Journal of the American Pomological Society 60(3): 144-148 2006

Stink Bug (Pentatomidae) Feeding Preferences among Apple Cultivars[1,4]

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Abstract

Thirty-one apple cultivars were evaluated for stink bug feeding injury at harvest in 2003 and 2004. Injury levels of 0 to 28% were found with significant differences among cultivars. There was a significant positive correlation of injury between years, indicating a temporal repeatability of estimates. 'Imperial Gala', 'Lawspur Rome', 'Red Fuji', and 'Nittany' had consistently low levels of stink bug injury, whereas 'Braeburn', 'Jonica', 'Jonagold', 'Starkspur Dixiered', 'Granny Smith' and 'Stayman' had consistently high stink bug injury levels. These results show that differences exist in cultivar susceptibility to stink bug feeding on mid- to late-season apples. Cultivars with consistently low levels of injury could be used to reduce losses due to stink bugs in areas where they have been a problem.

Introduction

Stink bugs (Heteroptera: Pentatomidae) can cause injury to mid- and late-season apple (*Malus x domestica* Borkh.) fruit (2,4). This injury is visible on the surface of the fruit as a depressed and discolored area before and at harvest with the underlying flesh having a cork-like appearance (2). Many factors, including the presence of several species of stink bugs and numerous alternate hosts, combine to complicate management of stink bugs to minimize fruit injury in the orchard (1). Several species of stink bugs [*Euschistus servus* (Say), *E. tristigmus* (Say), *E. variolaris* (Palisot de Beauvois), *Acrosternum hilare* (Say), and others] injure fruit (4), thus confounding specific behavioral and chemical control options. Injury is caused by adults that fly into the orchard from surrounding habitats containing alternate hosts. Feeding injury can occur up until the day of harvest (4), making spray-to-harvest intervals a critical concern for any chemical control option. Monitoring methods for detecting stink bugs in orchards are being devised (5) but the ability of several species to cause injury also complicates this aspect of pest management.

Due to the difficulties in predicting injury and controlling stink bugs, any existing difference in cultivar susceptibility could be a valuable tool for reducing the impact of this pest where stink bugs are a perennial problem. However, little is known about the differences in stink bug preferences for apple cultivars. This study was done to begin developing a data base to document the range in stink bug feeding injury among several current apple cultivars under orchard conditions.

Materials and Methods

Preliminary sampling of stink bug injury was done in 2003 at the Appalachian Fruit Research Station, Kearneysville, WV. Fruit samples were taken at the appropriate harvest date (based on a fruit flesh starch index rating scale for fruit maturity) for each of 27 culti-

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[4] Acknowledgements: We thank Henry Hogmire, Richard Bell, Rich Marini and two anonymous reviewers for their valuable comments on earlier drafts of the manuscript and Brent Short for assistance with field evaluations and statistical analysis.

vars. Cultivars were selected for evaluation to cover the range of maturity dates for apple and to include several commonly planted cultivars in the mid-Atlantic region. From 59 to 321 fruit per cultivar, taken from 2 to 6 trees per block, were examined for stink bug injury. All suspected injury sites were cut to examine internal characteristics of stink bug feeding (2). Fruit samples were pooled to give one estimate of injury per cultivar per block. Apples were examined from 3 different cultivar evaluation blocks. Most fruit were collected from a 4.2 ha block with trees planted from 1981 to 1995, hereafter referred to as the WV cultivar orchard; all the fruit evaluated were from trees planted in 1995. Trees of each cultivar were originally planted as 5 consecutive trees in a row on the south side of the orchard, with a second replicate of 5 trees on the north side of the orchard. The second orchard sampled was part of the NE-183 Regional Project (3) for evaluating pest damage, referred to as the NE-183 WV reduced spray orchard. This orchard, planted in 1995, had 5 single tree replicates per cultivar in a randomized complete block design. The third orchard was another planting of the NE-183 Regional Project planted for evaluation of horticultural properties of the cultivars, referred to as the NE-183 WV orchard. This orchard was planted in 1995 and 1999, also with 5 individual tree replicates in a randomized complete block design.

