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Resistance of Bedding Plants to Twospotted Spider Mite and Sweetpotato Whitefly

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ABSTRACT

Variation in resistance to twospotted spider mite (*Tetranychus urticae* Koch) and sweetpotato whitefly [*Bemisia tabaci* (Gennadius)] were studied in impatiens, marigold, petunia and vinca (periwinkle) bedding plants. Adult female mites placed on leaf disks in petri dishes were allowed to feed and oviposit. After 48 or 72 hours, the eggs were counted and significant (ca. 3-fold) differences among individual plant cultivars were found. In the whitefly bioassay, plant cultivars were randomly placed in large cages within a greenhouse and infested with adult whiteflies. Four weekly samples taken two weeks after infestation detected up to an 8-fold difference in egg and nymph populations among plant cultivars. The development of host plant resistance as an arthropod management strategy is discussed.

RESUMEN

Se estudió la variación en la resistencia a la arañuela de dos manchas (*Tetranychus urticae* Koch) y a la mosca blanca del camote {*Bemisia tabaci* (Gennadius)} en plantas de cama de *Impatients wallerana, Petunia X hybrida, Tagetes patula,* y *Cantharanthus roseus.* A arañuelas hembras adultas colocadas sobre discos de hojas dentro de cajas petri se les permitió alimentarse y ovopositar. Después de 48 a 72 horas, los huevos fueron contados y se encontraron diferencias significativas (alrededor del triple) entre los distintos cultivares. En el experimento realizado para la mosca blanca, los cultivares fueron arreglados aleatoriamente en jaulas grades dentro de un invernadero y fueron infestados con moscas blancas adultas. Cuatro muestreos semanales tomados 2 semanas después de la infestación detectaron una diferencia de hasta ocho veces en las poblaciones de ninfas y huevos entre los cultivares. El desarrollo de resistencia en la planta hospedera como estrategia para el manejo de artrópodos es discutida.

The U.S. bedding plant industry produced $867 million wholesale based on nearly 472 million flats in 1989 (USDA 1990). The industry continues to grow due to strong consumer demand and a wide market base. Bedding plant production is distributed across the nation, and in the top ten bedding plant production states, 10 to 66% of the reported floriculture value is in bedding plants (Tayama et al. 1989).

Arthropod pests pose a serious problem to bedding plant production by affecting both plant yield and quality. For instance, spider mites feed on plant sap, aphids and whiteflies deposit honeydew, and aphids, whiteflies, and thrips may transmit viruses. Traditionally, arthropod management strategies in commercial bedding plant production included cultural (sanitation) and chemical (insecticides and miticides) components. However, other integrated pest management (IPM) approaches, such as host plant resistance and biological control are now being studied and used in greenhouse and ornamental plant production (Heinz & Parrella 1990, Breene et al. 1992). Two important arthropod pests of bedding plants are twospotted spider mite, *Tetranychus urticae* Koch, and sweetpotato whitefly, *Bemisia tabaci* (Gennadius).

Host plant resistance research determines the variability in arthropod response to plant species, varieties, or hybrids. This research is followed generally by the breeding and development of resistant varieties, and determination of the mechanisms of resistance [antibiosis (adverse effects by plant on arthropod's biology), antixenosis (avoidance of plant), or plant tolerance (ability of plant to withstand infestation)].

Plant resistance to spider mites may be related either to physical leaf attributes such as pubescence (hairiness), trichomes, or other characteristics (Kishaba et al. 1972, Paiva & Janick 1980, Weston et al. 1989), or biochemically-based host-arthropod interactions that affect mite feeding and fecundity (Elliger & Waiss 1991, Hesk et al. 1991, Soans et al. 1973). Studies with New Guinea *Impatiens* species and hybrids showed variability in twospotted spider mite feeding. The controlling factors affecting resistance, perhaps associated with leaf cuticle content, were found to possibly be polygenic and dominant (Al-Abbasi & Weigle 1982, Al-Abbasi et al. 1987)

Plant resistance studies with sweetpotato whitefly have determined that plants with higher leaf pubescence (Butler & Henneberry 1984, Butler et al. 1991) or lower biochemical constituents such as tannins and phenolics (Butter et al. 1992) had higher whitefly populations. Factors that affect variability to greenhouse whitefly attack in poinsettia were shown to include both physical and biochemical characteristics (Bilderback & Mattson 1977), but variability in attack of sweetpotato whitefly in bedding plants has not been documented.

