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Interactions in the biological control of western flower thrips *Frankliniella occidentalis* (Pergande) and two-spotted spider mite *Tetranychus urticae* Koch by the predatory bug *Orius insidiosus* Say on beans

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Abstract

An omnivore shows preference to its preys and thus its control efficiency could be altered in different mix infestation system. The efficiency of *Orius insidiosus* for biocontrol of either *Frankliniella occidentalis* or *Tetranychus urticae* alone or for the two pests in combinations was studied on beans. When only mites or thrips were offered as prey, 1 or 2 *O. insidiosus* could considerably suppress pest populations at an initial density of 20, 40, and 80 adult female mites, and 100 and 160 thrips larvae, respectively. A single *O. insidiosus* was able to reduce mite populations by 52.9, 38.7, and 25.8% at initial densities of 20, 40, and 80 mites, respectively, two bugs achieved control levels of 60.6, 63.1, and 38.4%. Releases of 1 and 2 *O. insidiosus* resulted in corrected mortalities of 62.5 and 87.9%, and 46.3 and 71.9% in *F. occidentalis* at initial larval densities of 100 and 160, respectively. When two pests were simultaneously offered, the efficiency of *O. insidiosus* in controlling *T. urticae* markedly decreased. Furthermore, mite control decreased with increasing *T. urticae* densities and was also affected by the density of *O. insidiosus*. The presence of mites at initial densities of 20–80 females did not significantly influence thrips control by *O. insidiosus*. The presence of *F. occidentalis* resulted in higher oviposition by *O. insidiosus* females than the presence of mites, indicating that thrips are a more suitable resource than *T. urticae* for *O. insidiosus*. The implications for biocontrol of *F. occidentalis* and *T. urticae* are discussed.

Keywords: Thrips; Spider mites; Mix infestation; Predatory bug; Mutual relation; Biocontrol

1. Introduction

The western flower thrips *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae) (WFT) and the two-spotted spider mite *Tetranychus urticae* Koch (Acari: Tetranychiidae) (TSSM) are economically important pests in ornamentals and vegetables. WFT is native to the western part of North America, and since the late 1970s it has become a highly cosmopolitan pest; today it is considered to be the number one pest of many crops, particularly in greenhouses (Beshear, 1983; Kirk and Terry, 2003). TSSM is likewise a universally occurring pest and often invades greenhouses (Cloutier and Johnson, 1993).

Orius spp. (Hemiptera: Anthocoridae) are omnivores, feeding on a variety of preys, including thrips, spider mites, insect eggs, aphids, and small caterpillars. However, thrips and mites are believed to constitute important parts of an *Orius* spp. diet (Wright, 1994). *Orius* spp. have been successfully used as biological control agents against WFT, for instance in cucumbers (Chamber et al., 1993; Michelakis and Amri, 1997; Ravensberg et al., 1992),

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sweet pepper (Chamber et al., 1993; Dissevelt et al., 1995; Funderburk et al., 2000; Ramachandran et al., 2001; Sanchez et al., 1997; Van den Meiracker and Ramakers, 1991), strawberries (Frescata and Mexia, 1996; Sterk and Meesters, 1997), sunflower (Chyzik and Klein, 1995), and gerbera (Brødsgaard and Enkegaard, 1997). Yet, bi-weekly releases of *O. insidiosus* Say on tomatoes at a rate of 10 adults per plant failed to reduce thrips populations to economically acceptable levels (Shipp and Wang, 2003). TSSM constitutes an alternative prey for *Orius* spp. (Cloutier and Johnson, 1993). Yet, although predatory bugs are considered to be important predators of TSSM (Oatman and McMurthry, 1966), they are rarely used for biological control of mites. However, Colfer et al. (1998, 2000) could demonstrate that *O. tristicolor* (White) and *Geocoris* spp. (Hemiptera: Lydaeidae) could efficiently control TSSM. Hence, the first objective of this study was to investigate whether *O. insidiosus* is capable of successfully suppressing TSSM or WFT populations, using beans as the model plant.

