7.8	2.0
Methomyl	0.0	0.0	0	15.6	3.9
B. thuringiensis	0.0	1.1	0	29.1	7.6
None	3.5	0.0	0	2.0	1.4
Average (fungicides)	1.4 a[y]	0.2 a	0 a	13.5 b	

[z]No significant differences (P = 0.05) among means.
[y]Confidence intervals established at P = 0.05 Tukey HSD. Means with any letter in common are not significantly different. Individual HSD = 31.1 (not significant), insecticide average HSD = 11.6 (not significant), and fungicide average HSD = 8.8.

Table 5. Percent of melons from the first of 2 harvests with pickleworm feeding damage.

Insecticides	Fungicides: Mancozeb + benomyl	Metalaxyl + benomyl	Chlorothalonil	None	Average (insecticide)
Acephate	0	0	0	1	0 a[z]
Methamidophos	1	1	1	0	1 a
Methomyl	0	6	0	0	2 a
B. thuringiensis	2	14	38	13	17 b
None	8	38	24	20	22 b
Average (fungicides)	2 a[z]	12 b	13 b	7 ab	

[z]Confidence intervals established at P = 0.05 by Tukey HSD. Means with any letter in common are not significantly different. Individual HSD = 31.0, insecticide average HSD = 11.6, and fungicide average HSD = 0.8.

Table 6. Percent of melons from both harvests with pickleworm feeding damage.

Insecticides	Fungicides: Mancozeb + benomyl	Metalaxyl + benomyl	Chlorothalonil	None	Average (insecticide)
Acephate	6	13	3	7	7 a[z]
Methamidophos	15	6	7	1	7 a
Methomyl	25	4	24	2	14 ab
B. thuringiensis	18	18	49	13	24 bc
None	22	36	49	29	34 c
Average (fungicides)	17 ab[z]	15 a	26 b	10 a	

[z]Confidence intervals established at P = 0.05 by Tukey HSD. Means with any letter in common are not significantly different. Individual HSD = 34.5, insecticide average HSD = 12.9, and fungicide average HSD = 9.8.

Table 7. Percent soluble solids, an indication of fruit quality, from insecticide and fungicide treated plots (average of 9 melons per treatment).

Insecticides	Fungicides: Mancozeb + benomyl	Metalaxyl + benomyl	Chlorothalonil	None	Average (insecticide)
Acephate	12.5	11.3	11.4	9.6	11.2[z]
Methamidophos	12.2	12.7	13.0	9.2	11.8
Methomyl	7.6	11.5	7.8	8.1	8.8
B. thuringiensis	12.9	11.4	11.1	6.3	10.4
None	12.2	10.6	7.7	9.3	10.0
Average (fungicides)	11.5 a[y]	11.5 a	10.2 ab	8.5 b	

[z]No significant differences (P = 0.05) among means.
[y]Confidence intervals established at P = 0.05 by Tukey HSD. Means with any letter in common are not significant different. Individual HSD = 8.85 (not significant), insecticide average HSD = 3.3 (not significant), and fungicide average HSD = 2.5.

methomyl tank mixed with metalaxyl and benomyl. The combination resulted in a slightly misshapen leaf with marginal chlorosis and necrosis. No yield loss was attributed to the phytotoxicity. No incompatible reactions were evident during mixing of any combinations.

The percent soluble solids, a measure of fruit quality (sugar), was not significantly affected by insecticide but was affected by fungicide (Table 7). The 2 heaviest yielding fungicide treatments, mancozeb with benomyl and metalaxyl with benomyl, also had fruit with the highest average solid solids. The coefficient of correlation for percent soluble solids and disease was significant at –0.62 with a coefficient of determination of 0.39; 39% of the loss in percent soluble solids was attributable to increase in disease.

Discussion

The 'Morgan' honeydew melon was originally described as tolerant to downy mildew but not to powdery mildew or gummy stem blight (2). From these results and others (4, 6) it is obvious that 'Morgan' is sufficiently susceptible to downy mildew to cause disease losses. Also, gummy stem blight has been a problem in the Immokalee area (4). Both diseases were adequately controlled without insecticide interactions by all of the mancozeb with benomyl, metalaxyl with benomyl, and chlorothalonil fungicide programs. The absence of powdery mildew is important to note since that disease has caused losses in the area in past seasons (4). The control of powdery mildew cannot be predicted for these programs. Control of scab on the fruit was adequate with all programs.

The 2 principal insect pests of 'Morgan' are pickleworm and melonworm (1, 3, 7, 8). Pickleworms were the only lepidopterous larvae found associated with damaged fruit. However, even though the melonworm usually feeds on terminal buds or melon rinds without entering the fruit (8), its absence from inside 'Morgan' fruit may not be a true indication that only the pickleworm was present. Control of lepidopterous larval feeding damage on 'Morgan' fruit was effectively achieved with acephate, methamidophos, or methomyl. The fungicide program did not affect efficacy of these 3 insecticides.

The 2 insecticides acephate and methamidophos had treatment average yields significantly better than the no insecticide control. The 2 fungicide programs mancozeb with benomyl and metalaxyl with benomyl also had treatment average yields significantly better than the no fungicide control. Either fungicide program in combination with either insecticide would be recommended by these results. No phytotoxicity or incompatibility were noticed among these combinations. Although the performance of these 2 fungicide programs was adequate as tested, powdery mildew was not present. This disease has caused severe symptoms on 'Morgan' crops in the Immokalee area previously when benomyl was being used (4).

Literature Cited

1. Adlerz, W. C. 1977. Pickleworm control on cantaloupe and summer squash. Proc. Fla. State Hort. Soc. 90:399-400.
2. Chupp, C. and A. F. Sherf. 1960. Vegetable diseases and their control. The Ronald Press Co., New York. 693 pp.
3. Crill, Pat, D. S. Burgis, and P. H. Everett. 1976. 'Morgan'—A high quality, vine ripening honeydew type melon for Florida. Univ. Florida, Inst. Food Agr. Sci., Agr. Expt. Sta. Cir. S-241.
4. Dougherty, D. E. 1978. Evaluation of a systemic fungicide for control of melon diseases. Amer. Phytopath. Soc. Fungicide and Nematicide Tests—Results of 1977 33:75-76.
5. Horsfall, J. G., and R. W. Barratt. 1945. An improved grading system for measuring plant diseases. Phytopathology 35.655 (Abstr.).
6. Jones, J. P. 1978. Disease thresholds for downy mildew and target leafspot of cucurbits and late blight of tomato. Plant Dis. Rptr. 62:798-8C2.
7. Schuster, D. J. 1975. Melonworm, *Diaphania hyalinata*, control on cucurbits, 1976. Entomol. Soc. Amer. Insecticide and Acaricide Tests 2:54.
8. Whitner, B. F., Jr., D. G. A. Kelbert, James Montalero, George Swank, Jr., and J. W. Wilson. 1953. Cantaloupes in Florida. Proc. Fla. State Hort. Soc. 66:100-103.