N O T E

Thrips (Thysanoptera: Thripidae) Feeding Response to Concentration of Imidacloprid in Tomato Leaf Tissue[1]

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Thrips have become primary pests in many horticultural crops, particularly as vectors of *Tospoviruses* (Ullman et al. 1997. Pages 539-565 *In* T. Lewis (ed.), Thrips as Crop Pests, CAB International). They penetrate their stylets through upper plant cells and feed on materials from fractured cells. Thrips feeding alone can cause reduction in maturity and yield when plants are infected with high populations. When a plant virus is present in the crop system, thrips can transmit plant viruses either propagatively, requiring incubation inside the vector's body, or non-propagatively. *Tomato spotted wilt virus* (TSWV) is a propagative virus transmitted by several thrips species. TSWV has been particularly devastating in tomato and pepper in Georgia (Gitaitis et al. 1998. Plant Dis. 82: 752-756, Riley and Pappu 2000. Plant Dis. 84: 847-852). In tomato plants in the southeastern United States, the vector species are mainly *Frankliniella occidentalis* (Pergande) and *F. fusca* (Hinds) (Salguero Navas et al. 1991. J. Econ. Entomol. 84: 1818-1822). Thrips acquire TSWV during their first and second instars by feeding on TSWV-infected tissue, and they remain infective throughout their lives (Van de Wetering et al. 1996. Phytopath. 86: 900-905). Adult *F. occidentalis* do not acquire TSWV because of a midgut barrier (Ullman et al. 1992. Phytopath. 82: 1333-1342), but viruses are retained in saliva tissue and can be transmitted to healthy plant tissue during feeding.

Foliar insecticides are effective for the control of thrips in certain vegetable crops (Sparks et al. 1998, Subtrop. Plant Sci. 50: 58-62). However, to prevent TSWV transmission by thrips vectors, insecticides have to be applied frequently and have to possess rapid efficacy to kill the viruliferous thrips before inoculation can occur. A systemic insecticide, imidacloprid (1-[(6-chloro-3-pyridinyl)methyl]-N-nitro-2-imidazolidinimine) under trade names Admire® and Provado® (Bayer Corp., Kansas City, KS), has been reported to be effective in reducing incidence of TSWV in some crops such as tomato and pepper (D. Rogers, Bayer Corp., pers. commun.) but can increase incidence in peanut (J. Todd, Univ. Georgia, pers. commun.) when used as a soil drench. This chemical could prevent TSWV infection by suppressing viral expression in plant cells or inhibiting the transmission of TSWV by killing thrips or by

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deterring thrips from feeding on plant tissue. Because plants treated with imidacloprid have been observed to be infected with TSWV by mechanical inoculation (Chaisuekul, unpubl. data), and mortality of thrips with imidacloprid is low (D. Riley, unpubl. data), we suspected that imidacloprid is affecting thrips feeding behavior rather than affecting the virus or thrips mortality.

Recently, soil application of imidacloprid plus various foliar insecticide treatments reduced infection of TSWV in tomato (Riley and Pappu 2000. Plant Dis. 84: 847-852), presumably affecting the thrips vector population. Viruliferous thrips were either reduced in numbers, deterred from feeding, or were unsuccessful in the transmission of virus. Our study investigated the effect of imidacloprid on feeding behavior of thrips in tomato plants by comparing feeding response (number of feeding scars) to concentration of imidacloprid in the leaf tissue. The null hypothesis was that feeding response was not affected by concentration of imidacloprid.

In an experiment conducted in the summer of 1999 at Tifton, GA, various concentrations of imidacloprid (Admire 2F®, Bayer Corp., Kansas City, KS) were applied to 4-wk-old potted tomato plants, cv. 'Sunny Hybrid' (Asgrow Seed Co., Kalamazoo, MI). One control and five rates of Admire were applied to the top of the soil in pots (15.24 cm diam) as a soil drench. The applied rates of Admire 2F were 0.0 µl, 2.17 µl, 3.26 µl, 4.35 µl, 8.69 µl, and 17.39 µl per plant. Each rate was applied in 100 mls of water.

Formulated Admire 2F, according to the treatment rate, was first measured in µl for all 6 pots using a micropipette in 600 ml water. Then the mixtures were stirred, and 100 ml was poured around the base of each tomato plant. These tomato plants later were transferred to a screened, thrips-exclusion cage in greenhouse. These plants were watered by drip tube irrigation, programmed for 20 min every other day.