Plants are often simultaneously infested by both WFT and TSSM (Fejt and Jarosík, 2000; Sterk and Meesters, 1997; Trichilo and Leigh, 1986; Wilson et al., 1996), where they compete for food resources. In addition, WFT is an omnivore, feeding on plant tissues but occasionally also preying on TSSM eggs (Trichilo and Leigh, 1986). Thrips respond to the presence of predatory bugs by hiding in the webbing of TSSM (Cloutier and Johnson, 1993; Venzon et al., 2000), thereby enhancing the probability that they feed on TSSM eggs. Damage of bean leaves by WFT but not by TSSM leads to an increase in search time of *O. tristicolor*, indicating that the predator uses WFT-specific infochemicals to locate thrips as prey (van Laerhover et al., 2000). Hence, dual infestations by thrips and mites might increase TSSM control by *O. tristicolor* and possibly other *Orius* spp. through an increased likelihood of encounters between bugs and mites. Due to TSSM webbings' impediment the control efficacy of thrips by predatory bugs was decreased (Cloutier and Johnson, 1993; Venzon et al., 2000). Therefore, dual infestations by TSSM and WFT in the presence of predatory bugs presumably favor thrips rather than mites. However, this might be affected among others by the prey preference of the predators, prey density, and host plants (Venzon et al., 2002). Thus, the second objective of this study was to investigate how TSSM and WFT affect the control efficiency of *O. insidiosus* in mixed infestations.

2. Materials and methods

2.1. Plant material

Bean (*Phaseolus vulgaris* [Fabaceae] cv. Merona) seedlings with the two first true leaves unfolded, i.e., younger than 10 days, were used as test plants. Plants were grown in the nursery of the Institute of Plant Diseases and Plant Protection (IPP), University of Hannover, Germany, at a temperature of 20 °C, 75% relative humidity (r.h.) and 16:8 h L:D photoperiod.

2.2. Insects and mites

WFT and TSSM were obtained from stock cultures maintained at IPP. Mites and thrips were reared at 23 ± 1 °C, 65 ± 5% r.h. and 16:8 h L:D photoperiod on potted bean plants and bean pods, respectively. In all the experiments, 2-day-old WFT larvae and neonate gravid females of TSSM were used. *Orius insidiosus* were purchased from Katz Biotech. (Baruth, Germany). One day before the start of the experiments, males and females were isolated in a plastic bottle (200 ml) and bean pods were offered as food. Only active *O. insidiosus* females were used in the experiments.

2.3. Experimental procedures

The experimental unit consisted of four bean seedlings, which were transplanted into a plastic pot (16 cm diameter) and covered with a plexiglass cylinder (diameter 15 cm, height 40 cm). To insure ventilation and for releasing mites and insects, four holes were drilled into the cylinder walls (diameter 35 mm), three of which were sealed with thrips-proof nylon gauze (pore size ca. 60 μm, Sefar, Rüschlikon, Switzerland) and the fourth was left open for mite and insect transfer and was later closed by a piece of paper using sticky tape. At the beginning of the experiment 5, 10 or 20 gravid TSSM females were transferred with a fine hairbrush on one leaf per plant, thus totalling 20, 40 or 80 TSSM. One day later, on the same leaves, 25 or 40 WFT first instar larvae were transferred, thus adding 100 and 160 thrips larvae to an experimental unit. On the same day after WFT was transferred, 1 or 2 *O. insidiosus* were introduced into each experimental unit. In treatments without WFT, *O. insidiosus* were added a day after TSSM. More details of the treatments are provided in Table 1. Plants were subsequently incubated for eight days in a climate chamber (23 ± 1 °C, 65 ± 5% r.h. and 16:8 h L:D photoperiod) and thereafter cut at the ground level. The cut plants (leaves and stems) were immediately examined for presence of thrips larvae, prepupae and pupae. If found, they were transferred to a fresh bean leaf which was returned to the original pot. In all treatments with WFT, the emerging adults were counted. According to Berndt et al. (2004), approximately 98% of the late second instar larvae of WFT descend from the plants to pupate in the soil. The emerging WFT adults are photosensitive and leave the soil to re-colonize plants. Thus, the pots were enclosed with another pot of the same size, whose bottom was cut and covered with a petri dish. The inner surface of the petri dish was painted with insect