IMPACT OF SUGAR BEET ROOT APHIDS ON SUGAR BEET YIELD AND RESPONSE OF RESISTANT VARIETIES

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ABSTRACT

Sugar beet variety trials in the United States have shown that sugar beet varieties vary greatly in the level of resistance to sugar beet root aphid feeding. The objectives of this study were to quantify the impact of root aphids on sugar beet yields and determine if multiple components of resistance are functioning. In the summers of 2000 and 2001, paired plots (infested vs non-infested) were used to compare six varieties with varying levels of resistance and determine the impact of sugar beet root aphids on the yield of these varieties.

Root aphid infestations developed to a significant level in both years. Susceptible varieties showed significantly reduced sugars for infested plots as compared to non-infested plots with an average reduction of 1.8 percentage points. Reductions in percent sugar correlate well to root ratings (aphid presence). For each of the highly susceptible varieties, aphid-infested plots yielded at least 1680 kg/ha sugar less than the non-infested plots. These data demonstrate the severity of the impact of this insect pest and the great potential that resistant varieties have in reducing that damage. Also, it appears that multiple resistant factors may be involved in aphid resistance for some varieties.

INTRODUCTION

The sugar beet root aphid, *Pemphigus betae* Doane, is a serious problem in sugar beet production in several growing areas of the United States. Because of the proximity of the western plains sugar beet production areas to the range of the aphids' over-wintering host, the narrowleaf cottonwood, *Populus angustifolia* James, the aphid is a consistent threat to sugar beet production in this region.

Wallis and Gaskill (1963) and Harper (1964) first identified sugar beet varieties that had substantial resistance to the aphid, and he proposed that beet varieties could be developed with high levels of resistance. Through the years some seed companies were able to develop and market resistant varieties. Variability in response to root aphids by commercial varieties is demonstrated by Campbell and Hutchison (1995).

The impact of the root aphid on sugar beets has been investigated. Summers and Newton (1989) demonstrated a 50% reduction in sugar for aphid-infested areas of fields. Hutchison and Campbell (1994) found similar levels of sucrose reduction by comparing infested and non-infested portions of the field. Both of these studies identified infested areas by the presence of wilted or stunted infestation foci within the field. Sugar beet variety trials in the western plains region have shown that sugar beet varieties vary greatly in the level of resistance to sugar beet root aphid feeding (Harveson et al., 2002). Correlative data from these trials in Nebraska, Wyoming and Colorado indicate that varieties that were susceptible to root aphids had yield reductions of as much as 30% compared to those varieties with a high level of resistance. These trials were performed under irrigated conditions so water shortage was not really a factor in these results and foliar symptoms of damage were not apparent. Despite the documented potential severity, no direct comparisons have been made to determine the true impact of aphids on sugar beet yields.

The recent variety trial data (Harveson et al., 2002) indicates that the mechanisms of root aphid resistance may also vary between varieties. Root aphid resistance has always been measured as the ability of the aphid to feed and survive on the beets as judged only by numbers of aphids surviving. A measure of the tolerance of the plant to aphid feeding has never been established. Field screening trials are needed to establish yield responses to aphids for varieties with varying levels and possible types of resistance.

The availability of the insecticide Aphistar (active ingredient triazimate, Rohm and Haas Co.) has enabled us to be able to establish aphid infested and non-infested paired plots. This capability allows for a direct measurement of root aphid impact on sugar beet yield. The objectives of this study were to quantify the impact of root aphids on sugar beet yields and to determine if multiple components of resistance are functioning in these varieties.

MATERIALS AND METHODS

Plots established in the summers of 2000 and 2001 were used to determine the impact of sugar beet root aphid on the yield of six sugar beet varieties. The six varieties ranged from highly resistant (Seedex Monohikari) to very susceptible (Holly HH110, Beta 6863). The remaining three varieties had intermediate responses with Beta 4546 being a variety that is segregating for strong resistance. Beta 4006R and Holly Rizor have no known resistance in their respective pedigrees, but they have consistently shown intermediate responses in aphid ratings in field trials. The experimental design was a split plot with varieties being the main plots and aphid infestation being the split plot. Four row plots of each variety were separated by two rows of resistant Monohikari and established parallel to the irrigation sprinkler used to water the plots. Plots were four rows wide by 55 feet long, and replicated five times in each year. Aphid sampling was always done in the outer two rows of the four row plots, and the middle two rows were left undisturbed until harvest. All sugar beets varieties were over-planted and thinned in the four-leaf stage to approximately 86,500 plants per ha to insure uniform stands and minimal harvest variability.

