Efficacy of a Biopesticide and Predatory Mite to Manage Chilli Thrips, Scirtothrips dorsalis Hood (Thysanoptera: Thripidae) in Strawberry

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Efficacy of a biopesticide and predatory mite to manage chilli thrips, *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae) in strawberry

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In recent years, chilli thrips, *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae), has developed into a significant economic pest of horticultural crops in Florida (Seal et al. 2006a; Panthi et al. 2020). Larvae and adults feed on plant tissues, causing leaf distortion, petiole and vein bronzing, cracking and bronzing, and size reduction of fruit, resulting in plants and plant parts becoming unmarketable (Seal et al. 2006b).

Spinetoram and cyantraniliprole insecticides are effective in *S. dorsalis* adult and larval suppression in strawberries, *Fragaria* × *ananassa* Duchesne (Rosaceae) (Lahiri & Panthi 2020). Also, there is an increasing demand for organic strawberry currently, but limited options are available to manage *S. dorsalis*. Generalist predatory mites such as *Amblyseius swirskii* Athias-Henriot and *Neoseiulus cucumeris* (Oudemans) (Arachnida: Phytoseiidae) are effective in *S. dorsalis* suppression on sweet pepper, *Capsicum annuum* L. (Solanaceae) (Arthurs et al. 2009). Additionally, several studies have shown the repellant and pesticidal properties of certain *Capsicum* accession extracts to suppress pests such as twospotted spider mites, *Tetranychus urticae* Koch (Arachnida: Tetranychidae), *Anopheles stephensi* Liston, and *Culex quinquefasciatus* Say (both Diptera: Culicidae) (Antonious et al. 2006; Madhumathy et al. 2007). No information is available currently regarding the potential of these techniques for strawberry pest management in Florida. Therefore, the objective of this study was to evaluate the efficacy of *A. swirskii* and *Capsicum oleoresin* to manage *S. dorsalis* infesting strawberry.

Materials and Methods

Potted strawberry plants of variety 'Florida Radiance' (Chandler et al. 2009) maintained in nylon mesh cages (0.027 m^3) (BugDorm, BioQuip Products, Rancho Dominguez, California, USA) in the greenhouse located at University of Florida, Gulf Coast Research and Education Center, Wimauma, Florida, USA, were used for this experiment at natural photoperiod and ambient temperature of 24.5 ± 0.5 °C, and relative humidity of 76.0 ± 0.5% (HOBO U23 Pro v2, Onset Computer Corporation, Bourne, Massachusetts, USA). Each experimental cage had a single plant. A laboratory colony of *S. dorsalis* was maintained on potted cotton, *Gossypium hirsutum* L. (Malvaceae) in a growth room at 25 ± 5 °C, 60 ± 5% relative humidity, and 14:10 h (L:D) photophase. For the experiment, a single fresh strawberry plant with a minimum of 5 expanded trifoliates was inoculated with 20 newly emerged adult female *S. dorsalis* and left undisturbed for 7 d. Four treatments: *A. swirskii*, *Capsicum oleoresin* extract-based biopesticide (Captiva® Prime, Gowan Company, Yuma, Arizona, USA), conventional insecticide spinetoram (Radiant® SC, Dow AgroSciences LLC, Indianapolis, Indiana, USA), and control sprayed with tap water only, were tested for *S. dorsalis* adult and larval suppression. Each treatment had 5 replicates. Seven d after *S. dorsalis* inoculation, 20 adult female *A. swirskii* individuals of unknown age (from a commercially available source, BioBee Biological Systems, Atlanta, Georgia, USA) were released per plant in treatment nylon mesh cages. On the same d, insecticide treatments also were applied using spray bottles of volume 210 mL (8 fl oz) (Air-spray™, Tech Spray, Inc., Peachtree City, Georgia, USA). The manufacturer's recommended rate of application (731 mL per ha or 10 fl oz per acre) was followed for both insecticide applications.

The number of *S. dorsalis* adults and larvae, and plant damage rating was recorded by collecting 3 randomly selected strawberry leaflets (1 trifoliate = 3 leaflets) per cage both before and after the treatment. Insect count data were collected at pre-treatment, and 7, 14, 21, and 28 d after treatment. Plant damage rating data were collected at pre-treatment, 7, and 28 d after treatment. The 3 freshly collected leaflets per cage were pooled and washed in 70% ethanol to count all thrips adults and larvae.