This study determined the relative susceptibility (attractiveness and suitability) of impatiens (*Impatiens wallerana* L.), petunia (*Petunia X hybrida*), french marigold (*Tagetes patula* L.) and vinca (*Cantharanthus roseus* L.) cultivars to twospotted spider mite and sweetpotato whitefly attack using both laboratory and greenhouse screening techniques.

MATERIALS AND METHODS

Plants. All cultivars or hybrids were planted in bedding trays and transferred to 10.2 cm pots when they were 3 to 4 weeks old. Standard media (Sunshine Mix #5 Plug, Fisons Horticulture Inc., Vancouver, B. C. Canada), fertilizer (Nutrileaf 20-20-20, N-P_2O_5-K_2O) and watering practices were used, and plants were grown in a greenhouse (fan and cooling pad design, under 73% shadecloth).

Spider Mites. Ovipositional preference was evaluated in the laboratory using 2 cm diameter mature leaf disks or small leaves (leaf area = 3.14 cm^2) placed on 100mm petri dishes filled with a 2% agar medium. Five adult female mites each from stock culture plants (lima beans, *Phaseolus lunatus* L.) were placed on seven leaf disks per petri dish and were allowed to feed and oviposit. Mite eggs were counted either 48 (impatiens, marigold and petunia) or 72 hours (vinca) later. A total of five (impatiens, marigold and petunia) or six (vinca) petri dishes (replicates) per bedding plant were used, and egg counts from the seven leaf disks were combined to produce one mean per replicate. Data

Table 1. Eggs oviposited per mite on several bedding plant cultivars in the ovipositional petri dish experiments.

	BedddingPlant	Eggs per Mite[z]
Impatiens		
	Fantasia Fushsia	3.5 ± 0.9 a
	Twinkles Red	3.6 ± 0.9 a
	Dazzler Orange	4.3 ± 0.5 ab
	Showstopper Deep Orange	4.6 ± 0.5 ab
	Novette, Bright Orange	5.2 ± 0.5 ab
	Accent Orange	6.5 ± 0.8 b
	Blitz Rose	10.4 ± 1.5 c
Marigold		
	Golden Boy	8.0 ± 0.8 a
	Little Devil Flame	10.3 ± 1.1 a
	Hero Orange	10.5 ± 0.5 ab
	Aurora Fire	10.9 ± 2.1 abc
	Queen Mixture	13.6 ± 2.0 bcd
	Janie Tangerine	13.8 ± 0.5 cd
	Bonanza Bee	15.9 ± 0.5 d
	Early Spice Orange	16.2 ± 1.3 d
Petunia		
	Supercascade Pink	0.65 ± 0.08 a
	Midnight Madness	0.66 ± 0.18 ab
	Sugar Daddy	0.66 ± 0.29 ab
	Salmon Dreams	0.70 ± 0.11 ab
	Primetime Rose Star	0.77 ± 0.11 ab
	Plum Carpet	0.85 ± 0.24 ab
	Ultra Burgandy	1.05 ± 0.17 b
	Rose Picotee	1.48 ± 0.29 c
	Polo Salmon	2.05 ± 0.40 d
Vinca		
	Snow Carpet	12.3 ± 2.4 a
	Sahara Madness Pink	13.0 ± 1.6 ab
	Sahara Madness Bright Eye	13.3 ± 1.5 ab
	Peppermint Cooler	14.0 ± 2.2 abc
	Pretty in Rose	15.2 ± 2.1 abc
	Rose Carpet	15.3 ± 1.5 abc
	Pink Carpet	16.2 ± 2.3 abc
	Grape Cooler	16.2 ± 2.2 abc
	Pretty in Pink	16.4 ± 1.5 abc
	Dawn Carpet	16.6 ± 2.2 bc
	Parasol	16.9 ± 2.4 bc
	Pretty in White	17.9 ± 1.9 c

