

HEIN, G. L., R. HARVESON, J. A. SMITH, R. G. WILSON, and C. D. YONTS, University of Nebraska, Panhandle Res. & Ext. Center, 4502 Ave. I, Scottsbluff, NE 69361. **Varietal Resistance to Sugarbeet Root Aphid.**

INTRODUCTION

Sugar beet root aphids are a regular problem in sugar beets grown in the high plains region near the Rocky Mountains. Sugar beet root aphids have a complicated life cycle which includes an over wintering generation on narrowleaf cottonwood trees, found along rivers and dry creek beds at elevations above 4-5,000 feet above sea level. In the spring, the over wintering eggs hatch, and the aphids seek expanding cottonwood leaves where galls develop. Within the gall, the female aphid produces a colony of winged aphids (summer migrants) that when mature, leave the cottonwood trees and fly to and infest sugar beet fields. Aphid populations on the beets peak in early September when winged fall migrants begin to leave the beet fields in search of over wintering habitats.

In the 1960's varieties resistant to sugar beet root aphids were identified in the Rocky Mountain growing region. Root aphid resistance has been maintained in many lines developed and grown in the region, but limited attention has been paid specifically to the testing and development of sugar beet root aphid resistant lines. Because sugar beet seed is developed by commercial companies, the presence of this resistance in today's sugar beet varieties is not well documented. Several sugar beet companies claim varieties to be resistant to the sugar beet root aphid. Because little standard testing has been done to screen beet lines for resistance, reliance on this valuable aphid management tool has been limited. Also, attempts to establish resistance levels from greenhouse studies have yielded variable results that do not always correspond with observations seen in production fields.

The objectives of this study were to: 1) establish techniques that can be used to screen varieties for aphid resistance in the field, 2) determine the levels of resistance to the sugar beet root aphid for a number of commercial lines of sugar beets used in western Nebraska, 3) establish the potential limits of the yield response of susceptible and resistant varieties to sugar beet root aphid populations.

MATERIALS AND METHODS

Sugar beet varieties from five seed companies were selected using several criteria including, resistance to common pests (plant diseases and root aphid), yield potential, and commercial availability. In 1998, 28 varieties were tested, in 1999, 36 varieties were tested, and in 2000, 40 varieties were tested. In 1999 and 2000, additional entries were added that included varieties receiving an additional fungicide treatment. Plots were 3 rows wide by 50 feet long, and replicated six times in a randomized complete block design.

In 1998, trials were located at five sites in western Nebraska. In 1999, trials were located at eight sites in western Nebraska, southeastern Wyoming (1 site), or northeastern Colorado (2 sites). In 2000, five sites were located in western Nebraska (2 sites), northeastern Colorado (2 sites), and in southeastern Wyoming (1 site). These sites were chosen to represent a wide range of growing conditions found in the region. All sites were irrigated, with some sites being

irrigated with center pivot (overhead) systems and some sites irrigated with furrow irrigation.

In late September, root aphid populations were evaluated on the sugar beet roots by rating the aphid presence on a 0-5 scale as follows: 0 = no sign of aphids, 1 = 1-2 small aphid colonies, 2 = > 2 small aphid colonies or the equivalent of one larger (1" to 2" dia.) colony, 3 = multiple larger colonies (< 50% of beet area covered), 4 = colonies encircling beet and extending well into soil (>50% of beet area covered), 5 = aphid colonies nearly covering entire surface of beet. This scale is a modification of the rating scale used by Hutchison and Campbell (1994). At all locations, two known susceptible varieties were evaluated in all reps to establish the level of aphid pressure for that location. Those locations with at least moderate root aphid pressure were sampled more extensively by digging and rating five roots from all varieties in all reps. In each year, all varieties were dug at only three sites. At all sites, all three rows of each plot were machine harvested, weighed, and two sub-samples of 8-12 beets taken for quality analysis. Sugar and quality analyses were done by the Western Sugar Company tare laboratory (Gering, NE) or by Holly Sugar Company tare laboratory (Torrington WY).

