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Tarnished Plant Bug Injury on Six Strawberry Cultivars Treated with Differing Numbers of Insecticide Sprays[1]

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Abstract

Six strawberry (*Fragaria x annassa* Duch.) cultivars known to vary in susceptibility to tarnished plant bug (*Lygus lineolaris* P. de B.) injury (apical seediness) were grown for two seasons under three insecticide regimes (three sprays, one spray and no spray) to determine if differences in susceptibility could be used to modify chemical controls for this insect. The most susceptible cultivars harbored more nymphs than the least susceptible cultivars. Increased marketable yield as a result of insecticides was most pronounced on susceptible cultivars. Differences in injury among cultivars were greatest when no insecticide was applied. 'Honeoye' and 'Sparkle' had the least apical seediness, followed by 'Redchief,' 'Guardian' and 'Kent.' 'Mic Mac' consistently had the highest level of injury. When insecticide applications were reduced, apical seediness did not increase significantly for cultivars exhibiting low susceptibility. Chemical name used: O, O-dimethylphosphorodithioate of diethylmercaptosuccinate (malathion).

Injury to strawberry fruit caused by tarnished plant bug (*Lygus lineolaris*) can result in serious economic loss to farmers in most regions of North America. This insect feeds on strawberry flowers and fruit causing a distinctive malformation of the fruit tissue described as "apical seediness" (12) and commonly called "buttoning" or "catfacing." As few as one tarnished plant bug per four flower clusters can cause significant economic loss in commercial fields (7, 11). The feeding destroys developing achenes and/or their supporting tissues, disrupting the export of auxin from achenes to the receptacle. Apical seediness occurs because of impaired receptacle development (1, 4, 8, 9).

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Tarnished plant bug infestations in June-bearing strawberries are controlled almost exclusively through two to five insecticide applications from prebloom to petal fall (10). Integrated pest management techniques, including population monitoring, and the use of action thresholds and biological controls, have recently been suggested (2, 3, 6, 7), but have not been widely adopted by farmers. Genetic resistance offers potential for control. Resistance to tarnished plant bug has been observed in cotton and alfalfa and is now being exploited in breeding programs (13). Recently differences in damage from tarnished plant bug have been observed among strawberry cultivars, suggesting that some resistance may exist (5). The present study was initiated to evaluate how differences in susceptibility to injury among June-bearing strawberry cultivars may affect insecticidal control of tarnished plant bug.

Materials and Methods

Based on a previous evaluation of 16 strawberry cultivars for susceptibility to tarnished plant bug injury (5), six June-bearing strawberry cultivars were selected to reflect a range of vulnerability. The cultivars, from least to most susceptible, 'Honeoye,' 'Sparkle,' 'Redchief,' 'Guardian,' 'Kent' and 'Mic Mac,' were planted in narrow raised beds with ten plants spaced 15 cm apart in single rows, 1.5 m between rows, and 1.5 m between plots, at the Agricultural Experiment Station in Monmouth, Maine. All blossoms were removed during the planting year and runners were removed throughout the experiment. Straw mulch was applied to all plots for winter protection. Treatments were assigned to plots arranged in a split plot design in six replications with insecticide sprays as the main plots and cultivars as the subplots. For both harvest seasons, one third of the plots received sprays of malathion (O,-dimethylphosphorodithioate of diethylmercaptosuccinate 50% at a rate of 7.9 ml per l water) at prebloom, early bloom and petal fall. One third of the plots received only the prebloom spray, and one third of the plots received no malathion. Tarnished plant bug nymphs were counted prior to the start of harvest by shaking two flower clusters per plot over a white plate and counting the fallen insects. Fruits were harvested, counted, weighed and placed into one of three grades: marketable; apical seediness, or other deformities. Tarnished plant bug injury was measured as percent weight of fruit exhibiting apical seediness. Data was subjected to analysis of variance. Means were adjusted by arcsine or square root transformations where necessary, and separated using Duncan's Multiple Range Test.

Results

Populations of nymphs were much higher during 1990 than 1991 (Table 1). Within cultivars, plots which received three applications of malathion had the lowest populations. Compared to no spray, a single spray did not significantly reduce nymph populations, except on 'Kent' in 1991. Differences among cultivars were most apparent during 1990 in plots not receiving malathion, although a similar trend was evident for each insecticide treatment. 'Honeoye' had the lowest number of nymphs, significantly fewer than on 'Guardian,' 'Mic Mac' and 'Kent.'