To analyze the effect of treatments on each date (pre-treatment, 7, 14, 21, and 28 d after treatment) on adult and larval *S. dorsalis* count, and untransformed plant damage rating, an analysis of variance (ANOVA) was conducted on natural log-transformed data of insect count. Significant differences were subjected to a separation of means test (Tukey 1953) (PROC MIXED, SAS Institute, Cary, North Carolina, USA). The mean and standard error of untransformed data is presented in the figures.

Results

Seven d after 20 newly emerged *S. dorsalis* adult females were released on each of the 20 caged strawberry plants, an average of 2 adults and 6 larvae were present per 3 leaflets (1 trifoliate), and no observable plant damage was recorded. There was a significant effect of treatments on *S. dorsalis* adults on 7, 14, and 21 d after treatment ($F_{3,12}$ = 14.18, P = 0.0003; $F_{3,12}$ = 3.97, P = 0.0354; $F_{3,12}$ = 5.7, P = 0.0116, respectively; Fig. 1). All 3 treatments provided significant adult suppression by 7 d after treatment, so that adult *S. dorsalis* infestation was 21 times

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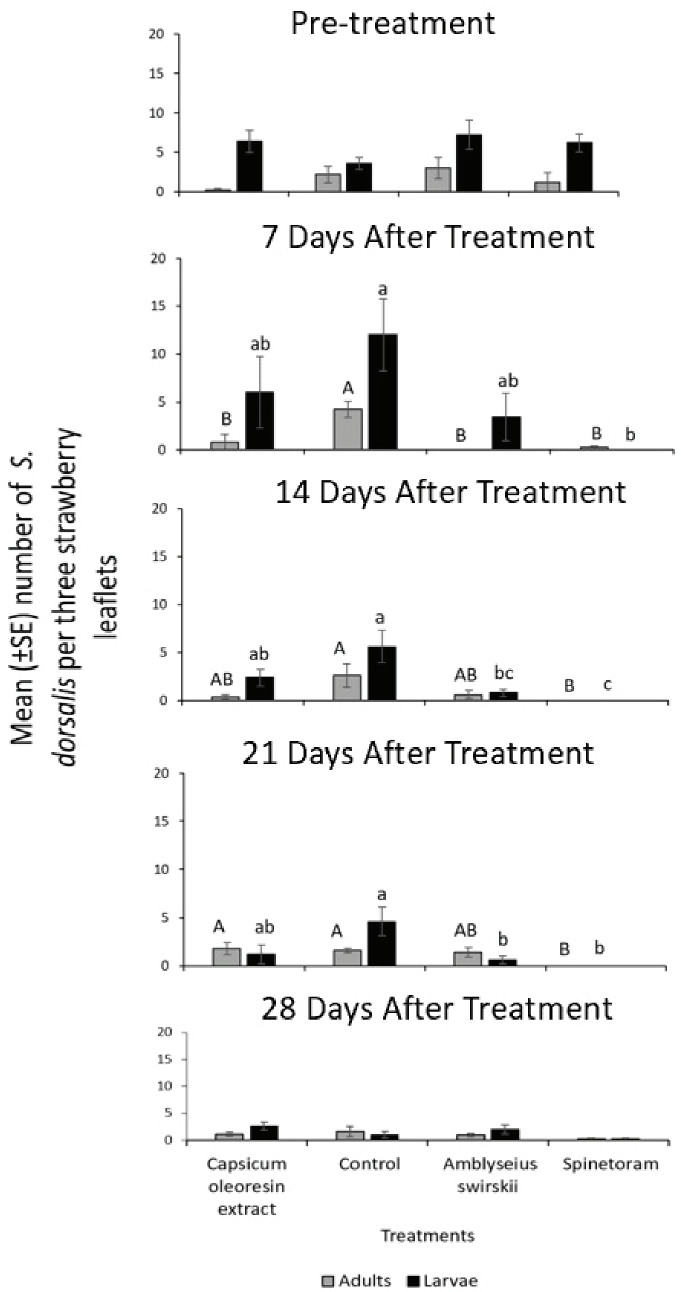

Fig. 1. Mean (± SE) adult and larval *Scirtothrips dorsalis* Hood per 3 strawberry leaflets on caged strawberry plants treated with (1) *Capsicum oleoresin* based biopesticide, (2) predatory mite *Amblyseius swirskii*, and (3) conventional insecticide spinetoram, and compared with control plants for 7, 14, 21, and 28 d after treatment. Means with the same letter are not significantly different ($P < 0.05$; Tukey HSD).

