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Interactions of plant resistance and insecticides on the development and survival of *Bactericerca cockerelli* [Sulc] (Homoptera: Psyllidae)

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Abstract

Relatively few studies have investigated potential interactions of host plant resistance and insecticides for insect control. To examine possible interactions, host plant resistance was measured independently for four tomato cultivars and one wild tomato accession against tomato psyllids, *Bactericerca* [*Paratrioza*] *cockerelli* [Sulc] (Homoptera: Psyllidae). Plant lines tested included the commercial cultivars ‘Shady Lady’, ‘Yellow Pear’, ‘7718 VFN’, ‘QualiT 21’ and the plant accession PI 134417. Cultivars showed variable resistance; PI 134417 was the most resistant line tested with significantly reduced developmental rates and survivorship. Insecticides tested against the commercial cultivars included a kaolin-based particle film, pymetrozine, pyriproxyfen, spinosad and imidacloprid. Although all chemicals significantly reduced egg–adult survivorship, the effectiveness of some insecticides varied between-plant lines as measured by survivorship, development time and growth index (GI) data, which indicated significant interactions between-plant lines and insecticides. For example, survivorship from egg to adult varied significantly between cultivars under pymetrozine treatment. For kaolin-based particle film applications, numbers of days required to reach the adult stage were significantly different between cultivars. GI values were also variable between cultivars for pymetrozine and spinosad. Although all chemicals tested had potential for psyllid control within an integrated pest management program, imidacloprid and pyriproxyfen worked consistently well on all cultivars tested. For the other chemicals, cultivar selection could influence pesticide efficacy.

Keywords: *Bactericerca* [*paratrioza*] *cockerelli*; Pymetrozine; Kaolin-based particle film; Pyriproxyfen; Spinosad; Imidacloprid; Plant resistance

1. Introduction

Interactions between-plant lines and pesticides can complicate pest control. Unique cultivar characteristics such as days to harvest expose some cultivars to higher insect densities, resulting in substantially greater crop damage (Story et al., 1983; Gonzalez and Wyman, 1991). Allelochemicals that induce production of enzymes in insects can increase tolerance to pesticides (Kennedy, 1984; Brewer et al., 1995). In addition, biological control agents may be affected by plant surface features (van Lenteren et al., 1995) or by allelochemical content of some plant lines (Barbour et al., 1993; Braman and Joyce, 2002). Other studies have demonstrated that plant developmental stage can affect pesticide resistance in insects (Attah and van Emden, 1993), and that the architecture of crop canopies impacts coverage of foliar applications (Cooley and Lerner, 1994). Abro and Wright (1989) demonstrated that feeding rates (and thereby pesticide ingestion) could vary with plant line such that resistant lines reduced pesticide intoxication. In contrast, resistant plant lines also have negative effects on insect body size and vigor, leading to stress that can increase the effectiveness of pesticides (Eigenbrode and Trumble, 1994; van den Berg et al., 1994). Therefore, integrating plant resistance into integrated pest management (IPM) programs may not always be a simple process.

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An IPM program is needed for the psyllid (*Bactericerca* [*Paratrioza*] *cockerelli* [Sulc]) (Homoptera: Psyllidae) on tomatoes in Mexico and California. This insect recently developed high densities on fresh market tomatoes in Baja, Mexico resulting in losses of up to 85% of mature plants (Liu and Trumble, 2004). In California, substantial losses have occurred in southern and central California (John T. Trumble, pers. ob.). Until recently, sustainable, low input IPM strategies for tomato production in California's $350 million tomato industry were widely adopted. Pesticide use on tomatoes declined by nearly 50% from the late 1980s to the late 1990s (California Department of Food and Agriculture, 1989, 1997). Unfortunately, these recent gains have been jeopardized by the development of large densities of the tomato psyllid.

