Resistance to Western Flower Thrips Feeding Damage in Impatiens Populations from Costa Rica

Daniel F. Warnock
Department of Natural Resources and Environmental Sciences, 1201 S. Dorner Drive, University of Illinois at Urbana–Champaign, Urbana, IL 61801

Abstract. Western flower thrips (WFT) [Frankliniella occidentalis (Pergande)] is a pest of greenhouse-grown floriculture crops worldwide. To determine if plant resistance varied within a species, 59 genotypes of Impatiens wallerana were screened for the presence of resistance to feeding damage caused by WFT in Costa Rica, 59 genotypes were evaluated for resistance to feeding by WFT. Individual insect-free plants of each genotype were inoculated with 20 laboratory-reared WFT. Thrps were allowed to feed on individual plants for a 4-week period followed by visual evaluations to estimate feeding damage. Feeding damage varied among genotypes. Thirty-seven genotypes had feeding damage levels similar to the susceptible control, while 22 entries were significantly more resistant than the susceptible control. Of the 22 genotypes with some level of resistance, six genotypes were commercially acceptable, having mean visual ratings below 4.0 on a 1 to 9 evaluation scale. Five of these six genotypes were seedlings from a single population and represented 13.9% of the seedlings in that population. The remaining seedling was from a second San Vito population. The plants in these populations identified as having acceptable levels of damage may be useful in a breeding program designed to enhance resistance to WFT feeding damage. Because WFT feeding damage varied among genotypes, the potential for improving impatiens resistance to WFT exists within available germplasm.

Western flower thrips (WFT) is an opportunistic insect pest in commercial greenhouses worldwide (Mound and Teulon, 1995). Western flower thrips is a species of pest that inflicts economic damage and vectoring tomato spotted wilt virus (TSWV) and impatiens necrotic spot virus (INSV) in many crops (Parrella and Jones, 1995). Host plant resistance breeding, a component of IPM, is the first step toward broadening the identification and development of germplasm with improved resistance to feeding damage. As a means of broadening available resistance genes, crop producers rely on insecticides for control. However, insecticides are expensive (screening) and not effective for control (biological controls). Additional pest management options in IPM programs are needed.

Seed were collected from three naturally infected impatiens populations in Costa Rica. The first step toward finding wild-type populations was to determine the level of host plant resistance to feeding by WFT in seedlings from three naturally infected populations. The objective of this study was to identify all possible resistance mechanisms associated with resistance can represent a broad array of chemical classes, but are likely to be similar to the secondary metabolites found in chrysanthemums (de Jager et al., 1995). Additional germplasm resources are needed to identify all possible resistance mechanisms in impatiens. Recent acquisitions of wild-type impatiens populations provide researchers with the opportunity to broaden available resistance mechanisms. The development of impatiens populations and elite breeding lines with resistance to feeding by WFT is desirable. Evaluation of impatiens populations is the first step toward finding wild-type populations. Identification and development of germplasm with improved levels of resistance to feeding damage. As a means of broadening available resistance genes, crop producers rely on insecticides for control. However, insecticides are expensive (screening) and not effective for control (biological controls). Additional pest management options in IPM programs are needed.

Received for publication 11 Oct. 2002. Accepted for publication 6 June 2003. This research was supported in part by funds from USDA CRIS Hatch Project ILLU-63-0308. The author gratefully acknowledges Pan-American Seed Co. for the donation of impatiens seed.

1 Assistant Professor.
Seeds from the three populations were sown on 1 May 2000 in 806 cell-packs (48 cells per flat 0.125-L cell) containing Universal Germination Mix (Strong-Lite Corp., Longview, Texas) and were germinated under intermittent mist and natural light levels at temperatures ranging from 21 to 24 °C. Individual seedlings were transplanted from plug flats into 12.7-cm (1.2-L) plastic pots filled with a soilless media (Strong-Lite Universal Mix, Seneca, Ill.) on 15 June 2000. Standard cultural practices, including growing the plants in a glass greenhouse (81.2 m²) with temperatures set at 19 to 20 °C night/24 to 29 °C day under natural light, were followed (Corr, 1998). Plants were fertilized with 200 mg·L⁻¹ nitrogen solution in a constant liquid feed program with 20N–4.4P–16.6K (Nutriculture, Plant Marvel Laboratories, Chicago Heights, Ill.).

Due to poor germination and weak plants upon emergence, only 58 seedlings were acceptable for use in the current experiment (Table 1). One additional impatiens seedling from population one was identified as highly susceptible to WFT feeding in a preliminary experiment seeded on 15 Mar. 2000 and completed on 30 June 2000 (data not presented). Previous research identified commercial cultivars with varying levels of resistance (Herrin and Warnock, 2002), but the phenotype of commercial cultivars is completely different from the wild-type phenotypes in this experiment. Because resistance to feeding by WFT may be influenced by phenotype, and WFT aggressiveness may vary with season, the previously evaluated seedling from population one, listed as genotype number 58 in Table 1, was added as a susceptible wild-type control. This control served to indicate that WFT feeding aggressiveness was maintained and as a bottom line standard for susceptibility to which the seedlings in this experiment were compared. Population one, two, or three was represented by 36, 17, or 6 plants, respectively. Plants were treated as individual genotypes in the experiment without regard to the population from which they originated.

