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CURRENT STATUS OF MANAGEMENT OF MELON THRIPS, *Thrips palmi* KARNY (THYSANOPTERA: THRIPIDAE) IN TOMATOES IN SOUTH FLORIDA

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Abstract: The melon thrips, *Thrips palmi* Karny, is an invasive insect pest that arrived in Miami-Dade County, Florida, USA in 1990. Since its arrival, it has established as a key pest of all vegetable crops in the southern part of Florida. Growers use insecticides of various classes to control this pest but with minimum success due to its development of resistance against various classes of chemical insecticides. Three studies were conducted in commercial fields and Tropical Research and Education Center research fields to evaluate efficacy of chemical insecticides belonging to the classes: neonicotinoid, diamide, spinosyn, organophosphate, pyridinecarboxamide, pyrethroid and carbamate for controlling melon thrips. In the first study, bifenthrin (Brigade®) provided 71% reduction of melon thrips followed by chlorpyrifos (Lorsban®) in combination with esfenvalerate (Asana®). In the second study spinetoram (Radiant®) in combination with tolfenpyrad (Torac®) significantly reduced melon thrips than all other treatments. In the third study, spinetoram provided significant reduction of melon thrips followed by a premixed product (abamectin + cyantraniliprole). This information will be useful to tomato and other vegetable growers to control melon thrips and other thrips on their crops.

Keywords: thrips, new insecticides, vegetable crops, management

INTRODUCTION

Melon thrip, *Thrips palmi* Karny, is a key pest of vegetable crops since its arrival in 1990. It is a polyphagous insect feeding on about 50 different plant species (Wang and Chu 1986). It feeds on almost all vegetable crops belonging to the families- solanacea, cucurbitacea and leguminoseae (Nakahara 1984, Talekar 1991). Until the present study, it has not been found as a pest of tomato in the United States (Seal 2015, unpublished data). However, it has been reported as a pest of tomato in the Caribbean (Capinera 2000).

It is a native to Sumatra and Java (Indonesia) where it was first reported by Karny (1925) as a pest of tobacco. Subsequently, it became established in most Asian countries (Bangladesh, Brunei Darussalam, China, Hong Kong, India, Japan, Malaysia, Myanmar, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan and Thailand. In Africa, it was reported from Mauritius, Nigeria, and Sudan. In North America, it was reported from Hawaii and Florida. In Central America and Caribbean, it was reported from Antiqua, Barbuda, Barbados, Dominica, Dominican Republic, Grenada, Guadeloupe, Haiti, Martinique, Puerto Rico, St. Lucia, St. Kitts and Nevis, Trinidad and Tobago. In South America, it was reported from Brazil, Guyana, and Venezuela. In Oceania, it was reported from Australia, Guam, New Caledonia, Samoa, Wallis and Futuna. In Europe, it was reported from the Netherlands. Later it extended its distribution to Sudan and Taiwan. It has been considered as a significant pest in southern Japan (Sakimura et al. 1986). In 1990, melon thrips arrived in Homestead, FL.

Melon thrips is a foliage feeder and damage is mostly caused by both adult and larval feeding. Although it feeds on all vegetable crops, its populations become rapidly abundant on eggplant, cucumber, bean and squash. At the initiation of infestation, melon thrips adults and larvae congregate on the underside of a host leaf along the main veins and veinlets. As infestation progresses and population abundance increases, adults and larvae move to rest on the under surface of a leaf and then to the upper surface of the infested leaf. Melon thrips also attack flowers and fruits of the host crops. In a severe case, they infest leaf petioles and stems of feeding crops. In southern Florida, melon thrips has been reported as a devastating pest of bean, squash, cucumber, eggplant, pepper, potato and okra (Seal and Baranowski 1992). It was observed occasionally on tomato but did not reproduce there (Seal, field observation).

In a recent study in 2015, melon thrips adults were collected in >80% tomato flowers (Seal 2015, Unpublished data). However, very few larvae were collected from these samples. We did not observe any life stages of melon thrips in tomato leaf samples. Further sampling using tomato leaves and flowers will be continued. Melon thrips has been reported to transmit tospoviruses (Nagata et al. 2002). Further research studies need to be conducted to confirm *T. palmi'*s ability to transmit tospoviruses.

