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EFFICACY OF *BEAUVERIA BASSIANA* PLUS INSECT ATTRACTANTS FOR ENHANCED CONTROL OF *FRANKLINIELLA OCCIDENTALIS* (THYSANOPTERA: THRIPIDAE)

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Beauveria bassiana (Balsamo) Vuillemin strain GHA effectively controls western flower thrips, *Frankliniella occidentalis* (Pergande), on greenhouse ornamentals (Murphy et al. 1998). Although greenhouse growers commonly add additives, such as attractants, to tank mixes for enhanced insect control, little research has been conducted to test this practice. Thrips must come into contact with the *Beauveria* spores while they are still viable. The use of attractants theoretically would attract the insects to the spores soon after application. The objective of this study was to determine if the addition of insect attractants improve the effectiveness of *Beauveria bassiana* against western flower thrips on greenhouse grown chrysanthemums. Growers use attractants to enhance activity of some insecticides, our results will indicate if this practice aids in thrips management when attractants are used together with *B. bassiana*.

One rooted chrysanthemum 'Charm', *Dendranthema* × *grandiflora* (Ramat.) Kitamura, cutting was planted per 15 cm plastic pot containing Pro-Gro Professional Growing Medium®300 (Pro-Gro Products Inc., McCormick, SC). Each pot received an initial application of 4.5 g of 14-14-14 Osmocote® (Scotts, Marysville, OH). Plant terminals were removed to promote branching 2 and 4 wks after potting. A foliar application of 5,000 ppm daminozide (Uniroyal, Middlebury, CT), a plant growth regulator, was applied 6 wks after potting. Before the experiment began, plants were watered daily and fertilized two times a week with 200 ppm N [20-10-20 Peter's Peat-lite Special® (Scotts)].

The experiment was conducted as a randomized complete block design with eight treatments in two trials. Each study had six replicate pots of each treatment. Two greenhouses were used, each containing three replicates. The greenhouse temperature and humidity were similar so greenhouse effects were ignored and the data pooled.

At the initiation of the experiment each pot was placed in fiber plant sleeve 20 × 61 × 51 cm (B × H × T) (Kleen Test Products, Milwaukee, WI). The plant sleeves confined thrips to plants and prevented movement between treatments. Plants were placed onto and watered using ebb and flood tables. This eliminated the need for opening the sleeves to maintain the plants. As a result, the foliage remained dry and humidity within the sleeves was consistent with the surrounding greenhouse. To water the plants, benches were flooded daily with a solution containing 100 ppm N (20-10-20 Peter's Peat-lite Special®). The eight treatments investigated were 2.5 ml/l of *Beauveria bassiana* strain GHA (BotaniGard® ES, Mycotech, Butte, MO), 2.5 ml/l of Lure® Insect Attractant (Setre Chemical Co., Memphis, TN), 0.5ml/l of Stirrup® (Troy Bioscience, Phoenix, AZ), 1.2 g/l of sugar, a water control, and *B. bassiana* + Stirrup®, *B. bassiana* + sugar, *B. bassiana* + Lure® at the previously described rates. Treatments were applied using a hand sprayer at 241 kPa and applied to runoff. Stirrup® is a biochemical designed to modify the behavior of mites for use in combination with miticides. Lure® Insect Attractant is a commercially available 40.5% blend of mono- and polysaccharides. Consumer grade white granulated sugar was used in the sugar treatments.

Treatments in the first trial were initiated at bud break and continued weekly for a total of three applications. Treatments in the second trial were initiated when the bud were large. Thrips populations were determined weekly by randomly collecting four flowers (first trial) or buds (second trial) per pot and placing them in 200 ml of ethyl alcohol. Flowers or buds were removed from the alcohol and the number of adult and immature thrips remaining were counted. Temperature and humidity were recorded in the plant sleeves using StowAway® XTI temperature loggers and StowAway® RH relative humidity loggers (Onset Computer Corp., Pocasset, MA).

Data were transformed [log10 (x+1)] to make the variance independent of the means (Sokal & Rohlf 1995). Treatment efficacy, as measured by the number of thrips per sample period, was subjected to Analysis of Variance (GLM procedure). Means separation was accomplished using the least significant difference test (LSD) at the $P < 0.05$ level (SAS Institute 1985). Data are presented as untransformed means.

A sample was taken from each *B. bassiana* treatment to determine the spore viability of the treatment solution. Serial dilutions of 10^{-5} and 10^{-6} were plated on Sabouraud dextrose agar (SDA)

TABLE 1. MEAN NUMBER ± SD OF WESTERN FLOWER THRIPS PER FOUR CHRYSANTHEMUM FLOWERS IN THE FIRST TRIAL EVALUATING BEAUVERIA BASSIANA WHEN COMBINED WITH INSECT ATTRACTANTS (GRIFFIN, GA, SPRING 1999).

