Evaluation of Controls for Flea Beetle on Eggplant in an Organic Production System

M. Maletta
Rutgers Cooperative Extension of Hunterdon County
Flemington, New Jersey,
United States of America

K. Holmstrom
Rutgers Cooperative Extension
Vegetable IPM Program
New Brunswick, New Jersey,
United States of America

W. Tietjen
Rutgers Cooperative Extension of Warren County
Belvidere, New Jersey,
United States of America

W. Cowgill
Rutgers Cooperative Extension of Hunterdon County
Flemington, New Jersey,
United States of America

G. Ghidiu
Rutgers Agricultural Research & Extension Center
Bridgeton, New Jersey,
United States of America

Keywords: kaolin clay, particle film, rotenone, row cover, green peach aphid, potato leafhopper

Abstract

Materials and techniques for controlling flea beetle (subfamily *Alticinae*) on eggplant (*Solanum melongena*) were evaluated for two years under field conditions that conformed, with few exceptions, to the organic production requirements of the Northeast Organic Farming Association – New Jersey. Infestations of green peach aphid (*Myzus persicae*) in 2000 and potato leafhopper (*Empoasca fabae*) in 2001 allowed evaluation of the planned treatments for these pests, as well. Imidacloprid, an insecticide prohibited in organic production, provided nearly complete control of aphids and leafhopper damage and reduced flea beetle damage occurring at the end of the growing season. Rotenone, an insecticide approved for certified organic production, reduced flea beetle damage more than any other material. Rotenone also reduced aphid infestation but did not reduce leafhopper damage. A formulated kaolin clay product, Surround WP, approved for certified organic production reduced flea beetle and leafhopper damage but did not reduce aphid infestation. Imidacloprid-treated plants produced the highest total and marketable yields. Rotenone treatment resulted in increased total and marketable yield in 2000. Kaolin clay treatment resulted in increased total yield in 2001. Percentage marketable yield from clay-treated plants was lower than from plants from all other treatments. Plant growth was reduced in the clay-treated plots in 2000 but not in 2001.

INTRODUCTION

In 1997, the Organic Farming Research Foundation (OFRF, Santa Cruz, Calif.) reported that less than 0.01% of research projects listed in the USDA Current Research Information System could be considered “strong organic” (Lipson, 1997). There were no “organic-pertinent” federally funded projects in New Jersey although the number of certified organic farms in the state had grown from 12 in 1990 to 31 in 1997. A survey by OFRF of organic farmers found that management of insect pests, other arthropods or nematodes was among the fifth highest research priorities for vegetable, herb, flower or ornamental growers (OFRF, 1999). The survey concluded that organic growers “…want help from the extension and research community…[but] organic farmers have found those in extension lacking in experience or knowledge relevant to organic agriculture…." Extension professionals' need for training and resource materials related to organic production was cited as a primary reason for lack of extension support for organic growers (Creamer, 1999). Research on which such support would be based is needed.

Surround WP (Engelhard, Corp., Iselin, N.J.), a new pest management material, was approved for use in certified organic production by the Organic Materials Review Institute (OMRI, Eugene, Ore.) in 2000. The active ingredient is kaolin clay, which has been reported to suppress arthropod pests and diseases of tree fruit (Glenn et al., 1999; Puterka et al., 2000). Aphid (*Aphididae*) and whitefly (*Aleyrodidae*) populations were slightly reduced on vegetable crops treated weekly with kaolin clay (A.M. Simmons, pers. commun.). Striped cucumber beetle (*Acalymma vittatum*) damage and bacterial wilt (caused by *Erwinia trachelphila*) on pumpkin (*Cucurbita pepo* L. var. *pepo*) were reduced by kaolin clay treatment (R. Hazzard, pers. commun.).

Flea beetles are important pests of eggplant in New Jersey. Organic growers reported using rotenone or row cover to control flea beetle in various crops, including eggplant (T. Blew, J. Brandt, L. Guile, M. Rosweiller, pers. commun.). Surround WP is labeled for suppression of flea beetle on eggplant. A research project was designed to compare this product with some controls being used by organic growers.