Yields of marketable fruit differed significantly among cultivars and insecticide treatments in both years (Table 2). In unsprayed plots, all cultivars except 'Guardian' in 1990, and 'Sparkle' and 'Redchief' in 1991 had lower yields than plots receiving three sprays. A single spray improved yields consistently only for 'Honeoye.' When sprays were reduced from three to one, marketable yields declined for 'Kent,' 'Mic Mac' and 'Sparkle' in 1990, and 'Kent,' 'Mic Mac' and Guardian' in 1991. Reducing sprays did not affect yields of 'Honeoye,' 'Redchief' or

Table 1. Numbers of tarnished plant bug nymphs recovered from sampling among six strawberry cultivars and three insecticide treatments in 1990 and 1991.

	Number of insecticide sprays		
Cultivar	None	One	Three
		1990 data	
Kent	8.18 abc[z]	9.38 ab	2.48 def
Honeoye	2.93 def	3.97 cde	0.78 f
Sparkle	5.45 abcd	4.83 bcde	1.72 def
Mic Mac	7.87 abc	7.66 abc	4.04 cde
Redchief	5.35 abcd	5.18 abcd	1.37 ef
Guardian	9.28 ab	10.64 a	4.63 bcde
		1991 data	
Kent	3.03 a	0.55 cde	0.13 de
Honeoye	1.21 abcd	2.68 a	0.00 e
Sparkle	1.75 abc	0.55 cde	0.13 de
Mic Mac	1.37 abc	1.48 abc	0.00 e
Redchief	1.04 bcde	1.56 abc	0.00 e
Guardian	2.24 ab	1.24 abcd	0.00 e

[z]Means adjusted by square root transformation. Means within a year followed by the same letter are not significantly different (Duncan's Multiple Range Test, $P = 0.05$).

'Guardian' in 1990, or of 'Honeoye,' 'Sparkle' or Redchief' in 1991. 'Kent' had the highest yields under the three-spray treatment, but when no insecticide was applied, its yields were less than or equal to nearly all other cultivars. 'Honeoye' produced high yields when no malathion was applied, significantly higher than all other cultivars except 'Kent' and 'Redchief' in 1991.

Unsprayed plots had more tarnished plant bug injury than sprayed plots for all cultivars except 'Honeoye' in 1990 (Table 3). 'Honeoye' injury levels were not significantly affected by malathion sprays. There were fewer injured fruit in single spray plots than in unsprayed plots for 'Mic Mac' in 1990, and 'Mic Mac,' 'Kent,' 'Sparkle,' and 'Guardian' in 1991. Three sprays compared to no spray reduced injury for all cultivars except 'Honeoye' and, compared to one spray, for all cultivars except 'Honeoye' (1990) and 'Kent,' 'Honeoye' and 'Sparkle' (1991).

Differences in the amount of apical seediness among cultivars were diminished when malathion was applied. 'Honeoye' and 'Sparkle' had the lowest levels of injury when no malathion was applied. Injury to 'Honeoye' fruit in unsprayed plots was no greater than to fruit of other cultivars receiving three sprays. 'Mic Mac' had the highest level of injury of all cultivars in 1990. 'Kent,' 'Redchief' and 'Guardian' also had high injury levels. In 1991, 'Mic Mac,' 'Guardian' and 'Kent' had the highest injury levels.

Fruit deformities other than apical seediness, such as creasing and puckering, tended to be greatest on 'Honeoye' and 'Sparkle,' which had the lowest levels of tarnished plant bug injury (data now shown). Insecticide sprays had no effect on the incidence of these deformities except for an increase on 'Mic Mac' in 1990.

Discussion

The range of tarnished plant bug injury observed among the cultivars is consistent with previous research (5).

Table 2. Marketable yield (grams/plot) of six strawberry cultivars with different numbers of malathion sprays.

	Number of insecticide sprays		
Cultivar	None	One	Three
		1990 data	
Kent	799 defgh[z]	1311 cde	3078 a
Honeoye	1346 cd	2345 b	2340 b
Sparkle	761 efgh	644 fghi	1473 c
Mic Mac	104 i	281 hi	1106 cdef
Redchief	339 hi	733 efgh	979 cdefg
Guardian	383 hi	458 ghi	868 defgh
		1991 data	
Kent	1592 cd	2737 b	3632 a
Honeoye	1890 c	2793 b	2839 b
Sparkle	970 de	1184 cde	1481 cd
Mic Mac	961 de	1445 cd	2713 b
Redchief	1266 cd	1450 cd	1910 c
Guardian	475 e	1043 de	1833 c

[z]Means within a year followed by the same letter are not significantly different (Duncan's Multiple Range Test, $P = 0.05$).