	Days after first treatment[a,b]			
Treatment	7	14	21	28
B. bassiana	42.0 ± 14.3 ab	23.7 ± 16.6 d	26.3 ± 17.0 c	190.5 ± 54.1 b
B. bassiana + Sugar	40.5 ± 12.9 ab	27.2 ± 19.2 cd	36.2 ± 9.9 bc	300.7 ± 137.6 a
B. bassiana + Lure®	64.8 ± 17.9 a	23.0 ± 14.8 d	49.5 ± 34.2 bc	342.8 ± 148.2 a
B. bassiana + Stirrup®	56.0 ± 37.0 a	37.5 ± 24.5 bcd	90.8 ± 81.9 ab	331.4 ± 199.0 a
Control	91.3 ± 61.1 a	95.0 ± 29.8 a	86.2 ± 71.1 ab	411.8 ± 232.6 a
Lure®	87.3 ± 44.1 a	74.0 ± 24.7 a	131.5 ± 104.8 a	354.8 ± 129.1 a
Stirrup®	64.3 ± 27.5 a	57.3 ± 24.5 ab	138.7 ± 106.4 a	480.8 ± 280.4 a
Sugar	21.8 ± 10.1 b	53.7 ± 33.1 abc	141.8 ± 87.4 a	473.8 ± 162.1 a

[a]Means in each column followed by the same letters are not significantly different ($P > 0.05$).
[b]Treatments applied on day 0, 7, and 14.

and stored at 27°C to determine the viability of the test solution. Results from all applications indicated the *B. bassiana* spores were viable.

In the first trial, thrips numbers were lower in the *B. bassiana* treatment than in the control and non-*B. bassiana* treatments the second and third sample days. By day 28 (14 d after the final application), *B. bassiana* was no longer efficacious and the thrips populations had increased dramatically from the previous week (Table 1). *Beauveria bassiana's* efficacy was not increased when combined with sugar, Lure®, or Stirrup®. The mean temperature and relative humidity recorded in the sleeves in each greenhouse were: 20.3 ± 6.7°C, 69.3 ± 25.2% and 19.9 ± 7.4°C, 64.2 ± 25.5%.

Lower thrips populations were observed in the second trial. This was due to the collection of flower buds instead of flowers. Thrips are capable of building larger populations in flowers than in buds. Thrips populations were statistically lower than the control in the *B. bassiana* plus sugar and *B. bassiana* plus Lure® treatments on day 15 and 23 and in the *B. bassiana* treatment on day 23 (Table 2). The mean temperature and relative humidity recorded in the sleeves in each greenhouse were: 20.1 ± 4.0°C, 81.0 ± 16.7% and 22.9 ± 5.4°C, 75.8 ± 20.0%.

When thrips populations were large, applications of *B. bassiana* resulted in lower populations (first trial). Unfortunately when populations were low, applications of B. bassiana did not eliminate the thrips populations (second trial). Combining attractants with *B. bassiana* for control of *F. occidentalis* on chrysanthemums did not reduce thrips populations compared to the *B. bassiana* alone treatment. These results indicate thrips made contact with the *B. bassiana* spores without the aid of the attractants. This may have been a result of western flower thrips being an active insect that came into contact with thorough and repeated applications of *B. bassiana*.

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TABLE 2. MEAN NUMBER ± SD OF WESTERN FLOWER THRIPS PER FOUR CHRYSANTHEMUM FLOWERS IN THE FIRST TRIAL EVALUATING *BEAUVERIA BASSIANA WHEN COMBINED WITH INSECT ATTRACTANTS* (GRIFFIN, GA, SPRING 1999).

	Days after first treatment[a,b]				
Treatment	0	8	15	23	30
B. bassiana	8.0 ± 6.3 abc	1.5 ± 1.4 a	2.7 ± 5.1 ab	0.2 ± 0.4 c	1.5 ± 1.9 a
B. bassiana + Sugar	10.0 ± 4.9 ab	0.8 ± 1.2 a	0.2 ± 0.4 c	0.3 ± 0.5 bc	1.4 ± 1.5 a
B. bassiana + Lure®	0.8 ± 0.8 d	0.3 ± 0.8 a	0.2 ± 0.4 c	0.2 ± 0.4 c	1.5 ± 1.3 a
B. bassiana + Stirrup[7]	3.2 ± 3.5 cd	1.2 ± 2.4 a	0.5 ± 06 bc	1.3 ± 1.0 ab	0.2 ± 0.4 a
Control	3.2 ± 2.9 cb	0.7 ± 0.8 a	3.0 ± 1.8 a	2.2 ± 2.2 a	1.0 ± 1.3 a
Lure®	7.3 ± 4.4 ab	0.5 ± 0.8 a	0.6 ± 0.5 bc	1.2 ± 1.2 abc	0.8 ± 1.6 a
Stirrup[7]	17.7 ± 23.1 a	1.2 ± 1.2 a	0.8 ± 1.0 bc	1.3 ± 1.4 abc	0.6 ± 0.5 a
Sugar	6.0 ± 4.6 bc	1.0 ± 1.3 a	1.0 ± 0.8 abc	0.7 ± 1.2 abc	0.5 ± 0.8 a

[a]Means in each column followed by the same letters are not significantly different ($P > 0.05$).
[b]Treatments applied on days 0, 8, and 15.

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Summary

The effectiveness of *B. bassiana* was evaluated when attractants were used in combination against western flower thrips on greenhouse grown chrysanthemums. While the treatments containing *B. bassiana* reduced thrips populations, treatments containing *B. bassiana* plus attractants did not reduce thrips population compared to the *B. bassiana* treatment without attractants.

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