[z] Means ± SE followed by the same letter in each bedding plant experiment are not significantly different, Waller-Duncan k-ratio *t* test, k-ratio = 100 (P=0.05); impatiens df=24, t=2.03; marigold df=28, t=2.009; petunia df=32, t=1.908; vinca df = 55, t=2.513.

were analyzed as a randomized complete block with five or six replications using PROC ANOVA and means were seperated using the Waller-Duncan k-ratio *t* test at k-ratio = 100 (*P*=0.05) (SAS 1985).

Sweetpotato Whiteflies. Ovipositional preference and development was tested by randomly placing bedding plants in large cages [1.8 (h) • 1.8 (w) •2.4 (l) m] within a greenhouse (fan and cooling pad design, clear plastic covering, no shadecloth). The cages had contiguous wooden frames and were covered with white organdy cloth. Seams and joints of the cages were sealed with caulk to prevent arthropod escape. Separate cages contained five replicates of either marigold (8 x 5 = 40 plants), petunia (45 plants) or vinca (40 plants) cultivars. Whitefly-infested muskmelon, *Cucumis* sp., from stock cultures were placed in the test cages for 2-4 days to infest the bedding plants. Two weeks after infestation, four weekly samples were taken. One leaf (petunia or vinca) or three leaflets (marigold) per five plants (replicates) were randomly selected for sampling. Whitefly eggs and nymphs were counted from either a 3.14 cm^2 leaf area (petunia, vinca) or 1.15 cm^2 leaf area (marigold). Whitefly eggs and nymphs per plant sample were averaged across dates. Data were analyzed as a randomized complete block with five replications using PROC ANOVA and means were separated using the Waller-Duncan k-ratio t test at k-ratio = 100 (*P* = 0.05) (SAS 1985).

RESULTS

Spider Mites. The data in Table 1 provide a measure for a non-choice test for substrate suitability for oviposition. More mite eggs were found on 'Blitz Rose' than any other impatiens. 'Fantasia Fuchsia' and 'Twinkles Red' contained the fewest mite eggs (3.5 and 3.6 eggs per mite, respectively). The other cultivars produced intermediate numbers of eggs (4.3 to 6.5 eggs per mite). Mites on the marigolds 'Early Spice Orange' and 'Bonanza Bee' produced almost twice as many eggs as on 'Golden Boy'. The other cultivars had intermediate numbers (10.3 to 13.8 eggs per mite). On petunias, egg deposition averaged 2.1 or less on all cultivars. 'Supercascade Pink' contained the fewest eggs per mite, while 'Polo Salmon' contained the most (0.65 and 2.05, respectively). There were few differences among vinca cultivars, Snow Carpet contained fewer eggs than Dawn Carpet, Parasol or Pretty in White.

Sweetpotato Whiteflies. The data in Table 2 provide a measure of adult ovipositional preference and suitability for nymphal development in a choice situation. Generally, egg

Table 2. Sweetpotato whitefly eggs and immatures on several bedding plant cultivars in the greenhouse cage experiments.

