CARIBBEAN FOOD CROPS SOCIETY

50

Fiftieth
Annual Meeting 2014

St. Thomas, United States Virgin Islands
Volume L

PROCEEDINGS

OF THE

50TH ANNUAL MEETING

Caribbean Food Crops Society
50TH Annual Meeting
July 7 – July 11, 2014

Sugar Bay Resort and Spa Hotel
St. Thomas, United States Virgin Islands

Edited by
Thomas W. Zimmmerman, Stafford M.A. Crossman,
Errol Chichester and Wilfredo Colón

Published by the Caribbean Food Crops Society

ISSN 95-07-0410

Copies of this publication may be obtained from:

CFCS Treasurer
Agricultural Experiment Station
Jardín Botánico Sur
1193 Calle Guayacán
San Juan, Puerto Rico 00936-1118

Proceedings of the Caribbean Food Crops Society. 50:28-36. 2014

NEW INSECTICIDES IN MANAGING AMERICAN SERPENTINE LEAFMINER, *Liriomyza trifolii* (BURGESS) (DIPTERA: AGROMYZIDAE) IN SOUTH FLORIDA

Dakshina R. Seal, Shashan Devkota and Catherine Sabines, University of Florida-IFAS, Tropical Research and Education Center, Homestead, FL 33031

Abstract: The American serpentine leafminer, *Liriomyza trifolii* (Burgess) is a polyphagous insect. It is an economic pest of all vegetable crops grown in south Florida, USA. Recently, we evaluated insecticides of various chemical classes to manage leafminer on bean. In the first study, six insecticide treatments belonging to dimaide, neonicotinoid, pyrazole, and spinosyn were used once as a soil application. All insecticides effectively suppressed leafminer infested leaves on beans. In the second study, two insecticides belonging to diamide class at different rates applied at planting as a soil drench significantly controlled leafminers on beans. In the third study, foliar formulations of diamide insecticide similarly controlled leafminers. In the fourth study, pyrethroids alone or in combination with diamide or neonicotinoid provided season long control of leafminers where insecticide treatments were applied weekly for four weeks.
This study generated some valuable information for controlling American serpentine leafminers on bean. This information can be used for controlling leafminers on other vegetable crops.

Keywords. Leafminer, insecticide, application method, management

INTRODUCTION

The American serpentine leafminer, *Liriomyza trifolii* (Burgess) is a major concern of vegetable growers in south Florida for its unique tropical environment for leafminers' rapid multiplication (Seal et al. 2002, Stegmaier 1966; Spencer 1965). Host crops including vegetable, ornamental and fruit are grown all year round which also facilitate continuous reproduction of leafminer populations. It has been speculated that leafminer has originated in Florida (Spencer 1965), and subsequently moved to Caribbean and Canada. With the increase of floral traffic, *L. trifolii* dispersed to different parts of the world (Minkenberg and Van Lenteren 1986, Parella 1987, Minkenberg 1988). Specifically, *L. trifolii* is abundant in tropical and subtropical regions around the world (Capinera 2001). *L. trifolii* has gained worldwide distribution.
It attacks a diverse group of plants comprising of 400 plants in 25 families (Parella 1987). The economically important crops attacked *by L. trifolii* include bean, celery, chrysanthemum, cotton, lettuce, pepper, potato and tomato, onions and cotton (Seal et al. 2002; Parrella et al. 1985; Leibee, 1984).

L. trifolii causes damage to host plants by the action of feeding and oviposition which result in stippled appearance on the leaves (Parella et al. 1985). However the major damage is caused by larval feeding resulting in long mines. The mines become distinctly visible in three to four days after egglaying. Mines length increases as larvae grow older feeding on leaf tissues. It has been observed that occurrence of full grown three mines per tomato leaf may account for yield loss (Levins et al. 1975, Schuster et al. 1976). Larval mining and stippling greatly reduce ability of photosynthesis and affect crop yield. The mines and stipples also serve as entry points for bacterial and fungal diseases which can be devastating to the host crops.