Thrips palmi is a tropical insect and could not survive winter conditions in southern Honshu (Tsumuki et al. 1987). At 25°C, duration from egg – egg lasts for 17.5 days. *T. palmi* mates immediately after emergence, but pre-oviposition period lasts for 1-5 days. Nonmated females oviposit within 1-3 days of emergence (Wang et al. 1986). Eggs are deposited individually in the host tissue underneath the epidermal layer positioning at 45° angle with the micropylar end somewhat exposed. Embryonic development lasts 3-5 days in a field condition. It has two larval instars, each lasts for 4 to 6 days. Larval stage is followed by a short prepupal period which drops from the plant hosts to the soil surface for pupation. Pupal period lasts for 2-4 days. The total development period from first instar to adult emergence lasts for 10 to 12 days.

Management of melon thrips were principally based on chemical insecticides, although importance of naturally occurring predators and pathogens should not be ignored (Seal and Baranowski 1992, Seal et al. 1993, Seal 1997, Seal and Sabines 2012). We evaluated several dozens of insecticides belonging to the classes- neonicotinoid, diamide, tetramic acid (Movento®, Group 23), pyridinecarboxamide (Beleaf®, Group 9c), pyrazole (Tolfenpyrad), carbamate, organophosphate, chinomethionate, inorganic, triazine IGR, botanical, benzoylphenyl urea, pyrethroid, wax, phenylpyrazole and fermentation product. Percentages reduction of melon thrips varied from 20 -95% depending on various classes. Fermentation products (spinetoram, spinosad and abamectin) were more effective (55-95%) followed by carbamates (methomyl, oxamyl) and organophosphates (malathion).

Among natural biocontrol agents, minute pirate bug, *Orius insidiosus* (Say) is the most effective with the ability to feed on 15 to 21 melon thrips larvae from first to 10th day of its life cycle (Seal 1997). Minute pirate bug disappears from the commercial fields due to the use of various chemicals for controlling pest insects.

Currently abundance of melon thrips is increasing in all vegetable crops (Seal 2015, unpublished data) even after routine application of commonly used insecticides. Further studies should be conducted to use insecticides in rotation or combination by applying them as a foliar spray or soil drench or both methods when needed in order to achieve better control of melon thrips. In the present program we conducted three studies to evaluate various insecticides of different mode of actions by applying them alone, in combination or in rotation. Information generated from this study will help growers to effectively manage melon thrips and other related thrips.

MATERIAL AND METHODS

Three studies were conducted to evaluate effectiveness of insecticides for controlling melon thrips on tomato varying in locations and insecticide treatments. The first study was conducted at Tropical Research and Education Center (TREC), University of Florida-IFAS, Homestead FL. The soil type of the experimental field was Rockdale. For planting tomato, raised beds of 6 in. high, 36 in. wide were prepared which were covered with black on white 1 ml polyethylene mulch (Grower's Solution LLC., 1211 A Boyd Farris Rd., Cookeville, TN 38506). Beds were provided with two parallel lines of drip tape (T-systems, DripWorks, 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 in. apart on both sides of the center of each bed to irrigate and fertigate the host plants. At the time of preparation of beds, granular fertilizer 8:16:16 (N: P: K) at the rate of 1200 lbs./acre was broadcast on the upper surface of a bed and incorporated mechanically with 4 in. deep soil. `BHN 585´ tomato seedlings were planted 18 in. apart within rows and 36 in. apart in between rows. Plants were drip irrigated and fertigated with 4-0-8 liquid fertilizer by applying 0.5 lb. N/day/acre starting at 4 weeks after planting and progressively with an increment of 0.25 lb. every two weeks until 4.0 lb. N/acre/day when plants were bearing fruit.