RESULTS

Sugar Beet Root Aphid Ratings. The average root aphid ratings for two susceptible varieties (Beta 6863, Holly HH110) evaluated at all trial locations are shown in Figure 1. In 1998, only one location had high ratings while three of the remaining trials had moderate populations. Again in 1999, only one location had high aphid ratings with two others in the moderate range. In 2000, there were two fields with high aphid populations and one other location with moderate populations. All varieties were rated at three locations in each year. The average ratings for these fields are shown in Figures 2 (1998), 3 (1999), and 4 (2000). The highest root aphid populations over the three years were seen at the Greeley, CO location in 2000 (Figure 5). The Greeley root rating data are typical of the individual performance of varieties at all the locations. From the root rating summaries, it is apparent that there is a wide range of resistance to the sugar beet root aphid represented by these varieties.

Variety - Yield Relationships. A significant relationship between root aphids and yield was seen at six of the 18 locations; Mitchell and Scottsbluff in 1998, Sterling in 1999, and Greeley, Sterling and Torrington in 2000. At six of the locations there was a significant linear relationship between % sugar and root aphid rating and between sugar yield and root aphid rating. At these locations it was apparent that the varieties with the highest aphid ratings had the lowest percent sugar or sugar yields of all the varieties. Regression lines for these relationships are shown in Figures 6 and 7. The R^2 s obtained for these relationships are surprisingly high as a great number of factors normally impact yield, resulting in a poor ability to predict yield from a single factor. The relationship between aphid ratings and tonnage were significant at some locations, but this relationship was much more variable than percent sugar or sugar yield.

Of all the relationships shown in Figure 6, the slopes were close for all the locations except the 2000 Greeley location (field '2000-2'). The slope at Greeley (-0.47) was much smaller than at the other locations indicating a lower rate of yield loss. The slopes for the remaining locations indicate that % sugar could be reduced nearly a full percentage point for every unit increase in root rating. The resulting losses from a root rating of a '3' would be nearly a reduction in 3 percentage points.

The slopes for the relationship between sugar yield and root ratings are not as consistent and range from -442 to -1028 (Figure 7). This indicates that sugar yield loss rate could vary to a greater degree than reduction in percent sugar. Correlation relationships do not imply cause and effect; however, the consistency of these relationships indicates the potential of a very strong relationship between aphid numbers and sugar yield.

SUMMARY

High levels of root aphid resistance were seen for many varieties, and several varieties were highly susceptible. For six of the 18 locations where aphid presence was the greatest, there were significant linear relationships between % sugar and root aphid ratings and between sugar yield and root aphid ratings. Slope estimates from these regressions showed sugar reductions of as high as one percentage point of sugar for each unit increase in root rating or 1000 pounds of sugar per acre for each unit increase in root rating were seen. These reductions resulted in potentially a 30% reduction in sugar yield across the varieties tested. This is dramatic considering that these fields were irrigated with little or no moisture stress, and no above ground symptoms were seen in the plots.

The techniques used in these trials allowed for evaluation of varieties for antibiotic resistance levels to sugar beet root aphid in the field. Levels of resistance were established for a large number of varieties, and a wide range of resistance exists in the commonly available sugar beet varieties. Data were also obtained that indicate the possibility that tolerance in addition to antibiosis may be involved in root aphid resistance with some varieties. Further work is needed to delineate this possibility. Sugarbeet root aphid populations were well correlated with reductions in sugar percentage and in total sugar yields across varieties ranging from very resistant to very susceptible. Data from this study produced significant regression relationships between % sugar and aphid rating and between sugar yield and aphid ratings in fields with uniform levels of root aphids. These relationships indicate that the aphid may have reduced sugar percentage up to three percentage points and reduced sugar yield up to 3000 pounds per acre (approximately a 30% yield reduction). Other studies and observations indicate that this impact will be magnified under stressed conditions.

LITERATURE CITED

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Figure 2. Average sugar beet root aphid ratings combined over three sites, 1998.