Insecticides of various modes of action are most commonly used tool for managing leafminers in commercial agriculture (Ferguson 2004, Cox et al. 1995). During the period of 1946 to 1957, insecticides belonging to carbamates, orgnanochlorine and organophates were frequently used to control leafminers and other insect pests on potato and tomato (Wolfenbarger 1954, Wolfenbarger and Wolfenbarger 1966). Due to extensive use of these insecticides, leafminers developed resistance against most of the known insecticides in two years (Ferguson 2004; Leibee 1984). As a result it was impossible to control leafminers in Florida (Leibee and Capinera 1995, Poe and Strandberg 1979).

In 1982 use of cyromazine gave some relief to growers of celery in Florida as *L. trifolii* populations came under control by the use of this insecticide. But in 1989, some problems of resistance with cyromazine were reported from Everglades, Florida. It was reported that *L. trifolii* larval mortality was very hard to achieve even at the highest dose (Leibee and Capinera 1995). After 1982, many research studies showed the efficacy of abamectin to control *L. trifolii* (Cox et al. 1995; Leibee 1984; Parrella et al. 1985). Seal et al. (2002) reported that abamectin and spinosad provided better control of *L. trifolii*. SpinTor® and Proclaim® were reported to be effective in controlling *L. trifolii* and were relatively benign to natural enemies (Webb 2002). Ferguson (2004) reported abamectin, cyromazine and Spinosad to be effective against *L. trifolii* and suggested that cyromazine resistance was limited to only one place in Florida in celery.

The objectives of this study were to evaluate new insecticides alone or in rotation to control leafminers. Different methods of application for better efficacy were also tested.

MATERIALS AND METHODS

Three studies were conducted in Tropical Research and Education Center (TREC), University of Florida-IFAS, Homestead, Florida research plots. The soil type of the study area was a Rockdale which consists of about 33% soil and 67% pebbles (>2mm). The pH of this calcareous soil ranged from 7.4 – 8.4. Raised beds, 6 inches high 28 inches wide, were formed. The beds were open without any mulch cover. Sandea, a preplant herbicide, was broadcast over the bed at the rate of 0.71 oz/acre three weeks before planting to prevent weeds. At the time of bed formation, granular fertilizer (N:P:K = 8:16:16) at 1600 lbs./acre was broadcast on the surface of each bed to fertilize plants. For irrigating plants, beds were provided with two parallel lines of drip Tape (T-systems, Drip Works, Inc., 190 Sanhedrin Circle, Willits, CA 95490) having 5 inch emitter spacing to supply 1500 gallons of water/acre/day. The T-tapes were placed 12 inches apart on both sides of the center of each bed to irrigate and fertigate tomato plants. `Pod Squad' beans were directly seeded on 18 July at a depth of 2.5 cm. on the center of the bed with 6 inch spacing within the row and 36 inches spacing in between the center of two adjacent rows. Addition liquid nitrogen fertilizer (4:0:8) was injected though irrigation drip line at the rate of 0.5 lbs. per acre /day starting four weeks after planting and continued weekly for four times.

Various treatments evaluated in three trials were arranged in a randomized complete block design with four replications. Treatment plots in each study consisted of 30 ft long two beds each 3 ft wide. Treatments evaluated in the first study includes: 1. Cyantraniliprole (20 oz/acre, Verimark® 20 SC, IRAC # 28, DuPont); 2. spinetoram (8.0 oz/acre, Radiant® SC, IRAC #5, Dow); 3. sulfoxaflor (5.0 oz/acre, Closure®, IRAC # 4C, Dow); 4. chlorantraniliprole (5.0 oz/acre, Coragen®, IRAC # 28, Dupont); 5. Tolfenpyrad (21 oz/acre, Torac® 15 EC, IRAC # 21A, Nichino); 6. clothianidin (6.0 oz/acre, Belay®, IRAC # 4A, Valent); and 7. a nontreated control.

In the second study, cyantraniliprole (Verimark®) and chlorantraniliprole (Coragen®) were applied once as a soil drench to control leafminers on beans. Three rates of cyantraniliprole (10, 15 and 20 oz/acre) and three rates of chlorantraniliprole (3, 4 and 5 oz/acre) were drenched by using a backpack sprayer without any nozzle delivering a volume of 150 gpa at 30 psi.
In the third study, foliar formulations of cyantraniliprole and chlorantrniliprole were sprayed once to compare their residual efficacy in controlling leafminers. Various rates used for each insecticide were as described above. Treatments were applied using a backpack sprayer provided with two nozzles/bed delivering 70 GPA at 30 psi.