Two weeks after the imidacloprid treatment, leaf samples taken from the fourth branch from the terminal bud were collected and sent to a pesticide analysis lab (Pesticide and Hazardous Waste Laboratory, Univ. Georgia, Athens) to measure imidacloprid residue in the leaf tissue. Thrips, primarily *F. occidentalis*, were collected from cotton blossoms and caged for 72 h in microcages clipped on the upper side of lowest leaves from the branch above the leaf taken for residual analysis. The microcage was made from a hair clip attached with hot glue to a plastic cap cut from 2.0 cm head of a plastic transfer pipette (Samco® transfer pipets #202, Samco Scientific Corp., San Fernando, CA). This microcage produces a circular feeding area of 1.5 cm diam on a leaf. After 72 h, thrips were removed from microcages and placed into 50% ethyl alcohol for identification. The thrips condition was categorized as either not present in the microcage after 72 h, present in the microcage and alive, or present in the microcage but dead. The circular areas on the tomato leaves were examined for feeding scars and recorded by digital camera for image analysis. After the first 72 h, new thrips were placed in the microcages on the next lowest leaves on the third branch, and the previous procedure was repeated. Five feeding tests were performed from 13 July to 2 August 1999.

The feeding scars were the areas on leaves showing feeding damage from thrips, usually 1 mm wide by 1 to 3 mm long section of damaged leaf cells. The damaged tissue could be categorized into white feeding scar areas (dry leaf tissue resulting from older thrips feeding) and black or dark feeding scar areas (wet leaf tissue from recent thrips feeding, less than 24 h). In either category, thrips feeding scars were eliminated at the highest concentration of imidacloprid used in this test. The null hypothesis of no effect on feeding response by imidacloprid was disproved with the data collected in this test.

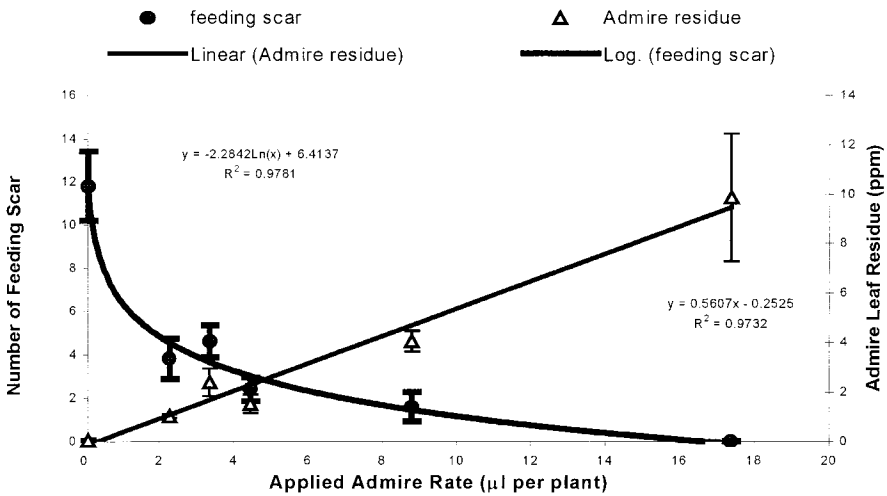

Fig. 1. Average feeding scars per 6 thrips per 10.6 cm^2 to applied Admire® rate (µl per plant) and Admire® leaf residue (ppm).

The results presented in Fig. 1 show that increased Admire soil drench concentration (µl per 100 ml water per pot) increased the amount of Admire in the leaf tissue (ppm), R^2 = 0.97 and P = 0.0003 (ANOVA). High variation in the highest rate of Admire in our study could be caused by greater variability in leaching of applied Admire. In Fig. 1, the results also show that the number of thrips feeding scars on tomato leaves negatively corresponded to the applied rates of Admire® and the amount of imidacloprid leaf residue. These data clearly demonstrate a reduction of thrips feeding, R^2 = 0.98 (natural logarithm transformation of applied Admire rate plus 0.1 µl) and P = 0.0002 (ANOVA), with increasing levels of imidacloprid, which increases in the leaf tissue as greater amounts were applied to the soil. It was clear from these observations that imidacloprid has an anti-feeding effect on thrips, even at concentrations lower than label recommendations. The critical rate of imidacloprid that provides anti-feeding activity on thrips will be studied further. Imidacloprid could interfere with thrips transmission of TSWV by means of inhibiting thrips feeding. We suspect that with the right insecticide program in addition to applications of imidacloprid to the soil, the incidence of TSWV infection could be reduced in tomato.