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Field Evaluation of Head Lettuce Varietal Resistance to the Green Peach Aphid and the Lettuce Aphid in Southern California

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ABSTRACT

The green peach aphid, Myzus persicae (Sulzer), and the lettuce aphid, Nasonovia ribisnigri (Mosley), are important pests of lettuce crops in western United States. Eight commercial head lettuce varieties including 'Desert Spring', 'Cool Breeze', 'Empire', 'Van Crisp', 'Cool Green', 'Synergene', 'PS 1265' and 'Bubba' were evaluated in field experiments for resistance to the green peach aphid and the lettuce aphid in southern California. 'Cool Breeze' and 'Cool Green' supported the lowest numbers of green peach aphids during the peak population growth. There were nearly 70% fewer immature green peach aphids in these two varieties compared to the most susceptible variety, 'Empire'. The mean number of immature green peach aphids per plant of the eight varieties ranged from 1.3 to 5.0 during the peak population growth. Susceptibility of lettuce varieties to lettuce aphids during the peak population period was in the following order: 'Bubba', 'Synergene', 'Empire', 'Cool Breeze', 'PS 1265', 'Van Crisp', 'Desert Spring', and 'Cool Green' with the number of the aphids per plant ranging from 18 to 3.6. Host plant resistance in integrated aphid management on lettuce is discussed.

Additional index words: green peach aphid, lettuce aphid, head lettuce, host plant resistance

The green peach aphid, *Myzus persicae* (Sulzer), and the lettuce aphid, *Nasonovia ribisnigri* (Mosley), are two of the most important pests of lettuce crops in western United States. These aphid species cause economic damage to lettuce through direct injury, virus transmission and contamination (Blackman and Eastop, 1984, Hinch et al., 1991, Polumbo and Kerns, 1994, Polumbo, 2004). The green peach aphid has a well-documented history of resistance to a variety of insecticide classes (Miyata, 1983, Kerns et al., 1998). The lettuce aphid is a relatively new introduction into the lettuce production areas of western US and was first found in 1998 in the Salinas area (Chaney, 1999). Infestation of this pest was subsequently observed in the desert lettuce production areas of southern California and central Arizona (Polumbo, 1999). Because lettuce aphids deposit their young near the lettuce terminal growing points and are found predominantly on the cap leaf and within the lettuce head, they are difficult to control with contact insecticides (Polumbo, 1999). Therefore, an integrated approach is required to control these pests on lettuce crops.

Host plant resistance has been proven to be an important component of integrated insect pest management system. Host plant resistance of lettuce against the green peach aphid and the lettuce aphid was studied in Europe and some resistant varieties have been developed (Eenink and Dielman, 1977, 1980, Eenink et al., 1982). In screening *Lactuca* for resistance to the green peach aphid, significant resistant and partially resistant genotypes were observed (Eenink and Dielman, 1977, 1980). Several European lettuce varieties have been shown to largely prevent lettuce aphid from surviving and reproducing (Polumbo and Hannon, 2002). However, little is known about host plant resistance potential of lettuce varieties currently available in the United States. The objective of this study is to evaluate head lettuce varietal resistance to the green peach aphid and the lettuce aphid in the desert lettuce production area of southern California.

MATERIALS AND METHODS

Experimental plots. Head lettuce (*Lactuca sativa* L.) was planted on 8 December 1999 under standard cropping system at the Coachella Valley Agricultural Experimental Station, University of California, Riverside. Eight varieties including 'Desert Spring', 'Cool Breeze', 'Empire', 'Van Crisp', 'Cool Green', 'Synergene', 'PS 1265' and 'Bubba' were evaluated in a

Table 1. Mean number ± SD of immature green peach aphids per plant of different lettuce varieties

Date	Desert Spring	Cool Breeze	Empire	Van Crisp	Cool Green	Synergene	PS 1265	Bubba
2/15	2.3 ± 0.4 ac	1.7 ± 0.2 bc	2.8 ± 0.3 a	1.3 ± 0.3 bd	1.8 ± 0.3 bc	1.8 ± 0.2 bc	1.5 ± 0.3 bc	2.5 ± 0.7 ac
2/23	1.9 ± 0.3 ac	0.8 ± 0.1 bd	1.4 ± 0.2 ad	1.2 ± 0.3 bc	1.1 ± 0.2 bc	2.1 ± 0.5 a	1.2 ± 0.5 bc	2.2 ± 0.5 a
2/29	3.3 ± 0.4 b	1.6 ± 0.4 c	5.0 ± 0.6 a	3.6 ± 0.6 b	1.3 ± 0.3 cd	2.8 ± 0.5 b	2.3 ± 0.4 bc	2.4 ± 0.5 ac
3/7	1.4 ± 0.3 ad	0.7 ± 0.2 cd	1.9 ± 0.3 a	1.3 ± 0.3 ad	1.1 ± 0.2 bd	0.7 ± 0.2 cd	0.8 ± 0.2 bd	1.1 ± 0.3 ad
3/14	2.5 ± 0.5 a	1.3 ± 0.3 bc	1.85 ± 0.3 ac	1.1 ± 0.3 bce	0.7 ± 0.2 bf	0.4 ± 0.1 def	0.6 ± 0.2 bf	0.7 ± 0.3 bf
3/21	0.3 ± 0.1 a	0.1 ± 0.0 ad	0.3 ± 0.1 a	0.1 ± 0.0 ad	0.0 ± 0.0 bcd	0.2 ± 0.0 ace	0.0 ± 0.0 bcd	0.0 ± 0.0

Means in a row followed by different letter are significantly different at $P < 0.05$.