In the fourth study five insecticide treatments and a control were used to control leafminers on beans. The treatments evaluated in the study were: 1. Lambda-cyhalothrin (5.5 oz/acre, Warrior®II, IRAC # 3, Syngenta); 2. Lambda cyhalothrin + thiamethoxam (5.12 oz/acre, Endigo®ZC =Warrior® + Actara®; IRAC # 3A+4A), Syngenta); 3. Thiamethoxam (9.0 oz/acre, Actara® 25 WG, IRAC # 4A, Syngenta); 4. Lambda cyhalothrin + chlorantraniliprole (5.0 oz/acre, Warrior® + Coragen®; IRAC # 3A + 28, Syngenta); 5. Bifenthrin (2.5 oz/acre, Brigade®2 EC, IRAC # 3A, FMC).

All treatments in the above studies were applied on foliage by using a backpack sprayer with two nozzles/row. Volume used for spraying each treatment measured 50 – 70 GPA which was delivered by using 30 psi. Efficacy of each treatment was evaluated by collecting 10 full grown young leaves from randomly selected 10 plants, one leaf/plant, from each treatment plot. All leaves from a plot were placed in a zip-lock bag and marked with date, treatment name and treatment plot. The bags were then transported to the IPM laboratory, TREC, UF at Homestead, FL. Leaves were checked carefully form leafminers mines. In some trials, all plants in a treatment plot were checked carefully for leafmines and counted by treatment and treatment plot.

Statistical analysis

Data were transformed using square-root (x + .25) before analysis of variance. The transformed data were analyzed with one-way analysis of variance (SAS, 1989). Means were then separated by Duncan's (1955) multiple range test when significant ($P<0.05$) values were found in the analysis of variance (ANOVA).

RESULTS AND DISCUSSION

In the first study, all insecticides were drenched once in soil at planting. On the first sampling date, mean numbers of leafminer infested leaves/treatment was significantly fewer when bean plants were treated with Verimark®, Radiant®, Coragen® and Torac® than the nontreated control (Table 1). Sulfoxaflor and Belay® did not differ from nontreated control in the numbers of leafminers infested leaves. On the second sampling date, 7 d after the first sampling date, Verimark®, Radiant® and Coragen® were effective in significantly reducing leafminer infested leaves when compared with the nontreated control. Sulfoxaflor, Torac® and Belay® did not differ from nontreated control. On the third and fourth sampling date, only Verimark® and Coragen® significantly reduced leafminer. Other treatments did not differ from the nontreated control. Effectiveness of Radiant in controlling American serpentine leafminerw was reported by Seal (2002). Spintor®, a same chemical group of Radiant®, is also effective incontrolling leafminers which is also benign to natural enemies (Webb 2002, Ferguson 2004). Seal et al (2002) reported that abamectin and spinosad provided better control of *L. trifolii*. SpinTor® and Proclaim® were reported to be effective in controlling *L. trifolii* and were relatively benign to natural enemies (Webb 2002). Diamide insecticides (Verimark® and Coragen®) were found effective in controlling leafminers in our various studies using beans, squash and cucumber (Seal 2014, unpublished reports).

Drench application of Verimark® and Coragen® provided significant reduction of leafminers infested bean leaves (Table 2). All rates of Verimark® (10. 15 and 20 oz/acre) and Coragen® (3, 4 and 5 oz/acre) provided suppression of leafminers up to third sampling date. On the fourth sampling date, two higher rates of Verimark® (15 and 20 oz/acre) were effective in reducing leafminer infested leaves on beans when compared with the nontreated control. Other treatments did not differ from the nontreated control.

In the third study, Exirel® (10. 15 and 20 oz/acre) and Coragen® (3, 4 and 5oz/acre) were sprayed once on foliage one week after planting (Table 3). All rates of both insecticides, except Coragen® at 10 oz/acre), significantly reduced leafmines on bean leaves on the 1st, 2nd and 3rd sampling dates as compared to the nontreated control. On the fourth sampling date, only Exirel® treated plants at 15 and 20 oz/acre had significantly fewer leafmines/leaf than the nontreated control. Other treatments did not differ from the nontreated control. However, mean numbers of mines/plot on the fourth sampling date showed increasing numbers irrespective of the treatment rates of both insecticides. Exirel belong to the same active ingredient as Verimark, and is similarly effective in controlling leafminers. Verimark is applied in soil and Exirel is sprayed on foliage. Irrespective of the application methods, both products showed potentiality in managing American serpentine leaf miners.