MATERIALS AND METHODS

Research plots of oriental-type eggplant 'Millionaire' were established 21 June 2000 and 26 June 2001 at the Rutgers Snyder Research and Extension Farm, Franklin Township, N.J. Plants were grown in single rows on raised beds with black plastic mulch and trickle irrigation. Plants were on 0.61 m centers and rows on 1.83 m centers. Plant population was 8970 plants/ha. Production practices conformed to NOFA-NJ certification standards with these exceptions: use of imidacloprid (Admire 2 F, Crop Production Products, Kansas City, Mo.) as one treatment and use of glyphosate (Roundup, Monsanto Co., St. Louis, Mo.) to kill cover crop. A 12N-0P-0K analysis bloodmeal fertilizer was applied preplant and incorporated in the Quakertown silt loam (fine-loamy, mixed, mesic, Typic Hapludults) soil at 473 $kg.ha^{-1}$ (57 kg N/ha) . Weeds were controlled in row middles with straw applied immediately after bed preparation at approximately 642 bales/ha. Rows and middles were hand-weeded during the season, as needed. A 4N-0.44P-0.83K liquid fish emulsion fertilizer was added to the transplant water at 7.8 $mL.L^{-1}$ and applied at about 0.24 L/plant.

Experimental treatments included in both years were: untreated check; imidacloprid (Admire 2F), 0.43 $kg.ha^{-1}$ a.i.; toxic principles of cubé (Rotenone 5%, Bonide Products, Inc. Yorkville, N.Y.), 1.12 $kg.ha^{-1}$ a.i.; kaolin clay (Surround WP), 56.6 $gm.L^{-1}$. Additional treatments in 2000 were: non-woven row cover (Covertan®, Suntex CP, Inc., Sarasota, Fla.), 30.5 gm. $(m^2)^{-1}$; canola oil, 8.26 $kg.ha^{-1}$ a.i. with pyrethrins, 0.045 $kg.ha^{-1}$ a.i. (Pyola, Gardens Alive, Lawrenceburg, Ind.). Imidacloprid was applied as a drench, 118 mL/plant, with a CO_2 backpack sprayer. Rotenone, kaolin clay and oil with pyrethrins were applied, in 2000, with a CO_2 backpack vertical boom sprayer delivering 488 $L.ha^{-1}$ or, in 2001, with a tractor-mounted diaphragm pump sprayer delivering 422 to 638 $L.ha^{-1}$. A randomized complete block design with six replications was used. A treatment plot consisted of one row of 12 plants at 2 ft spacing, guarded on each side by equal size plots that also received the experimental treatment. Data were collected from the middle ten plants.

Insect population or damage was rated in August and September. Plant height was measured during July and August. Plant height and spread per plot were measured in September. Fruit, four inches or longer, was harvested weekly beginning early August, graded for quality and weighed. In 2001, plant fresh weight was taken 12 Sept. All data were subjected to analysis of variance using SuperANOVA (Abacus Concepts, Inc., Berkeley, Calif.).

RESULTS AND DISCUSSION

Flea beetles appeared in late August 2000 and late July 2001; beetle numbers observed during field scouting were very low. Flea beetle damage began appearing on the upper portions of the untreated check plants. Small holes were present on fully expanded and mature leaves; unfurling leaves were being damaged. Two flea beetle species were identified: potato flea beetle (*Epitrix cucumeris*) and tobacco flea beetle (*Epitrix hirtipennis*). All treatments reduced flea beetle damage compared to the untreated check (Table 1). Rotenone reduced damage more than any other treatment compared to the untreated check. Flea beetle damage on the kaolin clay treated plants was the same as (2000) or more than (2001) damage on the imidacloprid treated plants.

In 2000, green peach aphid population was significantly lower on imidacloprid or rotenone treated plants than on the untreated check plants (Table 1). Population on kaolin clay treated plants and untreated check plants was the same. The eggplant plants were infested at transplanting, and subsequent kaolin clay treatment had no impact on the existing aphid population or on population increase. This is contrary to findings that kaolin clay reduced infestation by spirea aphid when the insects were introduced to treated plants and reduced nymph population (Glenn et al., 1999). Canola oil with pyrethrins reduced aphid population somewhat and row cover increased it compared to the untreated check. No aphids were present in 2001. In 2001, potato leafhopper damage was reduced by imidacloprid or kaolin clay treatments compared to the untreated check (Table 1). Reduction of potato leafhopper damage with kaolin clay treatment of apple has been reported (Glenn et al., 1999). Rotenone treatment increased leafhopper damage compared to the untreated check.

In 2000, imidacloprid or rotenone treated plants were taller than all others by 17 Aug. (Table 2). Plant volume was also larger for imidacloprid or rotenone treated plants and was lower for kaolin clay treated plants than for the untreated check. In 2001, imidacloprid-treated plants were significantly taller than all others by 11 Sept, but there were no significant differences in plant volume or fresh weight among treatments (Table 2). Reduced growth of kaolin clay treated plants in 2000 was greater than could be attributed to aphid infestation alone. The kaolin clay treatment apparently caused additional plant stress that reduced growth, but the mechanism was not investigated. Others have reported no reduction in leaf photosynthesis (Glenn et al., 1999) or leaf dry weight (Tworoski et al., 2002) from applications of kaolin clay. In 2001, the kaolin clay treated plants were the same size as all others (Table 2).