Table 3. Apical seediness (percent of yield in grams/plot) caused by tarnished plant bug among six cultivars and three levels of malathion sprays.

	Number of insecticide sprays		
Cultivar	None	One	Three
		1990 data	
Kent	46.0 bc[z]	35.6 cd	7.3 ghij
Honeoye	10.8 fghij	7.5 ghij	2.2 j
Sparkle	16.2 efgh	15.2 efgh	3.1 ij
Mic Mac	86.8 a	56.0 b	13.1 efghi
Redchief	36.4 cd	19.7 defg	5.6 hij
Guardian	29.6 cde	22.0 def	7.1 ghij
		1991 data	
Kent	33.7 a	11.7 bcdef	5.9 cdef
Honeoye	7.8 bcdef	5.5 def	1.4 f
Sparkle	16.4 bc	4.9 ef	1.1 f
Mic Mac	34.6 a	17.4 b	2.3 f
Redchief	18.4 b	14.5 bcde	1.2 f
Guardian	35.1 a	15.9 bcd	1.7 f

[z]Means within a year followed by the same letter are not significantly different (Duncan's Multiple Range Test, $P = 0.05$). 1990 means adjusted by arcsine transformation.

The reduced injury observed for some cultivars may be explained by the relatively small number of tarnished plant bug nymphs found on these as compared to other cultivars. This observation suggests an oviposition preference by adults, a feeding preference by nymphs, or possibly an antibiosis mechanism within less susceptible cultivars which reduces nymph survival. If the differences in injury are based primarily on a feeding or an oviposition preference, the effect might be greatly diminished if only a nonpreferred host were available. Studies using large, isolated, single cultivar plots could determine if differences in susceptibility are dependent on the selection of cultivars available.

Tolerance to feeding may also reduce apparent injury. The tendency for cultivars with little apical seediness to have higher levels of other deformities may indicate that feeding damage is being expressed differently or that there is compensation for injury during fruit development. Alternatively, other deformities may have been overshadowed by the more severe apical seediness in susceptible cultivars and therefore were not counted. However, previous research has suggested that 'Honeoye' is less likely to exhibit apical seediness than other cultivars when exposed to tarnished plant bugs for equivalent amounts of time (4).

Avoidance is another possible reason for cultivar differences. Early flowering cultivars may escape injury by passing through the preferred oviposition or feeding stage before tarnished plant bugs are present in significant numbers. 'Honeoye,' the cultivar least injured in this study, flowers relatively early, but other early flowering cultivars are known to be susceptible to injury (5), and some late flowering cultivars, such as 'Sparkle,' show relatively little damage.

The results of this experiment suggest that insecticide applications could be reduced or eliminated in plantings of 'Honeoye' which include other cultivars known to be susceptible to tarnished plant bug injury. Insecticide applications may also be reduced in plantings of 'Honeoye' alone, providing that a low injury level can be sustained in large, single cultivar plantings. Although monocultures of this type have not yet been studied, the data show promise for the development of effective resistance through selective breeding programs. Relatively few strawberry genotypes have been screened for susceptibility to tarnished plant bug injury to date, but significant variation in injury levels has been observed. There are some indications that relative susceptibility to tarnished plant bug injury has a genetic basis (5). Further screening of strawberry germplasm for susceptibility to tarnished plant bug injury and investigations into the mechanisms of susceptibility are warranted.

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Breeding of Fruit Crops in Poland

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Abstract

The main centre of fruit breeding in Poland is the Research Institute of Pomology and Floriculture in Skierniewice. Breeding work began there almost 40 years ago. Minor breeding programs are also conducted by Agricultural Academies in Warsaw, Poznań and Lublin. The breeding objectives for almost all fruit crops are similar: adequate winter hardiness, resistance to serious diseases and/or pests, high productivity, good eating and processing quality. As a result of controlled hybridization and local selection, over 40 cultivars have been introduced and many advanced selections show enough promise to be named and released soon.

Introduction

Poland is a medium size, mid-European country situated between the Baltic Sea and Carpathian Mountains, from 49° to 52°N latitude. Poland lies in the temperate zone, but its climate is too cold for wide commercial production of grapes, apricots or peaches.

According to long-term meteorological observations taken at Skierniewice, every second winter in average the minimum temperature reaches or surpasses -20°C. Once every 10-15 years, very severe winters occur with temperatures dropping below -30°C.

Major fruit crops grown in Poland include apples, strawberries, black currants, tart cherries, plums and pears. Average yearly production calculated

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