Table 2. Mean number ± SD of immature lettuce aphids per plant of different lettuce varieties

Date	Desert Spring	Cool Breeze	Empire	Van Crisp	Cool Green	Synergene	PS 1265	Bubba
2/15	1.1 ± 0.6 b	1.3 ± 0.7 b	0.2 ± 0.1 b	0.0 ± 0.0 b	0.7 ± 0.5 b	0.9 ± 0.6 b	0.5 ± 0.2 b	3.2 ± 1.3 a
2/23	2.2 ± 0.8 c	3.2 ± 0.9 b	1.0 ± 0.4 c	3.2 ± 1.9 b	1.9 ± 0.6 c	10.4 ± 2.2 a	5.2 ± 0.9 b	6.0 ± 1.6 b
2/29	5.4 ± 1.1 f	10.8 ± 1.4 b	13.9 ± 2.5 bcd	7.3 ± 1.7 f	3.6 ± 0.7 f	15.7 ± 2.4 ac	8.5 ± 1.5 e	17.6 ± 2.7 ad
3/7	8.7 ± 1.1 bc	10.9 ± 1.4 ac	7.6 ± 1.5 bc	5.6 ± 0.9 b	6.6 ± 1.2 b	14.4 ± 1.5 a	9.9 ± 1.7 bc	14.6 ± 1.9 a
3/14	6.5 ± 0.9 bc	5.3 ± 0.8 b	9.8 ± 1.3 a	4.7 ± 0.8 be	3.0 ± 0.3 de	4.1 ± 0.7 be	1.7 ± 0.3 d	8.0 ± 1.1 ac
3/21	0.8 ± 0.2 a	1.0 ± 0.3 a	0.9 ± 0.3 a	0.8 ± 0.3 ac	0.8 ± 0.3 ad	0.1 ± 0.0 bcd	0.6 ± 0.3 ad	0.7 ± 0.3 ad

Means in a row followed by different letter are significantly different at $P < 0.05$.

randomized complete block design with four replicates. The plot size was 15 m long and 8 m wide. Row spacing was 0.9 m and there were 8 rows in each plot. Plants were thinned at the 5-leaf stage to 20 cm interval spacing. The field was drip-irrigated. The frequency of irrigation was every 3 days.

Aphid numbers. Numbers of immature green peach aphids and lettuce aphids were monitored from 15 February to 21 March 2000 on a weekly basis. Numbers of aphids were counted on each of the 10 randomly selected lettuce plants (by destructive sampling) in the middle four rows of each plot.

Data analysis. The least significant difference (LSD) test in one-way randomized complete block ANOVA in SAS (SAS Institute, 2001) was used to analyze the data and to separate the means for each sampling date. Numbers of immature aphids were transformed using the formula log (y + 1) before analysis of variance in order to normalize the data.

RESULTS AND DISCUSSION

The seasonal aphid population peaked in late February and declined in mid-March (Tables 1 and 2). Among the 8 varieties tested, 'Cool Breeze' and 'Cool Green' supported the least number of green peach aphids during the peak population period (around 29 February). They had nearly 70% fewer immature green peach aphids than the most susceptible variety, 'Empire'. The mean number of immature green peach aphids per plant of the eight varieties ranged from 1.3 to 5.0 during the peak population period (Table 1). On 29 February, susceptibility of the lettuce varieties to lettuce aphids was in the following order: 'Bubba', 'Synergene', 'Empire', 'Cool Breeze', 'PS 1265', 'Van Crisp', 'Desert Spring' and 'Cool Green' (least susceptible) with the number of aphids per plant ranging from 18 to 3.6 (Table 2).

Polumbo and Hannon (2002) investigated the population growth of lettuce aphids on resistant butter and head lettuce varieties in central Arizona and found that plants of several varieties almost completely prevented aphid colonization. Although we did not find complete prevention of aphid colonization in this study, the differences in numbers of the aphids among varieties were significant.

Results of this study suggest that some varieties such as 'Cool Green' and 'Cool Breeze' are more resistant to green peach aphids, while 'Cool Green' and 'Van Crisp' are more resistant to lettuce aphids. Plant resistance to aphids has been largely attributed to the plant physiology and biochemistry (Van Emden et al., 1969, Niemeyer, 1990). A pea variety resistant to the pea aphid (*Aphis fabae* Scopodi) had a higher sugar/nitrogen ratio and lower amounts of soluble nitrogen (Maltais and Auclair, 1957, Auclear and Maltais, 1961). The rates of ingestion and assimilation by the pea aphid were also higher in susceptible than in resistant varieties (Auclair, 1959). The resistance of some tobacco varieties to the green peach aphid was due to a toxic material in the leaves (Thurston and Webster, 1962). Phenolic compounds such as chlorogenic acid, gallic acid and catechol in artificial diet caused enhanced mortality and reduced development of the green peach aphid and the lettuce aphid (Harrewijn, 1990). Benzyl alcohol was claimed to be involved in greenbug (*Schizaphis graminum* Rondani) resistance of Barley (Juneja et al., 1972, 1975). The exact physiological and biological mechanisms of the green peach aphid and the lettuce aphid resistance in head lettuce in this study need to be further investigated.

Partial resistance of some head lettuce varieties to the green peach aphid and the lettuce aphid was observed in this study. The use of such partially aphid-resistant varieties in combination with biological control agents (e.g. predators, parasites and bioinsecticides) could be the most environmentally friendly and economic method of aphid control in lettuce production. Furthermore, the results of this study suggest that lettuce breeding and selection for increased aphid resistance may be a viable option. Higher levels of aphid resistance could be developed from these partially resistant varieties by traditional plant breeding and/or genetic engineering.

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