higher on control plants. However, spinetoram alone continued to provide over 7 times higher adult suppression compared to control plants on 14 d after treatment. Also, there was significant effect of treatments on *S. dorsalis* larvae on 7, 14, and 21 d after treatment ($F_{3,12} = 5.63$, $P = 0.012$; $F_{3,12} = 13.48$, $P = 0.0004$; $F_{3,12} = 6.78$, $P = 0.0063$, respectively; Fig. 1). Spinetoram alone provided more than 12 times higher larval suppression on 7 d after treatment compared to control. On 14 and 21 d after treatment, both *A. swirskii* and spinetoram provided more than 5 times higher larval suppression compared to control. There were no statistical differences in *S. dorsalis* adult and larval numbers on pre-treatment date ($F_{3,12} = 1.95$, $P = 0.1751$; $F_{3,12} = 1.08$, $P = 0.3961$, respectively) and on 28 d after treatment ($F_{3,12} = 1.93$, $P = 0.1778$; $F_{3,12} = 2.89$, $P = 0.0797$, respectively; Fig. 1).

On the pre-treatment date, all plants had a plant damage rating of '0'; therefore, statistical analysis could not be conducted. There were no significant differences among treatments and the control damage rating (Mean ± SE: 1.2 ± 0.58) on 7 d after treatment either ($F_{3,12} = 0.35$, $P = 0.7893$; Fig. 2). However, significant difference among treatments were evident on 28 d after treatment ($F_{3,12} = 45.26$, $P < 0.0001$; Fig. 2). Spinetoram treated plants had the lowest damage rating (0.2 ± 0.2), followed by *A. swirskii* treated plants (2.4 ± 0.24), when compared to control plants (3.4 ± 0.24). However, the *Capsicum oleoresin* extract was ineffective in suppressing plant damage when compared to control plants.

Discussion

The results of this study indicate that the predatory mite, *A. swirskii* and the *Capsicum oleoresin* extract are as effective as spinetoram in the suppression of *S. dorsalis* adults up to 7 d after treatment only. Also, *A. swirskii* is as effective as spinetoram in suppression of larval *S. dorsalis* for at least 21 d after treatment. Plant damage can be suppressed as effectively by *A. swirskii* as spinetoram for up to 28 d after treatment due to effective larval suppression. Therefore, *A. swirskii* can be included as an effective biological control agent of *S. dorsalis* as a replacement for repeated use of synthetic insecticides.

This is especially relevant for organic strawberry production because there is only 1 effective insecticide (spinosad) currently labeled for use in strawberries for thrips management. The variable performance of plant essential oils or extracts for thrips management may be attributed to higher volatility, the ability of thrips to adapt rapidly to the negative stimuli in the absence of acceptable hosts, short residual properties, formulation of the product, or lower initial toxicity (Cloyd & Chiasson 2007; Koschier 2008).

Incorporation of a biological control agent (*A. swirskii* in this case) will reduce instances of disruptive effects of synthetic insecticides, on both biological control agents and natural enemies (Brødsgaard 2004). The *Capsicum oleoresin* extract can be used in organic strawberry fields during the early season to target adult *S. dorsalis* population, but additional plant rescue efforts will be needed 7 d after treatment.

The compatibility of *A. swirskii* with *Capsicum oleoresin* extract and synthetic insecticides for *S. dorsalis* control in open field strawberry fields needs to be evaluated. Thrips predators such as mites, *N. cucumeris* and *A. swirskii*, are available commercially for management of *S. dorsalis* and other phytophagous thrips species commonly occurring in strawberry fields. The possibility of synergistic relationships between *A. swirskii* and other biological control agents and natural enemies also needs to be explored. The resulting findings will benefit both small fruit and vegetable cropping systems.

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Summary

Efficacy of predatory mite, *Amblyseius swirskii* (Athias-Henriot) as a biological control agent of chilli thrips, *Scirtothrips dorsalis* Hood, was compared to a *Capsicum oleoresin* extract-based biopesticide,and a conven-