Each treatment plot consisted of two beds each 30 ft. long and was arranged in a Randomized Complete Block (RCB) design with four replications. A 5 ft. wide nonplanted area separated the blocks from each other. Insecticide treatments evaluated in this study included: i) combination of abamectin and chlorantraniliprole (8.0 oz/acre, A21390a, Syngenta Crop Protection); ii) combination of abamectin and chlorantraniliprole (8.0 oz/acre, A21390b, Syngenta Crop Protection; iii) combination of abamectin and chlorantraniliprole (8.0 oz/acre, A21390c, Syngenta Crop Protection); iv) spinetoram (8.0 oz/acre, Radiant®, Dow AgroSciences); v) combination of thiamethoxam + chlorantraniliprole (13.0 oz/acre, Durivo®, Syngenta Crop Protection); vi) cyantraniliprole foliar formulation (13.5 oz/acre, Exirel®, Dupont Crop Protection). All insecticide treatments, except Durivo, were applied on foliage.

The second study was conducted in a commercial field following all management practices as described in the first study. Twelve treatments used in this study included:
i. cyantraniliprole (21.4 oz, Exirel®); ii. spinetoram (8.0 oz/acre, Radiant®); iii. bifenthrin + imidacloprid (5.0 oz/acre, Brigadier®, FMC Corporation); iv. dinotefuran (5.0 oz/acre, Venom®, Valent USA) in combination with spinetoram (8.0 oz/A); v. acetamiprid (6.0 oz/acre, Assail®, United Phosphorus, Inc.) in combination with chlorpyrifos (16.0 oz/acre, Lorsban®, Dow AgroSciences); vi. flonicamid (4.0 oz/acre, Beleaf®, FMC; vii. spirotetramat (5.0 oz/acre, Movento®, Bayer Crop Science) in combination with spinetoram (8.0 oz); viii. clothianidin (6.0 oz/acre, Belay®, Valent USA) in combination with malathion (32.0 oz/acre, Malathion®, Loveland Products Inc.); ix. chlorpyrifos; x) abamectin (16.0 oz/acre, Agrimek®, Syngenta Crop

Protection); xi) bifenthrin (2.5 oz/acre, Brigade®, FMC) and xii) a nontreated control. All treatments were applied on foliage.

The third study was also conducted in commercial field following management practices as discussed in the previous two studies. Seven treatments included in this study were: i. tolfenpyrad (21.4 oz/acre, Torac®, Nichino America); ii. spinetoram (8.0 oz/acre Radiant®, Dow AgroSciences); iii. spinetoram (8.0 oz/acre) in rotation with tolfenpyrad (21.4 oz/acre); iv. clothianidin (6.0 oz/acre); v. oxamyl (32.0 oz/acre, Vydate®, Dupont Crop Protection) in combination with spinosad (8.0 oz/acre, Spintor®, Dow AgroSciences); vi. zeta-cypermethrin + bifenthrin (6.0 oz/acre, Hero®, FMC Corp.) in combination with abermectin (16.0 oz/acre, Agrimek®, Syngenta Crop Protection) and vii. a nontreated control. All insecticides were applied on foliage.

Foliar application of all insecticides was performed by using a backpack sprayer delivering 70 GPA at 30 psi. on four dates at weekly intervals. Induce®, a nonionic surfactant, was added to each treatment solution at 0.25% v/v. Soil application of insecticides was performed by drenching 120 GPA using a backpack sprayer without nozzle.

Evaluation of treatments was made 48 h after each spray by randomly collecting 10 flowers from each treatment plot. All flowers from a treatment plot were placed in a zip-lock bag and were marked with date, treatment and block number. While collecting in the field, the samples were temporarily placed in an icebox (28 x 16 x 16 in.) to avoid desiccation. At the end of collection, all samples were transported to the laboratory. Leaf sample in each zip-lock bag was soaked in 50 ml of 70% ethanol for 15-25 minutes to separate thrips from the flower samples. Flowers were then carefully taken out leaving thrips in the alcohol. All thrips left in the alcohol were separated by sieving alcohol using a 500 mesh (26 micrometer) nematode extraction sieve (W.S. Tyler® Industrial Group, 8570 Tyler Boulevard, Mentor, Ohio 44060). Finally, thrips specimens in the sieve were transferred to a Petri dish with 5-10 ml ethanol (70%) to count numbers of adults and larvae using a binocular microscope at 10-20 X.