Imidacloprid-treated plants produced higher total and marketable yields than all other plants in both years (Tables 3 and 4). In 2000, total and marketable yields from kaolin clay-treated plants were the same as from the untreated check plants and lower than yields from rotenone or oil/pyrethrins treated plants (Table 3). In 2001, total yield from kaolin clay-treated plants was higher than from the untreated check; yield from rotenone-treated plants was the same. Marketable yield from kaolin clay and rotenone treated plants was the same as from the untreated check plants (Table 4). In both years, kaolin clay treatment reduced percentage marketable yield compared to all other treatments (Tables 3 and 4). Fruit from all treatments was culled primarily because of physical defects, e.g., abnormal shape, corky skin areas, discolored skin. When skin-defect culls were separated from shape-defect culls in 2001, there was a significantly higher percentage of skin defect culls from the kaolin clay treated plots than from any other plot (Table 4). Fruit with chewing or boring insect damage but no other defect was not culled but was separated and weighed. Kaolin clay or rotenone treatment reduced this type of damage compared to the untreated check (Table 4). No fruit diseases were observed in either year.

CONCLUSIONS

Rotenone, an insecticide approved for certified organic production, controlled flea beetles and green peach aphid but did not control potato leafhopper. Yield was increased in 2000 compared to the untreated check. Kaolin clay, a new crop protectant allowed in certified organic production, reduced flea beetle and potato leafhopper damage and increased total yield compared to the untreated check in 2001. It did not control green peach aphid in 2000 and total yield was the same as that of the untreated check. Kaolin clay treatment reduced percentage marketable yield in both years compared to all other treatments. The superficial skin damage, seen on some fruit from all treatments but more prevalent on fruit from the kaolin clay treatment, was thought to be physical damage that may have resulted from leaf or stem rubbing. Kaolin clay, being a particulate coating, may have exacerbated this damage. Kaolin clay may be a viable flea beetle and potato leafhopper damage control alternative for certified organic eggplant production if used prior to fruit set. However, effectiveness under early season and/or heavy flea beetle pressure was not evaluated.

ACKNOWLEDGEMENTS

This project was supported in part by the New Jersey Agricultural Experiment Station Rutgers Snyder Research and Extension Farm Local Needs Grant Fund, a grant from Engelhard Corporation, Iselin, NJ, USA and The Hunterdon County Board of Chosen Freeholders.

Literature Cited

Creamer, N.G., Louws, F.W. and Baldwin, K.R. 1999. A training series in organic farming systems. HortScience 34: 558. (Abstr.)

Glenn, D.M., Puterka, G., Vanderzwet, T., Byers, R.E. and Feldhake, C. 1999. Hydrophobic particle films: a new paradigm for suppression of arthropod pests and plant diseases. J. Econ. Entomol. 92:759-771.

Lipson, M. 1997. Searching for the o-word. Organic Farming Research Foundation, Calif.

OFRA. 1999. Third biennial national organic farmers survey. Organic Farming Research Foundation, Calif.

Puterka, G., Glenn, D.M., Sekutowski, D.G., Unruh, T.R. and Jones, S.K. 2000. Progress toward liquid formulations of particle films for insect and disease control in pear. Envir. Entomol. 29:329-339.

Tworoski, T.J., Glenn, D.M. and Puterka, G.J. 2002. Response of bean to applications of hydrophobic mineral particles. Can. J. Plant Sci. 82:217-219.

Tables

Table 1. Effect of pest control treatment on insect population or damage.

	Rating			
	2000		2001	
Treatment[1]	Flea beetle Damage[2,3]	Aphid Population[2,4]	Flea beetle Damage[2,3]	Leafhopper Damage[2,5]
Check	3.4 d	4.3 d	3.2 d	3.0 c
Imidacloprid	2.7 b	1.0 a	2.4 b	1.0 a
Rotenone	2.0 a	2.1 b	1.9 a	3.3 d
Kaolin clay	2.5 b	4.1 d	2.7 c	2.0 b
Pyrethrins/oil	3.1 c	3.9 c	-	-
Row cover	-[6]	4.9 e	-	-
LSD	0.2	0.2	0.3	0.3

[1]Treatment schedule 2000: imidacloprid, June 22; rotenone, beginning 11 July, one to two week schedule, total nine applications; kaolin clay, beginning 26 June, at least weekly, total fourteen applications; oil with pyrethrins, beginning 11 July, seven to ten day schedule, total ten applications; row cover, installed 21 June, removed 3 Aug.