Standard fungicide sprays were applied to all the blocks (6). Insecticide applications on the WV cultivar and the NE-183 WV orchards were as follows: dormant oil, 8.88 l/ha, 3 April; permethrin, 0.09 l/ha, 14 April; phosmet, 3.36 kg/ha; 14 April, 16 June, 18 July, and 15 August; methomyl 0.84 kg/ha, 30 May; and carbaryl, 0.21 kg/ha, 2 July, 31 July and 29 August. The NE-183 WV reduced spay orchard received one application of carbaryl, 0.21 kg/ha, 15 May in 2003. In 2004 the same 3 orchards in Kearneysville, WV were sampled. The only difference was that individual tree samples were kept separate, and in the WV cultivar orchard, data were also kept separate by north and south sides of the block. Twenty-seven cultivars were sampled; 23 of the cultivars were in common with those sampled in 2003. Up to 50 fruit, if available, were randomly selected from the 4 to 6 trees per cultivar for evaluation using the same criteria as in 2003. In addition to the Kearneysville blocks, the NE-183 planting at the Alson H. Smith Jr. Agric. Res. and Ext. Center in Winchester, VA was sampled, referred to as the NE-183 VA orchard. This orchard was also planted in 1995 and had 5 single tree replicates per cultivar. Injury evaluations were made on all cultivars when fruit reached a commercial stage of maturity for normal harvest. Insecticides applied in 2004 in the Kearneysville orchards included: dormant oil, 56 l/ha, 26 March; chlorpyrifos, 2.90 l/ha, 26 March; permethrin, 0.56 l/ha, 3 April; phosmet, 3.36 kg/ha, 6 May, 24 May, 17 June, 30 July and 13 August; imidacloprid, 0.47 l/ha, 24 May; carbaryl, 0.21 kg/ha, 3 June, 2 July, 16 July, and 27 August; and pyridaben, 0.31 kg/ha, 2 July. The NE-183 VA orchard received applications of permethrin, 0.84 l/ha, 29 March; imidacloprid, 0.28 l/ha, 6 May and 15 June; carbaryl, 7.01 l/ha, 6 May, 13 July and 29 July; methomyl, 3.51 l/ha, 21 May, 3 June and 30 June; phosmet, 2.24 kg/ha, 21 May, 3 June, 15 June and 30 June. All orchards received a standard fungicide protection program (7).

The 2003 stink bug injury data were not statistically analyzed due to the inability to calculate variance estimates; means are provided for reference only. The percentage stink bug injury per tree was transformed with the square root arcsine transformation which normalized the residuals and equalized the variance among cultivars. The 2004 data from the WV cultivar and the NE-183 VA orchards were analyzed individually due to differences in plot design; the two NE-183 WV orchards were not analyzed because there were too few cultivars evaluated; means for these cultivars are presented for reference only. For the WV cultivar orchard the two halves were analyzed as different blocks as a two factor fixed randomized complete block ANOVA, the NE-183 VA orchard as a one factor randomized complete block ANOVA. Cultivar differences were separated using least significant difference, P=0.05. A nonparametric rank correlation was done for the cultivars sampled in both 2003 and 2004 to test the stability of the stink bug injury over time.

Results and Discussion

A total of 31 apple cultivars were evaluated for stink bug injury over the two years of sampling, with a range of 0 to 28 % of the fruit per cultivar having injury (Table 1). However, both the 0% injury estimate for 'Sunrise' and the 28% estimate for 'Autumn Gold' were based on a sample from only one block in one year and should not be considered to be a statistically robust estimate. However, it has been observed that 'Sunrise' had low stink bug injury and 'Autumn Gold' had high stink bug injury prior to 2003 (S. Miller, personal observation). In the analysis of variance for the 2004 data from the WV cultivar orchard there was no significant block effect (F=0.43; d.f.=1, 99; P=0.51) so the ANOVA was recalculated for just the cultivar effect. There was a significant cultivar effect for the WV cultivar orchard (F=6.33; d.f.=23, 99; P<0.01) and the NE-183 VA orchard (F=7.69; d.f.=9, 38; P<0.01). Mean separation among cultivars for these orchards is presented in Table 1.

Although a few cultivars had large variations in percentage stink bug injury between years, e.g., 'Golden Supreme', 'Imperial Red', and 'Golden Delicious' (see Table 1), the correlation between damage estimates for the two years was highly significant (r=+0.54, n=23, P<0.01). The significant positive correlation indicates that the estimates of stink bug injury are repeatable over time.

The similarity in injury estimates among orchards suggests that stink bug injury estimates are repeatable geographically. There were exceptions, however, with two cultivars showing large differences in injury in the NE-183 VA and the WV orchards. 'Sansa' had a large difference in injury, with 24% of the fruit injured by stink bugs in NE-183 VA and 3.6-6.0% in the NE-183 blocks in WV. Also, 'Gold Rush' had less injury in the NE-183 VA orchard, 0.4%, than in WV, 6.0-6.8%. Although these orchards did have different late season insecticide applications, the effect of insecticides on stink bug injury was not affected by the use of insecticides compared with no insecticides in previous studies (2). It is, however, possible that differences in evaluation time (Table 1) may have led to the different levels of injury. 'Sansa' in VA was evaluated 13 days later than in WV thus being exposed to stink bugs for a longer time. 'Gold Rush' was sampled 26 days earlier in VA than in WV possibly being harvested to early to be exposed to significant stink bug injury. Brown (2) did show that susceptibility to stink bug injury was dependent upon how close the fruit was to maturity.

