Current Status of The Greenhouse Whitefly Susceptibility to Neonicotinoid and Conventional Insecticides on Strawberries in Southern California

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Introduction

Ventura/Oxnard is a year-round intensive horticultural production area with multi-crop system in coastal southern California. Economically important crops produced in the area include strawberry, pepper, tomato, celery, cucumber, lettuce, cut flowers and citrus with strawberries predominating. Since 1998, the greenhouse whitefly, *Trialeurodes vaporariorum* Westwood (Homoptera: Aleyrodidae), has emerged as a major insect pest of these crops in the area. High populations of this pest stunt plants, decrease quality of crop products and transfer virus diseases. Control of this pest in the area has been heavily dependent upon chemical insecticides.

Neonicotinoids such as imidacloprid and thiamethoxam were registered on several crops in the area to control the greenhouse whitefly soon after its outbreak in 1998. Conventional insecticide classes such as chlorinated hydrocarbon, organophosphate, carbamate and pyrethroid are still being used for controlling several insect pests on various crops in Ventura/Oxnard area. At present, these insecticides are only recommended for limited use in rotation with neonicotinoids and/or insect growth regulators to control whiteflies. Extensive reliance on chemical insecticides for whitefly control has resulted in whitefly resistance to almost all major classes of conventional insecticides throughout the world. Resistance monitoring can be an effective component of a resistance management program and detection of changes in resistance/susceptibility can facilitate use of alternative control measures. The objective of this study was to determine the status of the greenhouse whitefly susceptibility to neonicotinoid and conventional insecticides on strawberries in southern California.

Materials and Methods

Strawberry bare-root seedlings were planted in pots in environmental growth chambers. For bioassay tests, adult whiteflies were collected from commercial strawberry crop from October 2004 to May 2005 and immatures were directly developed from eggs laid by these adults. The following neonicotinoid and conventional insecticides were used: imidacloprid (Admire 2F and Provado 1.6F), thiamethoxam (Platinum 2S and Actara 25WG), acetamiprid (Assail 70W) and dinotefuran (Venom 20SG), chlorpyrifos (Lorsban 4E), methomyl (Lannate 1.8L), bifenthrin (Brigade 10WP), fenpropathrin (Danitol 2.4EC), endosulfan (Thiodan 3EC) and malathion (Malathion 50 Plus). Each of these insecticides was diluted in deionized water and at least 6 concentrations were used to produce a range of 5-90% mortality.

The required quantities of soil-formulated compounds were diluted in 200 ml of deionized water and then poured into each pot. At 24 h after the application, 30 greenhouse whitefly adults were clip-caged on the lower side of a leaflet of the most-recently fully-expanded trifoliate. Adult mortality was assessed at 72 h after initial exposure. For immature greenhouse whitefly bioassay, 40 adults were clip-caged on an above-described leaflet. After an oviposition period of 24 h, the adults were removed. The infested plants were treated with the 200 ml of soil-formulated insecticide solution when the first and third instar nymphs were respectively reached. The immature mortality was determined at 10 d post-treatment. For foliar treatments, leaflets of strawberry plants were sprayed until run-off, with a specific amount of foliar-formulated insecticides dissolved in deionized water. After the leaf surface was dried, 30 greenhouse whitefly adults were clip-caged on the lower side of a leaflet of the most-recently fully-expanded trifoliate. Adult mortality was determined at 72 h after initial exposure. Second instar nymphs on leaflets were also sprayed and their mortality was determined at 10 d post-treatment.

Results

LD_{50s} of soil-applied imidacloprid, thiamethoxam and dinotefuran were 8.7-, 3.2- and 4.9 -fold higher for the adults, 1.8-, 1.2- and 1.5-fold higher for the first instar nymphs, and 89.4-, 390.3- and 10.4-fold higher for the third instar nymphs, respectively, than their top label rates (Figures 1, 2 and 3). LC_{50s} of foliar-applied imidacloprid, thiamethoxam and acetamiprid were 6.1-, 6.0-, 1.7-fold higher for the adults, 3.8-, 8.7-, and 4.4-fold higher for the second instar nymphs, respectively, than their top label rates (Figures 4 and 5). For the adults, LC_{90s} of endosulfan, malathion, methomyl, bifenthrin, and fenpropathrin were 2.2-, 1.2-, 1.9-, 2.3- and 4.9-fold lower than their respective top label rates (Figure 6). Chlorpyrifos was not very effective against the adults as indicated by its LC_{90} being 120% higher than its top label rate (Figure 6).

Conclusions

Soil-applied neonicotinoids are effective against the whitefly early instar crawlers and not effective against adults and older nymphs. Whiteflies are much more tolerant to imidacloprid than they were 5 years ago, suggesting that the whiteflies have developed a measure of resistance to this insecticide. Foliar-applied neonicotinoids are not effective against either adult or immature whiteflies. Adult greenhouse whiteflies are very susceptible to most of the conventional insecticides.

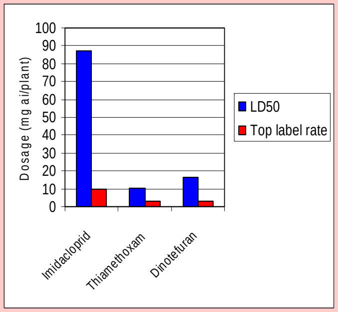

Figure 1. Susceptibility of adult greenhouse whiteflies to soil applied neonicotinoids

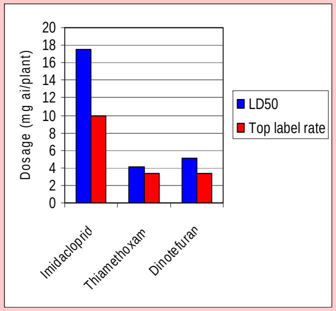

Figure 2. Susceptibility of first instar greenhouse whiteflies to soil-applied neonicotinoids

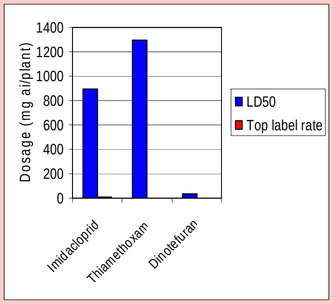

Figure 3. Susceptibility of third instar greenhouse whiteflies to soil-applied neonicotinoids

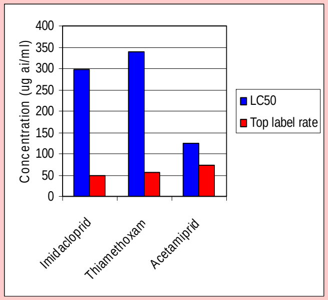

Figure 4. Susceptibility of adult greenhouse whiteflies to foliar-applied neonicotinoids

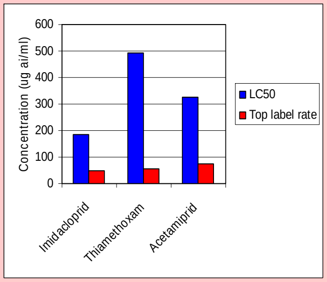

Figure 5. Susceptibility of second instar greenhouse whiteflies to foliar-applied neonicotinoids

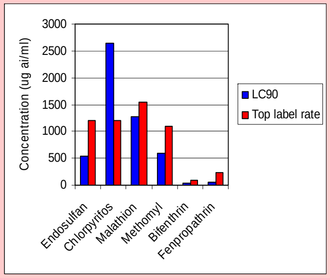

Figure 6. Susceptibility of adult greenhouse whiteflies to conventional insecticides