Sugar beet root aphids were established in colonies in pots in the greenhouse on a susceptible variety (Beta 6863) and increased for infestation into field plots to supplement natural infestations. All variety plots were divided in half (4 row by 27 feet subplots) and randomly assigned to be aphid-infested or remain non-infested. Aphid-infested soil from greenhouse colony pots was used to infest the field plots. To coincide with natural infestation timing in late June, plots were infested three times at about one-week intervals. The remaining non-infested plots were treated with the insecticide Aphistar in mid and late August to eliminate natural aphid populations. Plots were maintained with sprinkler irrigation, but plants were allowed slight stress between waterings to encourage aphid buildup.

Aphid establishment and survival in the variety plots were evaluated by digging ten sugar beet roots per plot and rating the roots for aphid presence (0-5 scale; similar to Hutchison and Campbell, 1994). Plots were machine harvested in early October by harvesting the middle two rows of the plot for the entire length of the plot. Plot yields were weighed, and two tare samples (10-15 kg each) were tested at the Western Sugar Company tare laboratory (Gering, NE) for percent sugar analysis and purity.

RESULTS

Root aphid infestations developed to a significant level in both years with infestations in 2001 being somewhat greater than 2000. Responses to aphids were similar in both years as indicated by a combined analysis that showed no interactions between treatments and years; therefore, data from both years were combined in a single analysis. The root aphid ratings for the various variety plots are shown in Figure 1. Significantly greater root ratings were seen in the infested plots than the non-infested plots for all varieties except Monohikari. This indicates that the Aphistar treatment was able to keep aphid populations low in the non-infested plots. The two susceptible varieties, 6863 and HH110, had significantly higher ratings than all the other varieties. 4006R and Rizor did not differ significantly in root ratings. 4546 was intermediate between these two varieties and Monohikari. The susceptible varieties had average infested root ratings in the range where economic damage would be expected. As we have seen in the other field trials the three intermediate varieties do consistently show significantly lower root ratings than the susceptible varieties, and Monohikari does not support any level of aphids.

Percent sugar for the plots is shown in Figure 2. Significant differences between the infested and non-infested plots were seen overall. 6863 and HH110 showed significantly reduced sugars for the infested as compared to the non-infested plots, averaging a reduction of 1.9 and 1.6% sugar, respectively. Percent sugar was also reduced for 4006R and Rizor by 0.9% sugar. No reduction in percent sugar was seen for 4546 and Monohikari. These results in percent sugar reduction correlate well to the root ratings as the varieties with the highest ratings showed the greatest reduction in percent sugar and the varieties with the lower aphid ratings showed little impact.

Root yield (kg/ha) was impacted little by the sugar beet root aphid. HH110 was the only variety with a significant difference between the aphid infested and non-infested plots, a reduction of 6,700 kg/ha. Total sugar yields are shown in Figure 3 with similar results to percent sugar. 6863 and HH110 showed significant reduction in sugar yield of 1,683 and 1,955 kg/ha of sugar, respectively. The only other variety to show a significant reduction in total sugar was 4006R, a reduction of 1,120 kg/ha. The remaining varieties did not differ in sugar yield between infested and non-infested plots. The most striking aspect of the aphids' impact on the two susceptible varieties was the magnitude of the impact. For each of the susceptible varieties aphid-infested plots yielded at least 1,680 kg/ha less than the aphid non-infested plots. This was about 15-20% reduction in sugar yield. This level of direct loss to the aphid is somewhat less than was demonstrated by Summers and Newton (1989) and Hutchison and Campbell (1994). However, it must be emphasized that the impact shown in this study is a direct measure of the root aphids' impact and that the above ground symptoms of the plants in this study were by no means highly visible like those described by Summers and Newton (1989) or by Hutchison and Campbell (1994).

Figure 1. Sugar beet root aphid infestation levels in infested and non-infested plots as measured by aphid ratings (0-5 scale),combined data 2000-2001, $LSD_{0.05}$=0.39.