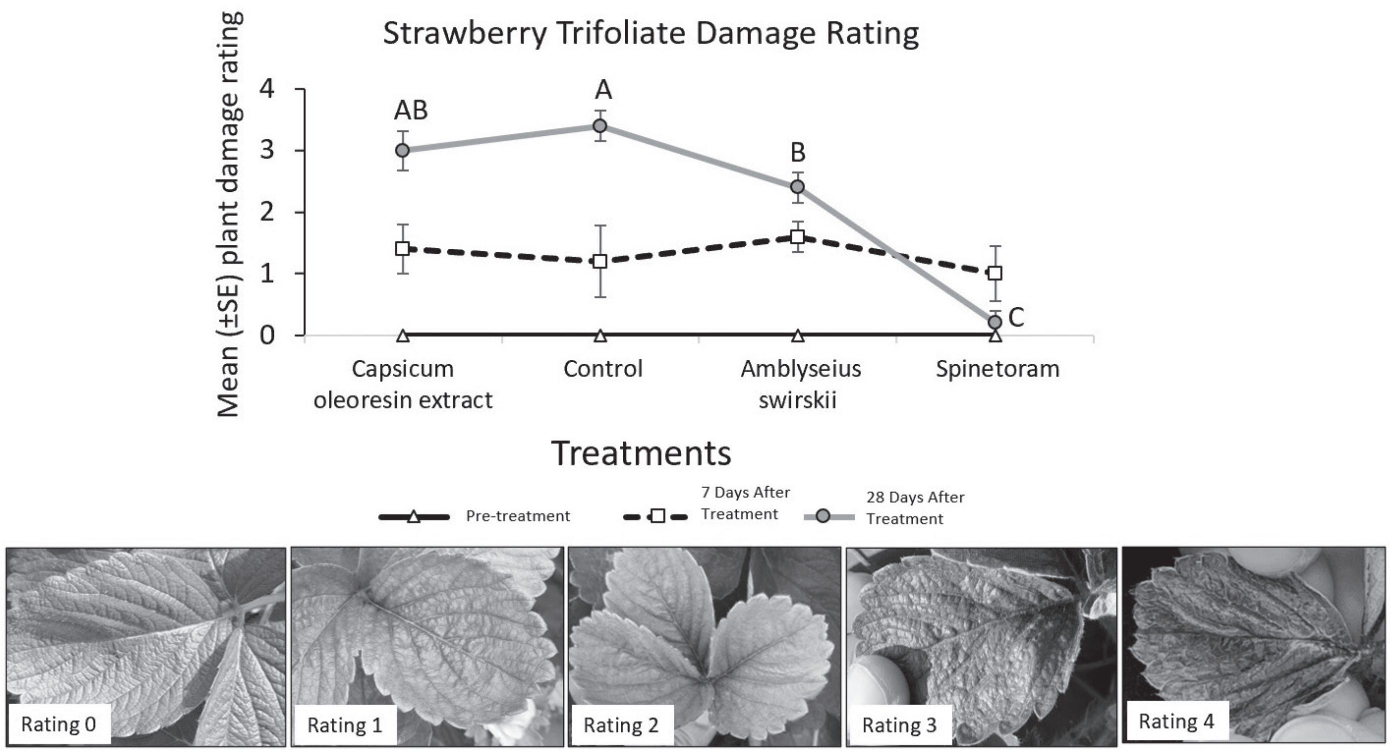

Fig. 2. Mean (± SE) plant damage rating caused by feeding of *Scirtothrips dorsalis* Hood on caged strawberry plants treated with (1) *Capsicum oleoresin* based biopesticide, (2) predatory mite *Amblyseius swirskii*, and (3) conventional insecticide spinetoram, and compared with control plants for 7 and 28 d after treatment. Means with the same letter are not significantly different ($P < 0.05$; Tukey HSD). Images of strawberry damage rating (0–4) shows the scale used to assign damage rating to plants.

tional insecticide, spinetoram, on entire strawberry (var. 'Radiance') plants with 5 expanded trifoliates under greenhouse conditions. Results indicate that *A. swirskii* and the biopesticide can be included as effective tools for integrated pest management of *S. dorsalis* in strawberries.

Key Words: biological control; integrated pest management; horticulture; small fruits

Sumario

Se comparó la eficacia del ácaro depredador *Amblyseius swirskii* (Athias-Henriot) como agente de control biológico del trips del chile, *Scirtothrips dorsalis* Hood, con un biopesticida basado en extracto de oleorresina de capsicum y un insecticida convencional, spinetoram, sobre plantas entera de fresa (var. 'Radiance') con 5 trifoliatos expandidos bajo condiciones de invernadero. Los resultados indican que *A. swirskii* y el biopesticida pueden incluirse como herramientas efectivas para el manejo integrado de plagas de *S. dorsalis* en fresas.

Palabras Clave: control biológico; manejo integrado de plagas; horticultura; frutas pequeñas

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