



Effect of Tank Mixing Pesticides in Controlling Western Flower Thrips,

Frankliniella occidentalis (Pergande) (Thysanoptera: Thripidae)

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Figure 1. Transvaal daisy without (upper left) and with (lower right) WFT feeding damage expressed as twisted petals and pigment degradation.

Introduction

Pesticides, which include insecticides and miticides, are intensively used to control many of the major arthropod pests such as greenhouse whitefly (*Trialeurodes vaporariorum*), silverleaf whitefly (*Bemisia argentifolii*), twospotted spider mite (*Tetranychus urticae*), and western flower thrips (*Frankliniella occidentalis*) in greenhouses¹. Western flower thrips (WFT) is one of the most important pests in greenhouses because it directly damages plants by feeding (Fig. 1) and indirectly by vectoring tospoviruses².

The loss of older, conventional pesticides that kill a broad-range of plant pests has led to the registration of biorational pesticides with a narrow-range of pest activity or selectivity. Biorational pesticides are less toxic to workers, have shorter residual activity, and are generally less harmful to beneficial arthropods than conventional pesticides^{3,4}. However, in order to continually manage the diversity of arthropod pests, greenhouse managers "tank mix" several biorational pesticides to broaden the spectrum of activity of the application thereby reducing the number of applications and associated labor costs. In addition, studies have shown that mixing two insecticides increases efficacy (synergism) against pests such as WFT⁵ and whiteflies⁶. Despite these benefits, problems may occur when two or more pesticides are mixed together. These problems include increasing the probability of resistance to multiple pesticides⁷, potential plant injury, pesticide incompatibility, or a reduction in tank mix efficacy compared to single applications (antagonism). There is little information to support or refute claims of antagonism or synergism for tank mixes used to control greenhouse pests. In addition, minimal information is available on how tank mixing affects the efficacy of biorational pesticides. As such, it is important to determine if tank mixes result in reduced efficacy against targeted arthropod pests.

The purpose of this study was to determine how mixtures of biorational pesticides labeled for and used to control thrips, spider mites, whiteflies, leafminers, and aphids in greenhouses affected the control of WFT.

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ABSTRACT

Greenhouse managers tank mix pesticides to broaden the spectrum of pest control, and reduce pesticide and labor costs. However, the effect of tank mixing an assortment of pesticides on control of targeted pests has not been documented. This study assessed how tank mixing commercially available insecticides and miticides in two, three, and four way combinations affected the control of western flower thrips (*Frankliniella occidentalis*) in greenhouse experiments. The pesticides screened were spinosad, abamectin, bifentazate, azadirachtin, and imidacloprid. Each pesticide was applied at the label-recommended rate. In two greenhouse experiments, lisianthus (*Eustoma grandiflorum*) and/or transvaal daisy (*Gerbera jamesonii*) flowers were inoculated with 25 adult western flower thrips (WFT), and then the flowers were sprayed with the designated treatments. After 72 hours, flowers were emasculated to assess the number of live and dead WFT. For these experiments, no antagonistic tank mixes were positively identified. Spinosad + abamectin was synergistic in the second experiment. All treatments with spinosad, including the individual application and the tank mixes, resulted in high mortality of WFT based on the number of live and dead WFT recovered, indicating that tank mixes of spinosad with the other pesticides tested do not affect the efficacy of spinosad in controlling WFT. The results of this research are important to greenhouse managers who want to tank mix pesticides and still control WFT in addition to other plant-feeding arthropods.

Materials and Methods

Five pesticides commonly used to manage greenhouse whitefly, silverleaf whitefly, twospotted spider mite, and WFT were screened to determine if 2, 3, and 4-way combinations had any synergistic or antagonistic effects in controlling WFT.

Experiment 1 (18 July to 25 July, 2003)

- Completely randomized design with 6 replications
- Treatments were spinosad, bifentazate, abamectin, and azadirachtin alone and in all possible mixtures
- Isolated transvaal daisy and lisianthus cut flowers (Fig. 2) were inoculated with 25 WFT adults 48 h before treatment application
- WFT mortality assessed after 72 h
- Data analyzed by ANOVA with means separated by Fisher's protected LSD at $P \leq 0.05$

Experiment 1

- Total number and number of live WFT recovered varied among crop and treatments
- Number of dead WFT recovered did not vary by crop or treatment
- Pesticides labeled for WFT effectively controlled WFT when applied alone and in most mixtures
- The tank mix of abamectin + azadirachtin displayed possible antagonism

Table 1. Mean (\pm SE) numbers of dead and live WFT recovered from transvaal daisy and lisianthus for the 17 spray treatments when combined across crop type and replication (n=12).

Treatment ^a	Dead WFT ^b	Live WFT
SP	6.2 \pm 0.9 a	4.0 \pm 1.7 efg
BI	5.3 \pm 1.1 a	10.4 \pm 1.3 abc
AB	7.2 \pm 0.9 a	4.6 \pm 1.2 efg
AZ	5.4 \pm 1.1 a	9.8 \pm 1.6 abcd
SP + BI	5.8 \pm 0.8 a	4.3 \pm 1.5 fg
SP + AB	8.0 \pm 1.0 a	2.4 \pm 0.7 g
SP + AZ	8.2 \pm 1.2 a	5.2 \pm 1.8 fg
BI + AB	7.0 \pm 0.9 a	4.2 \pm 1.5 g
BI + AZ	4.5 \pm 0.9 a	10.5 \pm 1.6 abc
AB + AZ	5.4 \pm 0.9 a	5.4 \pm 1.5 bcd
SP + BI + AB	7.5 \pm 0.9 a	2.4 \pm 0.6 g
SP + BI + AZ	5.2 \pm 1.0 a	7.6 \pm 1.6 cde
SP + AB + AZ	7.3 \pm 0.9 a	2.8 \pm 1.0 g
BI + AB + AZ	6.2 \pm 0.7 a	6.6 \pm 1.3 def
SP + BI + AB + AZ	6.4 \pm 1.1 a	2.7 \pm 0.7 g
Water Control	3.5 \pm 0.7 a	13.7 \pm 1.5 a
Untreated Check	5.6 \pm 0.9 a	10.8 \pm 1.3 abc

^aTreatment designations: SP=Spinosad, BI=Bifenazate, AB=Abamectin, and AZ=Azadirachtin.

