Verbena Cultivars Differentially Attract Adult Western Flower Thrips

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Abstract

Western flower thrips (*Frankliniella occidentalis*) significantly impact floricultural crops worldwide. Insecticides to control these pests are limited due to federal regulations and acquired resistance of western flower thrips (WFT) to many insecticides. Holistic integrated pest management (IPM) programs are emerging within the industry to manage WFT populations that minimize worker exposure and limit environmental impacts. However, the use of trap crops, which function by using a pest's preference for certain plants to localize the pest for insecticide applications or where they will have minimal impact on main crops, is not extensively utilized in commercial greenhouse crop production due to perceived economic obstacles. Four verbena (*Verbena* × *hybrida*) cultivars were monitored in ten greenhouses for six weeks to determine WFT preferences. Yellow sticky cards placed immediately above flowers were used to determine if endemic WFT were differentially attracted to verbena cultivars. Western flower thrips preferred the cultivar 'Tapien Lavender' to three other verbena cultivars from the same breeding series and the controls. 'Tapien Lavender' attracted up to 7.78 times more thrips than the control. Verbena cultivars could be a useful tool in IPM programs either as a trap crop for WFT or as a means of enhancing scouting efficiency by luring WFT into specific regions for easier detection.

INTRODUCTION

One of the most serious insect pests of ornamental crops is western flower thrips (*Frankliniella occidentalis*). Due to international transport of crops, western flower thrips (WFT) have become established in commercial greenhouses throughout the world. Thrips lay eggs inside plant tissues, have a rapid reproductive rate, and have a high level of insecticide resistance (Immaraju et al., 1992; Robb et al., 1995; Zaho et al., 1995). The physical damage caused by thrips feeding on developing leaves, flowers, and fruit is often hidden until plant maturation when silver mottling or blotching, streaking, and distortion of the leaves and/or petals becomes apparent. Western flower thrips can also vector plant viruses, including the tospoviruses tomato spotted wilt virus (TSWV) and impatiens necrotic spot virus (INSV), which can devastate ornamental crops (de Angelis et al., 1994).

Integrated pest management (IPM) programs seek to balance proactive cultural controls with minimal pesticide inputs during crop production. Over 8365 ha during 2000 were devoted to production of floricultural crops in the United States (USDA, 2001). In 1985, less than 6% of greenhouses used IPM approaches (Sunderland et al., 1992), indicating that most floricultural crop producers rely on insecticides to produce a marketable crop. In fact, nearly 2.8 million pounds of active ingredients were used in 1993 to control insect and mite pests in horticultural production systems (Hudson et al., 1996).

Government regulations and the development of resistance to available insecticides are limiting WFT controls available to producers. Alternative WFT control measures are therefore necessary. A multifaceted approach to limit thrips establishment in

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commercial greenhouses is the only viable option to ensure marketable products. The use of trap crops, which has been successfully incorporated into agronomic cropping systems (Berlinger, et al., 1996; Theunissen and Schelling, 1998), has not been utilized in greenhouses as a supplemental part of IPM programs to manage WFT. The floricultural industry has been reluctant to incorporate the use of trap crops into IPM programs due to perceived economic obstacles (Hokkanen, 1991). Trap crops function by using a pest's preference for a certain plant species, cultivar, or crop stage, to prevent pests from concentrating on the main crop or to attract pests to a certain area where they can be locally controlled. Trap crops comprise a percentage of the total crop area. Thus, the economic benefits associated with the use of trap crops must offset the costs associated with lost production area. The reduction of insecticide applications and increased yields results in net economic gains when trap crops are used in agronomic cropping systems (Hokkanen, 1991). Trap crops may also serve as reservoirs for natural enemies of insect pests thereby enhancing biological control effectiveness (Powell, 1986). Research to determine the economic benefits of trap crops in greenhouse production of floricultural crops is limited.

Thrips have crop preferences (Hoyle and Saynor, 1993), which suggest that the use of trap crops in greenhouses may be a feasible option to manage these insect pests. For example, WFT were more attracted to browallia (*Browallia speciosa*), gloxinia (*Sinningia speciosa)*, impatiens (*Impatiens wallerana*), and verbena (*Verbena* × *hybrida*) than other floricultural crops (Bennison, et al., 1999; Hoyle and Saynor, 1993). Bennison et al. (1999) found two verbena cultivars, 'Sissinghurst Pink' and ' Tapien Pink', to be effective lure plants when placed among ivy-leaf geranium (P*elargonium peltatum*) and chrysanthemum (*Dendranthema* × *grandiflorum*), respectively. They did not determine if verbena cultivars with similar genetic backgrounds differentially attracted WFT. In addition, plants with blue and yellow flowers are known attractants of WFT (Bergh and Le Blanc, 1997; Broadbent, et al., 1990). Commercial producers of floricultural crops indicated that recently introduced vegetatively propagated verbena (*Verbena* × *hybrida*) cultivars are preferred by WFT over other flowering potted plants (Mark Leider, pers. commun.). Although verbena cultivars have been determined to be attractive to WFT (Bennison et al., 1999), it is not known if cultivars within a breeding series differentially attract WFT. To determine if there are differences among vegetatively propagated verbena of similar genetic backgrounds, an experiment was designed to identify the attractiveness of four verbena cultivars to WFT when placed among floricultural or agronomic crops in greenhouses.