To obtain plant uniformity in regard to vegetative and floral maturity, eight terminal cuttings from each seedling (genotype) were taken on 31 July 2000, dipped in 0.3% indolebutyric acid (IBA) rooting powder (Hormex #3, Brooker Chemical, North Hollywood, Calif.), inserted in Oasis (Smithers-Oasis, Kent, Ohio) rooting blocks, and placed under the previously described growing conditions. Cuttings were removed from intermittent mist on 24 Aug. 2002, graded for size uniformity within genotype, and four rooted cuttings from each genotype were transplanted into 12.7-cm (1.2-L) pots as previously described. Thus, each of the 59 genotypes was represented by four single-plant replications of uniform maturity and size for a total of 236 plants in the experiment. Immediately after transplanting, each plant was placed in a completely randomized design and covered with a vented Vivak® isolation cage (62 cm high and 12-cm diameter with 135-μm thrips screening (Greenthrum Group, Downer’s Grove, Ill.) covering vents) to keep plants free of insects until inoculation with WFT. Due to a limited number of WFT, each plant was inoculated with 20 laboratory-reared adult WFT on 7 Sept. 2000, a deviation from the 30 WFT used in previous evaluations (Herrin and Warnock, 2002). Both 25 and 30 WFT per plant represent extremely high WFT population levels when compared to a loosely accepted commercial level of 2 WFT per plant in some WFT-tolerant crops and 0 WFT per plant in crops highly susceptible to feeding damage and INSV (Dreistadt, 2001). Four weeks after inoculation, the amount of WFT feeding damage on each plant was visually assessed using a 1 to 9 scale based on the number of leaves on each plant expressing damage (Herrin and Warnock, 2002). Each plant had >35 leaves, flower buds, and open flowers when evaluated. During the 4-week period of exposure to WFT, six plants in the experiment died due to fungal or bacterial pathogens and could not be evaluated for WFT feeding damage (Table 2). Thus, six genotypes had missing data points, leaving a data set of 230 plants for analysis. Data were transformed for proper statistical analysis by taking the square root of estimated visual damage (Little and Hills, 1978). Transformed data were analyzed using the GLM procedure and Fisher’s protected least significant difference test of the SAS System for Windows (SAS Institute, Cary, N.C.).

Results and Discussion

Genotype 58, the susceptible control, expressed a high level of feeding damage (Table 1). This indicates that the WFT colony aggressiveness was high and that genotypes of the three wild-type populations with similar ratings can be considered susceptible to feeding by WFT.

The amount of WFT feeding damage varied by genotype (df = 58, MS = 0.378, F = 2.45, P < 0.001) but not replication (df = 3, MS = 0.281, F = 1.82, P = 0.1452). As each genotype was an individual entry in the experiment, the impact of plant population on WFT feeding was not discernible with the analysis. The overall mean visual rating of feeding damage was 6.2, but ratings ranged...
from a high of 8.75 for genotypes 29 and 58, to a low of 2.75 for genotype 19 (Table 1). Most genotypes had damage that would be considered commercially unacceptable, having >10 damaged leaves (visual ratings >4.0) per plant (Herrin and Warnock, 2002). A rating >4.0 is considered commercially unacceptable, based on consumer preference for an unblemished product and standards for evaluating floral crop quality (Ferris, 1998). Thirty-seven genotypes had feeding damage levels similar to genotype 58, the highly susceptible control (Table 1). Of the 22 entries that were significantly more resistant than the highly susceptible control, genotypes numbered 6, 14, 18, 19, 20, and 46 were commercially acceptable, having mean visual ratings below 4.0 (Table 1). These six genotypes, with the exception of genotype 46 that was derived from population two, were from population one (Table 1). Thus, 13.9% of the genotypes derived from population one had acceptable levels of feeding damage by WFT while 5.9% of the plants from population two were acceptable. The plants identified in these populations as having acceptable damage levels may be useful in a breeding program as a source of resistance traits likely unavailable in commercial cultivars.

Of the 22 entries that were significantly more resistant than the highly susceptible control, nine were not significantly different from genotype 19, the most resistant genotype in this experiment, and visual ratings ranged from 2.75 to 4.75 (Table 1). The broad range may be attributed to the visual rating scale. Breeders must decide between slow, precise evaluation methods and faster evaluation methods with larger sampling errors, which may be attributed to the visual rating scale. The mechanism(s) of resistance in the San Vito populations and the commercial cultivars are unknown but may include factors that are chemical, physical, or both. Observations during data collection and plant breeding activities indicate that impatiens genotypes with little pollen shed are less attractive to WFT than good pollen producers (Warnock, personal observation). Chemical resistance factors exist in chrysanthemum (de Jager et al., 1995), and similar components in impatiens may explain the reduced level of physical damage expressed by some cultivars. In addition, resistance factors in the San Vito populations may be unique, thereby allowing gene pyramiding to enhance resistance to WFT feeding beyond the currently detected level. Populations containing various resistance factors should be crossed with plants selected from the San Vito populations with the greatest resistance to feeding by WFT. Subsequent offspring may then be selected for desirable phenotypes and resistance.

Conclusions

The amount of WFT feeding damage varied among impatiens genotypes derived from seed obtained from open pollinated plants of the San Vito, Costa Rica, area. This suggests that resistance factors to WFT feeding exist in impatiens germplasm and that resistance to WFT feeding damage may be improved through breeding and selection. Before plants from the San Vito populations are commercially acceptable, phenotypes must be selected that meet industry standards. When combined with other IPM, host plant resistance adds to options available to producers for managing damage caused by western flower thrips without the risks associated with increased insecticide usage.

Literature Cited