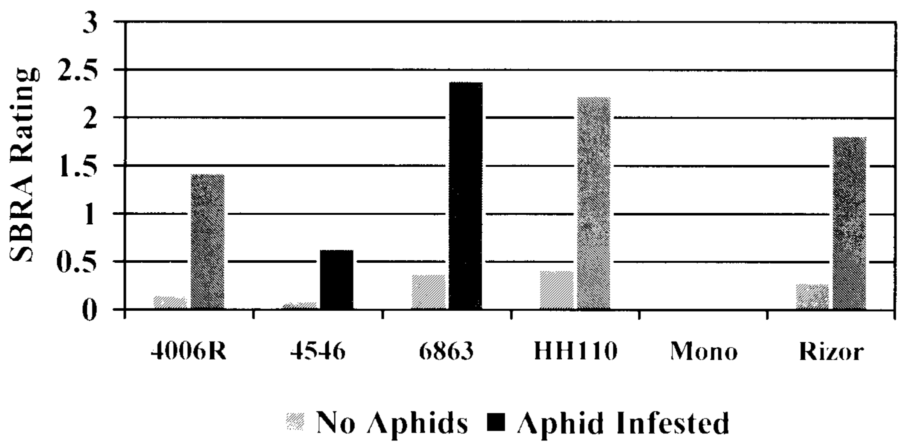


Figure 2. Reduction in percent sugar from sugar beet root aphid infestations, combined data 2000-2001, $LSD_{0.05}$=0.77.

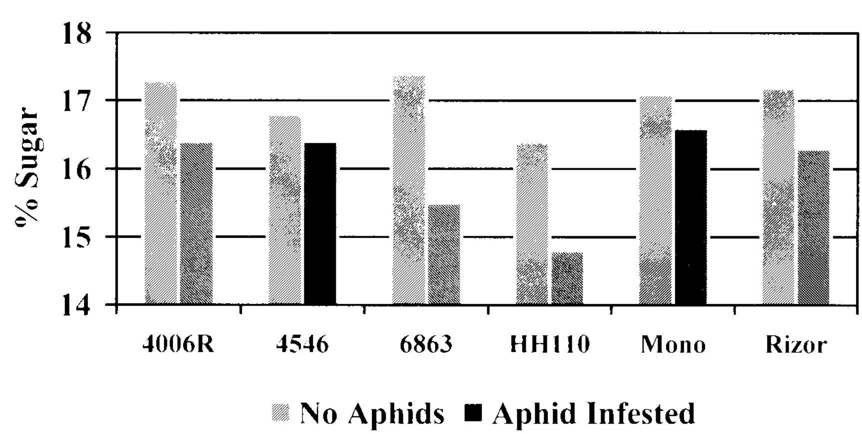
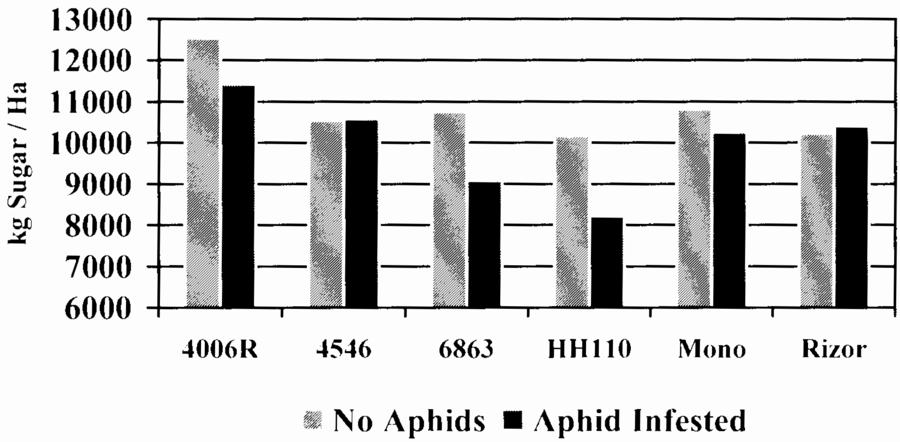


Figure 3. Reduction in total sugar yields from sugar beet root aphid infestations, combined data 2000-2001, $LSD_{0.05}$=1027.



CONCLUSIONS

This is the first study where direct losses due to the sugar beet root aphid have been measured and documented. These data demonstrate the severity of the impact of this insect pest and the great potential that resistant varieties have in reducing that damage. The tremendous impact from the sugar beet root aphid is demonstrated because the infestation rating of approximately '2', only a moderate infestation, resulted in 15-20% loss of total sugar yield. It appears that multiple resistant factors are involved in aphid resistance as demonstrated for the varieties 4006R and Rizor. These varieties contain no known resistance genes; however, both demonstrated significantly reduced aphid presence and yield impact when compared to the susceptible varieties.

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