MATERIALS AND METHODS

Individual liners of four verbena cultivars, 'Lavender', 'Blue Violet', 'Pink', and 'Soft Pink' from the Tapien series obtained from a commercial propagator were transplanted into 12.7-cm (1.24-L) azalea pots filled with a soilless media (Strong-Lite Universal Mix, Seneca, Ill.) on 6 February 2001. Transplanted liners were grown in a glass covered greenhouse in Urbana, Ill. with temperatures set at 18/22 °C (65/72 °F) night/day (Ball, 1998) until flowers were present on each cultivar. Plants were fertilized with 150 $mg{\cdot}L^{-1}$ nitrogen solution of 20N-4.4P-16.6K (Nutriculture, Plant Marvel Laboratories, Inc., Chicago Heights, Ill.) using a constant liquid feed program. Ten plants of uniform size and flower development from each cultivar were placed in a split plot design with ten replications. Main plots were verbena cultivars, sub-plots were sample dates, and replications were spatially separated in ten isolated 81.3 m^2 greenhouses known to historically contain high numbers of WFT.

On 6 March 2001, each 81.3 m^2 greenhouse was divided into quadrants and each quadrant was randomly assigned one verbena cultivar in a 12.7-cm (1.24-L) pot. To monitor the attractiveness of each verbena cultivar, a 5.08-cm x 10.16-cm yellow sticky card (Whitmire Micro-Gen Research Laboratories, Inc., St. Louis, Mo.) was placed ≈ 5.0 cm above the flower canopy of each pot. To determine relative endemic insect numbers in each greenhouse, a fifth 5.08-cm x 10.16-m yellow sticky card was placed at flower canopy height over a 12.7-cm (1.24-L) azalea pot filled with a soilless media (Strong-Lite Universal Mix, Seneca, Ill.). This control card was placed in the center of each greenhouse, equal distance from each verbena cultivar within the greenhouse. Dependent upon greenhouse, floricultural or agronomic crops surrounded the verbena cultivars and the control card. Floricultural crops included, but were not limited to chrysanthemum, impatiens, alstroemeria (*Alstroemeria* hybrids), azalea (*Rhododendron indicum*), coleus (S*olenostemon scutellarioides*), ficus (*Ficus benjamina*), geranium (*Pelargonium* × *hortorum*), gerbera daisy (*Gerbera jamesonii*), peace lily (*Spathiphyllum* sp.), and petunia (*Petunia* × *hybrida*). Agronomic crops were broccoli (*Brassica oleracea*), lavender (*Lavandula augustifolia*), rosemary (*Rosemarinus officinalis*), sweet corn (*Zea mays* var. *rugosa*), tobacco (*Nicotiana tabacum*), or tomato (*Lycopersicon esculentum*).

Beginning on 13 March 2001, the number of WFT attracted to the verbena cultivars and the controls were determined weekly for six weeks by counting the number of WFT on each card with a grid and stereomicroscope (Lecia GZ4, Buffalo, N.Y.). Each card with captured insects was replaced weekly with a new sticky card. Because endemic insect populations varied among greenhouses, WFT numbers were standardized by converting the absolute number captured to percent captured compared with the control card from each greenhouse before analysis. Data were analyzed using the general linear models procedure of SAS software (SAS Inc., Cary, N.C.). Means were separated using Fisher's protected least significant difference test at $P \leq 0.05$.

RESULTS AND DISCUSSION

The relative percentage of WFT captured on yellow sticky cards varied among cultivars and sample dates (Table 1). A significant interaction between cultivar and sample date impacted WFT capture.

Though the interaction between cultivar and sample date was significant, there was little consistency in the impact this combination had on percent WFT captured (Figure 1). When placed among floricultural and agronomic crops in multiple greenhouse locations, the verbena cultivar 'Tapien Lavender' attracted more WFT (up to 7.78 times the number found on control) than other verbena cultivars or the control (Figure 1). The cultivars 'Tapien Pink' and 'Tapien Blue Violet' attracted a high level of WFT on 20 March and 17 April, respectively. On 17 April, 'Tapien Blue Violet' attracted significantly more WFT than the control (4.17 times the number found on the control) and most other cultivars. As WFT fed on the plants, 'Tapien Blue Violet' remained a floriferous cultivar while the other cultivars had decreased flower numbers. The higher number of flowers available on 'Tapien Blue Violet' during the last few weeks of the experiment may explain some variability associated with cultivar and sample date. The high percentage of insects attracted to 'Tapien Lavender' on 20 March combined with the consistency of attraction on other sample dates indicates that 'Tapien Lavender' is preferred by WFT over the other verbena cultivars tested or the control.