Three of the cultivars with the lowest levels of stink bug injury; 'Pristine' 'Sunrise' and 'Williams Pride' may have escaped significant injury rather than possess resistance or non-preference to stink bug feeding. These three cultivars were the earliest ones evaluated (Table 1). The difference in injury shown by 'Sansa' also supports this conclusion; the 'Sansa' fruit evaluated on 6 Aug. had low levels of injury but when sampled 19 Aug in VA injury was at 24.0%. Little stink bug feeding on fruit occurs prior to early August (2); therefore, these early cultivars may have become mature before stink bugs are attracted to apples and thus escape injury. After mid-August, there does not seem to be any relation to the degree of stink bug injury and time of harvest (Table 1). 'Imperial Gala', 'Nittany', 'Red Fuji' and 'Lawspur Rome' showed notably less stink bug injury than other cultivars.

These results indicate that there may be genetic variation in susceptibility to stink

Table 1. Mean percent, non-transformed, fruit injured by stink bugs by cultivar in order of evaluation date; mean separation based on least square means from arcsine square root transformation. Where no mean separation is provided, data could not be normalized for analysis, or in the case of the 2003 trial, there was no within orchard replication available to estimate variance.

Cultivar	Evaluation date 2004[a]	Preliminary trial 2003	WV cultivar	NE-183 VA	NE-183 WV	NE-183 WV reduced spray
Pristine	(30 July)	2.0	-	-	-	-
Sunrise	(1 Aug.)	0.0	-	-	-	-
Williams Pride	3 Aug.	1.0	2.0 cd	-	-	-
Sansa[b]	6 Aug.	-	-	24.0 a	3.6	6.0
Golden Supreme	23 Aug.	14.0	1.3 cd	4.0 bc	0.0	0.0
Ginger Gold	25 Aug.	8.0	3.7 bc	2.8 bc	-	-
Honeycrisp	25 Aug.	7.5	2.8 c	2.5 bc	1.0	7.3
Pioneer Mac	27 Aug.	3.0	-	3.3 bc	-	1.6
Gibson Golden Del.	10. Sept.	-	4.3 bc	-	-	-
Stark Golden Del.	10 Sept.	-	4.7 bc	-	-	-
Golden Delicious	15 Sept.	3.0	-	12.7 a	-	8.1
Royal Empire	(16 Sept.)	14.0	-	-	-	-
Cortland	23 Sept.	3.0	6.1 b	-	-	-
Imperial Gala	23 Sept.	1.0	0.4 d	-	-	-
Jonagold	23 Sept.	9.0	12.4 a	-	-	-
Starkspur Dixiered	24 Sept.	11.0	9.7 ab	-	-	-
Imperial Red	24 Sept.	15.0	7.6 ab	-	-	-
Stardspur Ultrared	24 Sept.	7.0	5.7 bc	-	-	-
Braeburn	29 Sept.	17.0	14.0 a	15.2 a	-	9.6
Idared	29 Sept.	6.0	7.7 bc	-	-	-
Jonica	29 Sept.	8.0	12.7 a	-	-	
Red Fuji	30 Sept.	4.0	-	-	1.3	3.7
Autumn Gold	(30 Sept.)	28.0	-	-	-	-
Enterprise	1 Oct.	7.5	-	1.6 bc	2.0	5.0
Lawspur Rome	5 Oct.	2.0	4.3 bc	-	-	-
Nittany	5 Oct.	1.0	-	-	2.8	-
Stayman	8 Oct.	11.5	9.0 ab	-	-	-
Pink Lady	15 Oct.	4.0	6.7 b	3.8 b	-	-
Granny Smith	15 Oct.	7.5	9.3 ab	-	-	-
York	15 Oct.	-	6.6 ab	-	-	-
Suncrisp	15 Oct.	-	-	-	10.0	-
Gold Rush[c]	18 Oct.	6.0	6.8 b	0.4 c	-	6.0

[a] Dates in parenthesis refer to evaluation date in 2003 for those cultivars sampled only in that year.
[b] Evaluated 13 days later in VA than WV
[c] Evaluated 26 days earlier in VA than WV

bug injury among currently available apple cultivars that could be used to manage this injury. In addition to habitat management to reduce alternate host plants surrounding orchards (1), planting cultivars exhibiting less injury may be the best way to minimize the impact of stink bugs in areas with a history of high injury. Chemical control is an option, but the use of phosmet and carbaryl, as was done in these orchards and in earlier work (2), did not seem to be sufficient to reduce injury to economically acceptable levels in at least some of these cultivars.

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