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, melon thrips adults in all prespray samples did not differ statistically from the nontreated control (Figure 1). Mean numbers of melon thrips adults in the post spray samples, average across the four sampling dates, were significantly fewer than the prespray sample. Each insecticide treatment significantly reduced melon thrips as compared to the nontreated control. Radiant® provided the highest reduction of melon thrips adults on tomato. Effectiveness of Spintor®, a very closely related chemical of Radiant®, in controlling melon thrips adults and larvae was reported in a previous study by Seal et al. (2013).

In the second study, insecticide treatments significantly reduced melon thrips adults on tomato when compared with the prespray samples (Fig. 2). Mean numbers of thrips in each treatment sample differed significantly from the nontreated control. The highest percentage reduction of melon thrips was achieved by applying Beleaf® followed by Venom® plus Radiant® (Fig.3). When mean numbers of melon thrips adults for all treatments were compared together Radiant® in combination with Venom® provided better control of melon thrips than Radiant® applied alone or Radiant® applied in combination with Movento®. Belay® in combination with Malathion® did not differ significantly from Radiant® applied alone in the mean numbers of melon thrips adults.

In the third study, melon thrips were collected from all treatment plots (Fig. 4). Vydate® in combination with Entrust®, and Hero® in combination with Agrimek® did not reduce melon thrips when compared with their respective prespray samples. However, the mean numbers in these two treatments significantly differed from the nontreated control. In the nontreated control, the postspray date thrips number was greater than the prespray date number. In this study, Radiant® in rotation with Torac® provided best control of melon thrips followed by Belay® alone.

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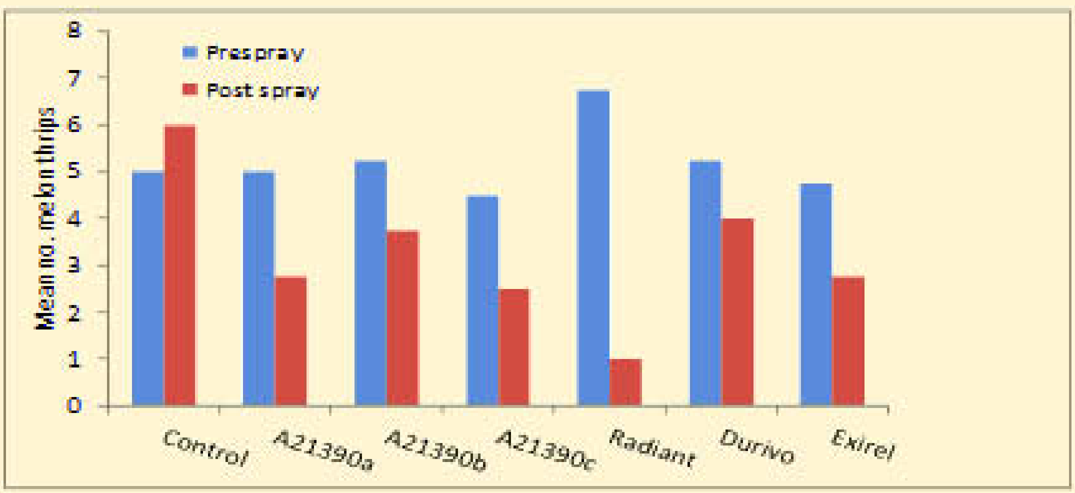

Figure 1. Melon thrips control on tomato using various insecticide treatments at TREC, UF-IFAS, 2014-2015