Bennison et al. (1999) found two verbena cultivars, 'Sissinghurst Pink' and 'Tapien Pink' to be effective lure plants for WFT in geranium and chrysanthemum crops. Subsequent experiments determined that these two cultivars contained flower volatiles that attracted WFT (Pow et al., 1998). The specific compounds that attracted WFT to these cultivars were not identified. Previous experiments did not include cultivars with similar genetic backgrounds to determine if differential attractiveness within a series of verbena existed. Results of the current experiment indicate that WFT are differentially attracted to verbena cultivars within a series. The factor(s) contributing to the varying attractiveness levels cannot be determined from the current experiment, but are likely a combination of flower area and volatiles.

Because verbena cultivars were attractive to adult WFT, this crop should be closely monitored in greenhouses. Insect preferences for this crop will allow producers to detect the presence of insect populations before they reach epidemic proportions and cause significant crop damage. The preference for verbena may be combined with other components of IPM programs to manage WFT in greenhouses. Minimally, the attractiveness of verbena to WFT may be manipulated to increase scouting efficiency with sticky cards by concentrating insects in a localized area. The preference of WFT for the 'Tapien Lavender' cultivar and the ability of 'Tapien Blue Violet' to maintain a high number of flowers can be used as a part of a "push-pull" strategy to lure WFT away from main crops for local applications of insecticides or biological controls. Localized applications of insecticides will lower costs through decreased application volume and would be compatible with most biological controls. Repellents applied to a main crop may further increase the attractiveness of trap crops. In this experiment, we kept the economic costs low through the use of single plant attractors. The economic impact of using verbena as a trap crop should be assessed before incorporating them into IPM programs in production greenhouses. Research in these areas is warranted based on previous and current findings.

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Tables

Table 1. Analysis of variance (ANOVA) summary for the percentage of western flower thrips (WFT) attracted to four verbena cultivars or a control card in ten greenhouses (replications) on six dates. Error a was used to test the significance of greenhouse and cultivar. Error b was used to test significance of all other variables.

		Percent WFT	
Source	**df**	**F-value**	**P**
Greenhouse (G)	9	1.80	ns
Cultivar (C)	4	3.12	*
G x C (Error a)	36	1.68	ns
Sample date (S)	5	2.96	*
C x S	20	2.21	**
G x C x S (Error b)	77		

^{ns}, *, ** Nonsignificant or significant at $P \leq 0.05$, 0.01, respectively.

Figures

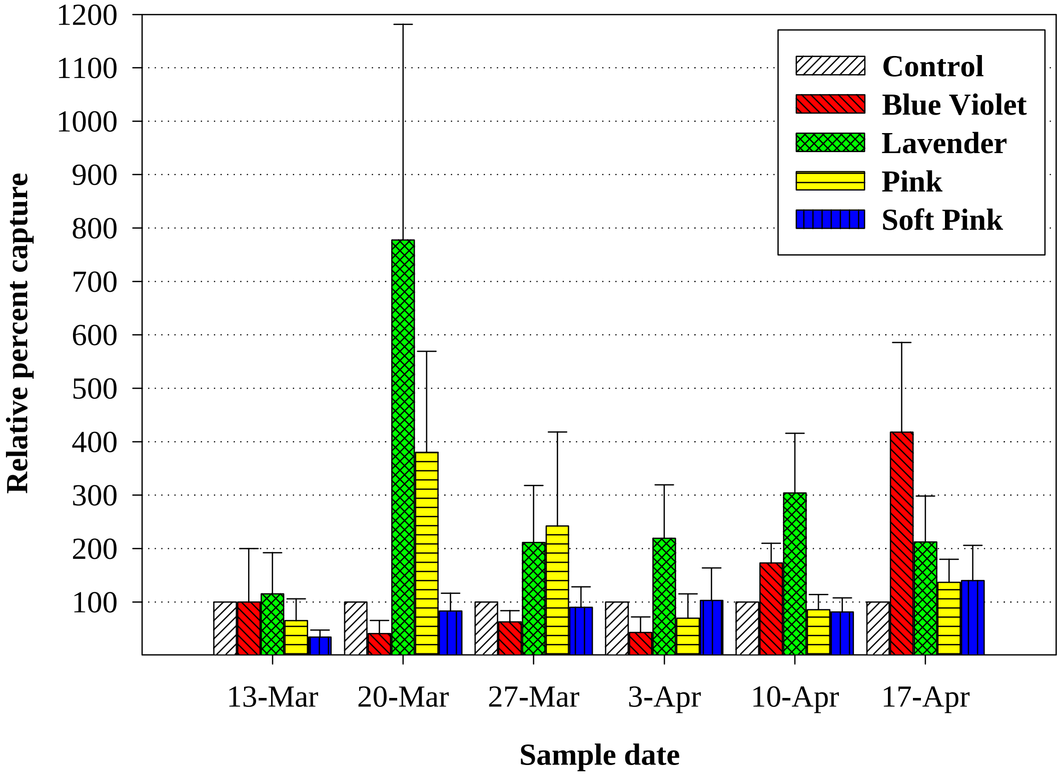

Fig. 1. Mean relative percentage (± SEM) of western flower thrips attracted to four verbena cultivars or a control on six sample dates as determined by the number of insects captured on yellow sticky cards placed immediately above plant canopy. Because endemic WFT populations were used, the number of thrips captured was converted to percent captured compared to the control cards for each cultivar-date combination.