Tomato psyllid nymphs and adults cause damage by injecting a toxin. In extreme cases, plant death can occur (Pletsch, 1947). However, a more common effect is plant stunting that results in little or no production of commercial grade fruit (Al-Jabar, 1999). Because the psyllid develops rapidly (less than 2 weeks) and can oviposit in excess of 1400 eggs/female, populations build explosively (Knowlton and James, 1931). Not surprisingly, the initial grower response has been to spray pesticides. The effects have been problematic because common broad-spectrum carbamates increase psyllid densities (Cranshaw, 1985, 1989). Other pesticides registered in California on fresh market tomatoes such as fenvalerate, esfenvalerate, endosulfan, methamidophos and phorate have been shown to reduce densities of biological control agents, resulting in outbreaks of secondary pests such as *Liriomyza* leafminers and spider mites (Trumble, 1990, 1998). The resulting pesticide use pattern is threatening to eliminate current IPM programs in tomatoes and may promote rapid development of insecticide resistance. Thus, an IPM strategy is required that is based on alternatives to broad-spectrum insecticides.

In a previous study, the behavioral responses of tomato psyllids were compared in response to five biorational chemicals and five tomato plant lines (Liu and Trumble, 2004). Psyllid behavioral responses were variable across plant lines, between chemical treatments within a plant line, and an interaction was detected between-plant lines and some insecticides. These results were useful, but information on development and survival of the psyllid in response to plant lines, insecticides and their possible interactions was necessary before an IPM program could be created. Therefore, the primary goals of this study were to (1) evaluate psyllid development and survival on selected tomato lines, (2) measure survival and development with exposure to selected insecticides that do not disrupt our existing IPM program, and (3) to document any potential interactions between-plant lines and pesticides.

2. Materials and methods

2.1. Insects

Adults collected from fresh market tomatoes in Orange County in December 2002 and August 2003 were used to establish a laboratory colony. The colony was maintained at 25 ± 1 °C, and a photoperiod of 14:10 (L:D). Host plants were potatoes (*Solanum tuberosum*, VanZyverden Russett, Meridian, MS). A plant genus other than *Lycopersicon* was chosen as the rearing host because Tavormina (1982) and Via (1984a, b) demonstrated that some insect species developed a preference for the host species from which they had been reared. Adults used in all tests were standardized by selection of insects with teneral coloration (light or pale green) indicating that they had emerged within the previous 2–3 d. Because oviposition does not occur within the first 3 d (Knowlton and James, 1931), selection of 2–3-d-old adults eliminated problems with oviposition status variability. Nymphal instar determination was made based on the maximum body width of the 1st–5th nymphal instar (0.2, 0.3, 0.5, 0.7 and 1.1 mm, respectively), and the development of wing pads (Rowe and Knowlton, 1935; Pletsch, 1947).

2.2. Plants

Tomato plants used in all tests were grown in 15-cm diameter pots with UC mix (Matkin and Chandler, 1957) and fertilized three times weekly with the label rate of Miracle Gro nutrient solution (Scotts Company, Ohio, USA). All plants used were between 1 and 2 months of age with 5–10 fully expanded leaves, at the developmental stage achieved approximately 1 week after transplanting in the field. Although damage can occur at any time, young plants are particularly susceptible (Carter, 1950). Plants of different cultivars with similar size and vigor were used for all replications. Plant leaves used as substrates for oviposition were standardized by selecting the upper-most fully expanded leaf.

Five tomato lines were tested, including four cultivars of *Lycopersicon esculentum* Mill. (Petoseed '7718 VFN', Petoseed 'Yellow Pear', Rogers 'QualiT 21' and Sunseeds 'Shady Lady'), and a *Lycopersicon hirsutum f. glabratum* accession, PI 134417. The 'Yellow Pear' cultivar is a variety commonly planted by consumers. The cultivars 'QualiT 21' and 'Shady Lady' are widely used commercial varieties in California, while Petoseed '7718 VFN' is an older commercial variety known to be susceptible to many insect pests (Eigenbrode et al., 1993). PI 134417 is a wild-type accession with considerable insect resistance that has been studied extensively (Farrar and Kennedy, 1992; Eigenbrode and Trumble, 1993). The line PI 134417 was not included in any