In the fourth study, we used two pyrethroid treatments (Warrior® and Brigade®), two premixed insecticides (Endigo® and Besiege®) and Actara alone. All insecticide treatments significantly reduced leafminers mines/bean leaf when compared with the nontreated control (Table 4). Both Endigo® and Besiege® are premixed products consisting two insecticides belonging to two modes of action. Endigo®, consisting of Warrior® and Actara®, is effective in controlling leafminers like its two components which are equally effective when applied individually. Similarly, Besiege® is a combination of Warrior® and Coragen® where Besiege® is as effective as two of its components when applied alone. It has been speculated that two effective insecticides when applied as a premixed might delay in development of resistance.

The results of this study are valuable to the commercial growers in controlling leafminers and other pests of vegetable. This information can be used to develop an insecticide based management program to delay insecticide resistance in American serpentine leafminers and in other associated insect pests of vegetable crops.

REFERENCES

Capinera, J.L. 2001. American serpentine leafminer, Liriomyza trifolii (Burgess) (Insecta: Diptera: Agromyzidae). Entomology and Nematology Department, Fl a. Coop. Ext. Serv. Univ. of Fla. Press, Gainesville.

Cox, D. L., D. M. Remick, J. A. Lasota, and R. A. Dybas. 1995. Toxicity of Avermectin to *Liriomyza trifolii* (Diptera: Agromyzidae) Larvae and Adults. J. Econ. Entomol. 88: 1415–1419.

Ferguson, J. S. 2004. Development and Stability of Insecticide Resistance in the Leafminer Liriomyza trifolii (Diptera: Agromyzidae) to Cyromazine, Abamectin, and Spinosad. J. Econ. Entomol. 97: 112–119.

Leibee, G. L. 1984. Influence of Temperature on Development and Fecundity of Liriomyza trifolii (Burgess) (Diptera: Agromyzidae) on Celery. Environ. Entomol. 13: 497–501.

Leibee, G. L. and J. L. Capinera. 1995. Pesticide resistance in Florida insects limits management options. Fla. Entomol. 78: 386-399.

Levins R. A., S. L. Poe, R. C. Littell, J. P. Jones. 1975. Effectiveness of a leafminer control program for Florida tomato production. J. Econ. Entomol. 68: 772-774.

Minkenberg, O. P. J. M. 1988. Life history of the agromyzid fly *Liriomyza trifolii* on tomato at different temperatures. Entomol. Exp. Appl. 48: 73–84.

Minkenberg O. P. J. M. and J. C. van Lenteren. 1986. The leafminers *Liriomyza bryoniae* and *L. trifolii* (Diptera: Agromyzidae), their parasites and host plants: a review. Wageningen Agric. Univ. Papers 86-2. 50 pp.

Parrella, M. P. 1987. Biology of *Liriomyza*. Annu. Rev. Entomol. 32: 201–224.

Parrella M. P., V. P. Jones, R. R. Youngman, L. M. Lebeck. 1985. Effect of leaf mining and leaf stippling of Liriomyza spp. on photosynthetic rates of chrysanthemum. Annals of the Entomological Society of America 78: 90-93.

Poe, S. L. and J. O. Strandberg. 1979. Crop protection through prevention and management, pp. 1-4. In S.L. Poe and J.O. Strandberg [eds.], Plant protection through integrated pest management. Opportunities for integrated pest management in celery production. University of Florida, Institute of Food & Agricultural Sciences. UF-IFAS-IPM2. 104 pp.

Schuster DJ., J. P. Jone, P. H. Everett. 1976. Effect of leafminer control on tomato yield. Proceedings of the Florida State Horticultural Society 89: 154-156.

Seal, D. R., R. Betancourt and C. M. Sabines. 2002. Control of *Liriomyza trifolii* (Burgess)(Diptera: Agromyzidae) using various insecticides. Proc. Fla. Hort. Soc. 115: 308-314.