^bMeans within a column not followed by a common letter are significantly different ($P=0.05$) as determined by a Fisher's protected least significant difference (LSD) mean separation test.

Experiment 2 (8 August to 15 August, 2003)

- Same as Experiment 1 except that only transvaal daisy flowers were used and spinosad, bifentazate, abamectin, and imidacloprid were applied alone and in all possible mixtures
- Jar test for compatibility (Experiments 1 & 2)
- 180 ml of each pesticide and all mixtures in jars
- Jars were tightly sealed and placed in a laboratory
- Evaluated for incompatibility 0, 2, 4, and 20 h later

Results

Experiment 2

- Number of live and dead WFT recovered varied by treatment
- Spinosad & abamectin had high mortality of WFT
- The tank mix of spinosad + abamectin was synergistic

Jar Test

- All treatment mixtures were compatible based on the lack of layering or precipitates forming

Table 2. Mean (\pm SE) numbers of dead and live WFT recovered from transvaal daisy flowers for the 17 spray treatments when combined across replication (n=6).

Treatment ^a	Dead WFT ^b	Live WFT
SP	6.3 \pm 1.9 bcdef	3.5 \pm 0.9 d
BI	3.5 \pm 0.5 efgh	15.2 \pm 1.5 a
AB	10.0 \pm 1.5 ab	7.8 \pm 0.8 c
IM	2.5 \pm 0.7 gh	14.5 \pm 2.2 ab
SP + BI	7.2 \pm 1.0 abcde	2.0 \pm 0.5 def
SP + AB	8.7 \pm 1.0 abc	0.7 \pm 0.2 ef
SP + IM	12.2 \pm 2.2 a	2.8 \pm 0.8 de
BI + AB	7.5 \pm 1.4 abcd	8.3 \pm 0.6 c
BI + IM	1.7 \pm 0.9 a	15.7 \pm 2.4 a
AB + IM	4.8 \pm 1.1 cdefg	10.3 \pm 3.0 bc
SP + BI + AB	7.7 \pm 1.5 abcd	0.5 \pm 0.3 f
SP + BI + IM	11.0 \pm 1.3 a	3.8 \pm 1.3 d
SP + AB + IM	8.2 \pm 2.4 abcd	0.7 \pm 0.3 f
BI + AB + IM	8.2 \pm 1.2 abc	8.5 \pm 0.9 c
SP + BI + AB + IM	11.5 \pm 1.1 a	2.3 \pm 0.8 def
Water Control	3.7 \pm 1.1 fgh	16.2 \pm 2.3 a
Untreated Check	5.3 \pm 2.4 defgh	18.7 \pm 3.5 a

^aTreatment designations: SP=Spinosad, BI=Bifenazate, AB=Abamectin, and IM=Imidacloprid.

^bMeans within a column not followed by a common letter are significantly different ($P=0.05$) as determined by a Fisher's protected least significant difference (LSD) mean separation test.



Figure 2. Cut flower isolation system (left) and experimental layout (right) used to evaluate tank mix efficacy in controlling WFT.

Discussion

The overall percent recovery for Experiment 1 was 53% (of the \approx 5100 WFT applied 2723 were recovered) with significantly more live WFT being recovered from the transvaal daisy flowers (9.1 ± 0.6) than the lisianthus flowers (4.0 ± 0.4). There was no significant difference in the number of dead WFT recovered between the two crop types. Based on these recovery data, transvaal daisy is a better flower to test the effects of tank mixing.

Based on the numbers of live WFT recovered from the flowers, we were not able to identify synergistic effects among the pesticide mixtures (Table 1). Spinosad and abamectin when applied individually had as few live WFT as the mixtures (Table 1). All treatments with spinosad, including the individual application and mixtures, had fewer live WFT than the water control and untreated check (Table 1). The abamectin, and bifentazate + abamectin mixture also had fewer live WFT than the controls (Table 1). Abamectin has been shown to be effective in controlling WFT in both single applications and tank mixes⁵. A mixture that had significantly more live WFT than the separately applied pesticides, possibly indicating an antagonistic effect, was the abamectin + azadirachtin mixture (Table 1).

Overall percent recovery for Experiment 2 was 57% with 1459 of the 2550 WFT applied recovered. Treatments with spinosad and abamectin had the highest mortality (Table 2). Additionally, the spinosad + abamectin tank mix resulted in significantly fewer live WFT recovered than the spinosad or abamectin individual applications indicating possible synergism (Table 2).

Few studies involving tank mixes have been conducted in field situations, such as the greenhouse environment used in this study. Based on our results, mixtures of spinosad with any of the other pesticides tested effectively controlled WFT. This is important information to managers who want to tank mix pesticides and still control WFT along with other plant-feeding arthropods.

Conclusions

Experiments 1 and 2

- Transvaal daisy is a good test flower for tank mix studies
- The tank mix of abamectin + azadirachtin displayed possible antagonism
- The tank mix of spinosad + abamectin was synergistic
- Spinosad, abamectin, & spinosad mixes controlled WFT

Jar Test

- All pesticides were compatible as mixtures

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