Treatment schedule 2001: imidacloprid, 21 June; rotenone, 29 June, 25 July, 9 Aug. then weekly until 6 Sept., total 8 applications; kaolin clay, 29 June, 11 July then weekly until 6 Sept., total 10 applications.

[2]Means separation in columns by Fishers Protected LSD, P=0.05; means followed by same letter are not significantly different.

[3]Damage rated 1-5 on 25 Sept. 2000, 11 Sept. 2001 by examining 10 shoots per plot (5 to 7 leaves per shoot): 1=no damage, <1 hole; 2=very light damage all leaves or light damage some leaves; 3=light damage most leaves; 4=moderate damage most leaves; 5=heavy damage all leaves.

[4]Population rated 1-5 on 1 Aug. by examining 3 fully expanded leaves on each of five plants: 1=<5 aphids; 2=scattered aphids or very small colonies; 3=some concentrations of aphids on <1/3 leaf surface; 4=infestation heavy on at least 1/2 surface; 5=heavy infestation of >2/3 leaf surface.

[5]Damage rated 9 Sept. 1-4 by visual examination of whole plot: 1=no damage; 2=occasional leaf margin yellowing; leaf margin yellowing obvious but scattered in plot; 4=obvious leaf margin yellowing and necrosis throughout plot and to near top of plants.

[6]Data not collected or treatment not included.

Table 2. Effect of pest control treatment on plant growth.

	Plant growth				
	2000		2001		
Treatment[1]	Ht[2] 17 Aug. (cm)	Vol[2,3] 9 Sept. (m^3/plot)	Ht[2] 11 Sept. (cm)	Vol[3] 11 Sept (m^3/plot)	Fresh wt[4] 12 Sept. (kg/plot)
Check	56.6 a	8.1 b	84.6 a	6.5	12.0
Imidacloprid	81.5 c	12.6 d	94.7 b	7.4	11.5
Rotenone	67.1 b	10.0 c	86.4 a	6.6	11.8
Kaolin clay	55.6 a	6.3 a	83.1 a	6.4	10.8
Oil/pyrethrins	58.4 a	7.9 ab	-	-	-
Row cover	-[5]	7.5 ab	-	-	-
LSD	3.3	1.7	8.1	NS	NS

[1]See Table 1, footnote 1.

[2]Means separation in columns by Fishers Protected LSD, P=0.05; means followed by same letter are not significantly different.

[3]Plant height x plant width x plot length.

[4]Plants severed at ground level, fruit removed, weighed immediately.

[5]Data not collected or treatment not included.

Table 3. Effect of pest control treatment on yield, 2000.

Treatment[1]	Total yield[2] (tons•ha^{-1})	Marketable yield[2] (tons•ha^{-1})	% Marketable yield[2] (by weight)
Check	16.0 a	13.1 a	81.8 b
Imidacloprid	38.9 d	32.7 d	84.2 bc
Rotenone	26.7 c	23.3 c	87.1 c
Kaolin clay	17.5 ab	13.0 a	74.3 a
Oil/pyrethrins	21.5 b	17.3 b	80.4 b
Row cover	15.0 a	12.1 a	80.3 b
LSD	4.2	3.7	4.3

[1]See Table 1, footnote 1.
[2]Means separation in columns by Fishers Protected LSD, P=0.05; means followed by same letter are not significantly different.

Table 4. Effect of pest control treatment on yield, 2001.

Treatment[1]	Total yield[2] (tons•ha^{-1})	Marketable yield[2] (tons•ha^{-1})	% Marketable yield[2] (by weight)	% Culled fruit w/skin defect (by number of fruit)	% Marketable fruit w/insect damage[2] (by weight)
Check	26.0 a	18.4 a	71.0 b	79.0 a	15.8 c
Imidacloprid	35.2 c	25.3 b	72.1 b	78.0 a	13.2 bc
Rotenone	27.3 ab	19.5 a	71.2 b	78.5 a	7.9 a
Kaolin clay	29.6 b	18.6 a	62.9 a	82.7 b	10.6 ab
LSD	2.7	2.5	3.7	3.5	3.5

[1]See Table 1, footnote 1.
[2]Means separation in columns by Fishers Protected LSD, P=0.05; means followed by same letter are not significantly different.