Spencer, K.A. 1965. A classification of the status of *Liriomyza trifolii* (Burgess) and some related species (Diptera: Agromyzidae). Proceedings of the Entomological Society of Washington 67: 32–40.

Stegmaier C. E. 1966. Host plants and parasites of *Liriomyza trifolii* in Florida (Diptera: Agromyzidae). Florida Entomologist 49: 75-80

Webb, S. E. 2002. Insects management for celery and parsley. Entomology & Nematology Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. http://edis.Ifas.ufl.edu/ig149.

Wolfenbarger, D. O. 1954. Potato yields associated with control of aphids and the serpentine leaf miner. Florida Entomologist 37:7-12.
Wolfenbarger, D. A., and D. O. Wolfenbarger. 1966. Tomato yields and leaf miner infestations and a sequential sampling plan for determining need for control treatments. Journal of Economic Entomology 59:279-283.

Table 1. Mean numbers of leafminers (LM) infested bean leaves per plot treated with various insecticides at planting as a soil drench.

		Mean numbers of leafminers infested leaves/plot			
Treatments	Rate [oz]/acre	2 Aug	9 Aug	16 Aug	26 Aug
Control		29.00a	76.00a	12.50ab	61.25a
Verimark	20.00	0.00c	0.00d	1.25c	3.75c
Radiant	8.00	0.00c	17.00bc	11.75ab	31.50ab
Sulfoxaflor	5.00	28.00a	67.25a	14.50ab	49.25a
Coragen	5.00	0.25c	0.50cd	5.25bc	8.75bc
Torac	21.00	7.75b	51.00ab	16.75a	23.25a-c
Belay	6.00	20.00a	54.25ab	13.50ab	28.50a-c

Means within the column followed by the same letter or no letter do not differ significantly (P> 0.5; DMRT).

Table 2. Mean numbers of leafminers infested bean leaves/plant treated once with various rates of two diamide insecticides at planting as a soil drench.

Mean numbers of leafminers infested leaves/plant

Treatments	Rate [oz]/acre	22 Aug	29 Aug	7 Sept	14 Sept
Control		9.00a	36.25a	14.00a	57.50a
Verimark	20.00	0.75b	2.50b	0.50b	12.00c
Verimark	15.00	0.25b	6.25b	1.50b	24.50b
Verimark	10.00	0.00b	5.25b	2.50b	30.00 a-c
Coragen	5.00	0.00b	5.25b	2.50b	30.00 a-c
Coragen	4.00	0.00b	2.25b	2.00b	30.00 a-c
Coragen	3.00	0.00bc	11.25b	4.50b	42.25ab

Means within the column followed by the same letter or no letter do not differ significantly (P> 0.5; DMRT).

Table 3. Mean numbers of leafminers infested bean leaves/plant sprayed once with various rates of two diamide insecticides at planting.

		Mean numbers of leafminers infested leaves/plant			
Treatments	Rate [oz]/acre	22 Aug	29 Aug	7 Sept	14 Sept
Control		8.25a	28.25a	33.00a	52.25a
Exirel	20.00	0.00b	0.00b	0.25b	15.00c
Exirel	15.00	0.00b	4.25b	0.50b	17.50c
Exirel	10.00	0.00b	3.25b	1.25b	34.00 a-c
Coragen	5.00	0.00b	3.25b	1.50b	29.00 a-c
Coragen	4.00	0.00b	4.25b	3.00b	27.00 a-c
Coragen	3.00	0.00bc	7.25b	5.50b	39.25ab

Means within the column followed by the same letter or no letter do not differ significantly (P> 0.5; DMRT).

Table 4. Mean numbers of leafminers mines/bean leaf sprayed weekly with various insecticides.

		Mean number of mines/leaf			
Treatments	Rate [oz]/acre	5 May	12 May	17 May	29 May
Control		1.75b	5.00a	10.00a	14.00a
Warrior ll	5.50	4.25a	2.50b	2.75b	4.00b
Endigo ZC	5.12	0.25c	0.00c	0.00c	0.00c
Actara 25 WG	9.00	0.00c	0.00c	0.00c	0.00c
Besiege	4.50	0.00c	0.00b	0.00c	0.25c
Brigade 2 EC	5.92	0.25c	1.75c	4.00b	4.75b

Means within the column followed by the same letter or no letter do not differ significantly (P> 0.5; DMRT).