Bedding Plant	Eggs/cm^{2z}	Nymphs/cm^{2z}
Marigold		
Golden Boy	10.8 ± 2.0 a	8.4 ± 1.4 a
Bonanza Bee	11.2 ± 2.7 a	9.0 ± 1.6 a
Hero Orange	12.0 ± 2.1 a	9.9 ± 1.2 a
Aurora Fire	14.3 ± 1.4 a	13.7 ± 0.7 a
Little Devil Flame	16.7 ± 4.9 a	12.8 ± 4.6 a
Early Spice Orange	17.7 ± 3.4 a	18.3 ± 2.0 a
Janie Tangerine	23.0 ± 4.8 a	15.3 ± 2.6 a
Queen Mixture Improved	76.5 ±24.9 b	35.4 ± 9.2 b
Petunia		
Supercascade Pink	1.2 ± 0.5 a	1.2 ± 0.5 a
Rose Picotee	2.0 ± 0.6 a	1.7 ± 0.8 a
Plum Carpet	2.2 ± 0.4 a	3.2 ± 1.2 a
Midnight Madness	2.3 ± 0.5 a	2.4 ± 0.6 a
Ultra Burgundy	2.6 ± 0.9 a	2.0 ± 0.4 a
Salmon Dreams	3.0 ± 1.3 a	1.9 ± 0.6 a
Primetime Rose Star	7.8 ± 2.4 b	8.7 ± 1.1 b
Sugar Daddy	8.1 ± 1.9 b	8.2 ± 2.1 b
Polo Salmon	9.3 ± 2.5 b	8.1 ± 1.9 b
Vinca		
Sahara Madness Pink	0.19 ± 0.05 a	0.30 ± 0.06 a
Sahara Madness Bright Eye	0.25 ± 0.20 ab	0.49 ± 0.17 a
Little Blanche	0.45 ± 0.14 abc	0.61 ± 0.08 a
Grape Cooler	0.53 ± 0.12 abc	0.62 ± 0.18 a
Parasol	0.67 ± 0.39 abc	0.61 ± 0.27 a
Dawn Carpet	0.88 ± 0.23 abc	0.96 ± 0.20 a
Polka Dot	0.92 ± 0.28 bc	0.80 ± 0.27 a
Little Pinkie	1.13 ± 0.18 c	1.26 ± 0.17 a

[z] Each mean± SE represents totals per plant sample. Means followed by the same letter in each bedding plant test are not significantly different, Waller-Duncan k-ratio t test, k-ratio = 100 (*P* = 0.05); marigold df = 28, eggs *t* = 2.054, nymphs t = 2.076; petunia df = 32, eggs *t* = 2.091, nymphs t = 1.983; vinca df = 28, eggs *t* = 2.427, nymphs *t* = 2.51.

populations were similar to nymph populations in the cage study. The marigold 'Queen Mixture Improved' had almost three times as many whitefly immatures (76.5 and 35.4 eggs and nymphs per cm^2) as all other marigold cultivars. The petunias 'Polo Salmon', 'Sugar Daddy' and 'Primetime Rose Star' contained over three times as many immatures as the other petunia cultivars. Relatively few eggs and nymphs were found on all vinca cultivars. 'Little Pinkie' contained almost six times more whitefly eggs than 'Sahara Madness Pink' (1.13 vs. 0.19 eggs/cm^2, respectively). Although there were significant differences in number of eggs among vinca cultivars, there were no differences in number of nymphs.

DISCUSSION

Results from these studies show that there is variation in the response of spider mites and sweetpotato whiteflies to different bedding plant cultivars within a crop type. The bioassays described are a basis for screening the most susceptible or resistant plant lines and provide a measure of anitxenosis and antibiosis. In some cases, even though the differences in arthropod numbers among cultivars were statistically significant, these differences may not be aesthetically important, but could be important for population control and spread of viruses. Care must be taken in relating bioassay results to horticultural concerns.

Historically, plant resistance has not been used as an important arthropod management strategy in potted, flowering, or bedding plant production. Although horticulturists have been evaluating and incorporating characters such as plant size, shape, flower color and disease resistance into breeding lines and cultivars (Howe & Waters 1990), evaluation of insect damage (Howe et al. 1991) and characters for insect and mite resistance have not been studied throughly. Future research should identify plant characteristics that result in arthropod resistance and use them in breeding programs to create new varieties and hybrids.

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