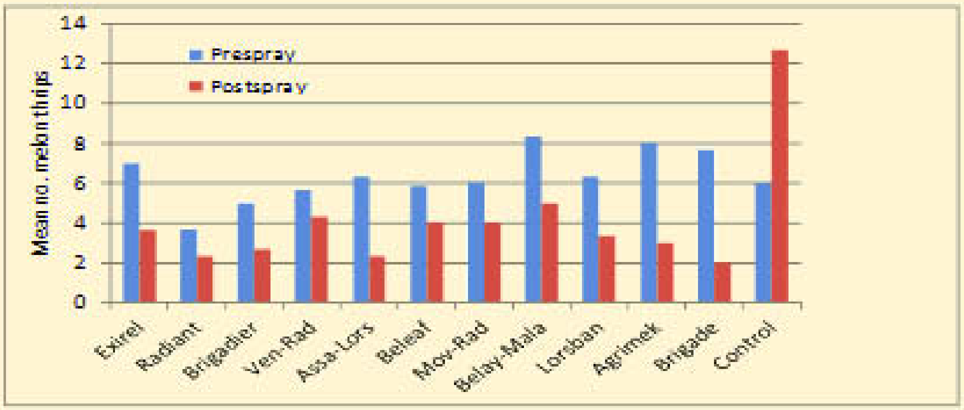

Figure 2. Melon thrips control using various insecticide treatments in a commercial tomato field, 2014-2015

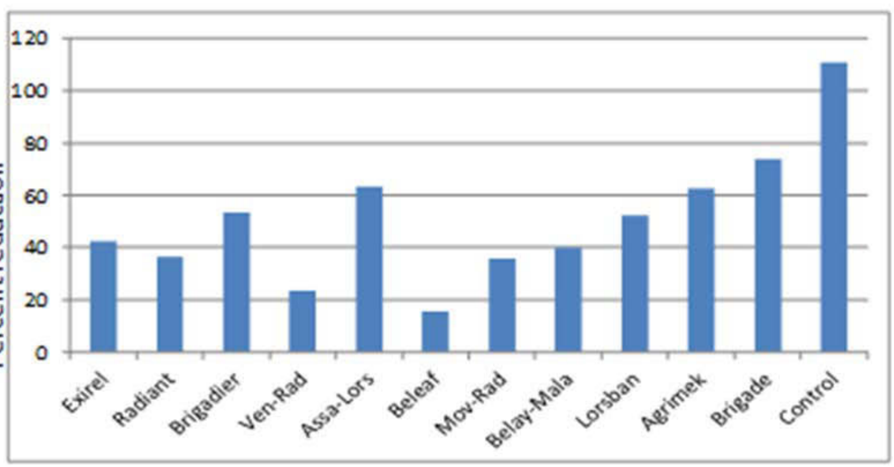

Figure 3. Melon thrips control using various insecticide treatments at a commercial tomato field, 2014-2015

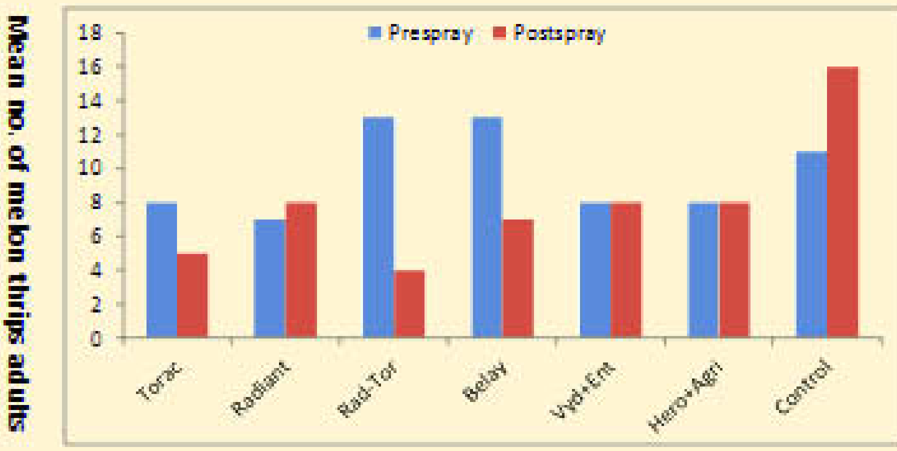

Figure 4. Melon thrips control using various insecticide treatments at a commercial tomato field, 2014-2015