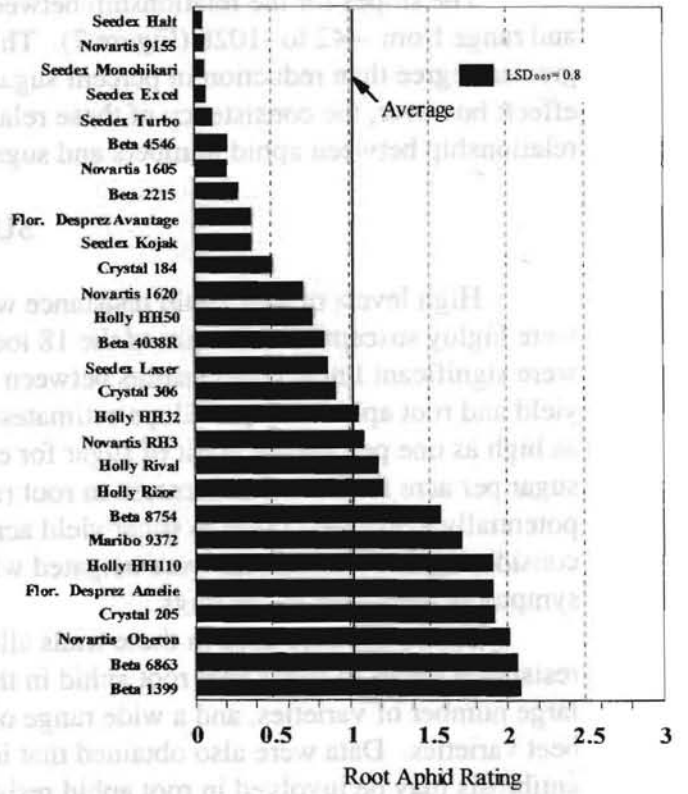


Figure 1. Sugarbeet root aphid occurrence in susceptible varieties; ratings on 0-5 scale, 1998-2000.

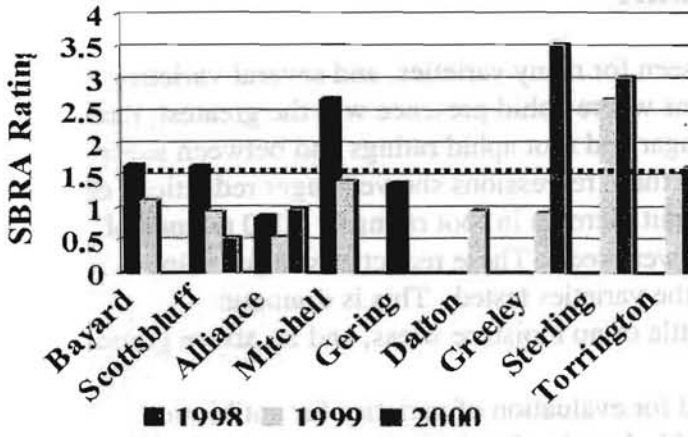


Figure 3. Average sugar beet root aphid ratings combined over three sites, 1999.

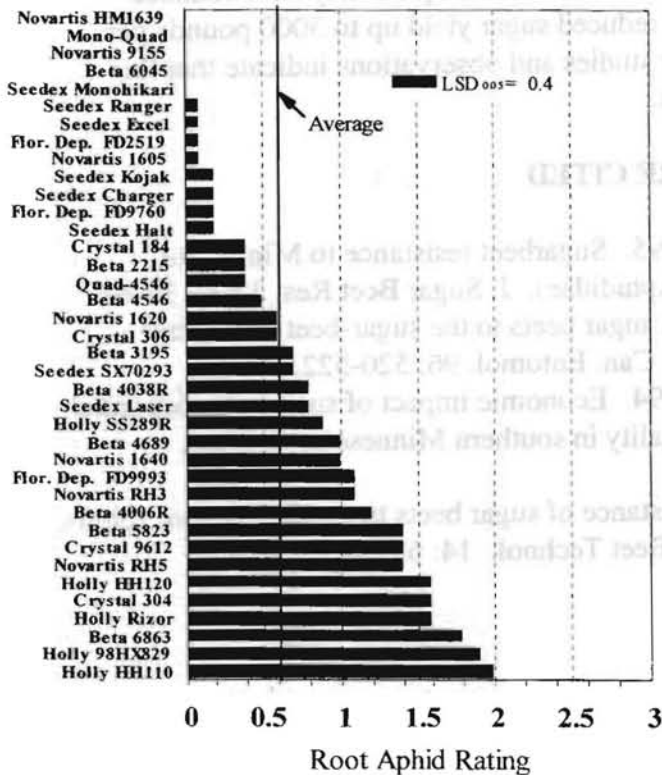


Figure 4. Average sugar beet root aphid ratings, combined over three sites, 2000.

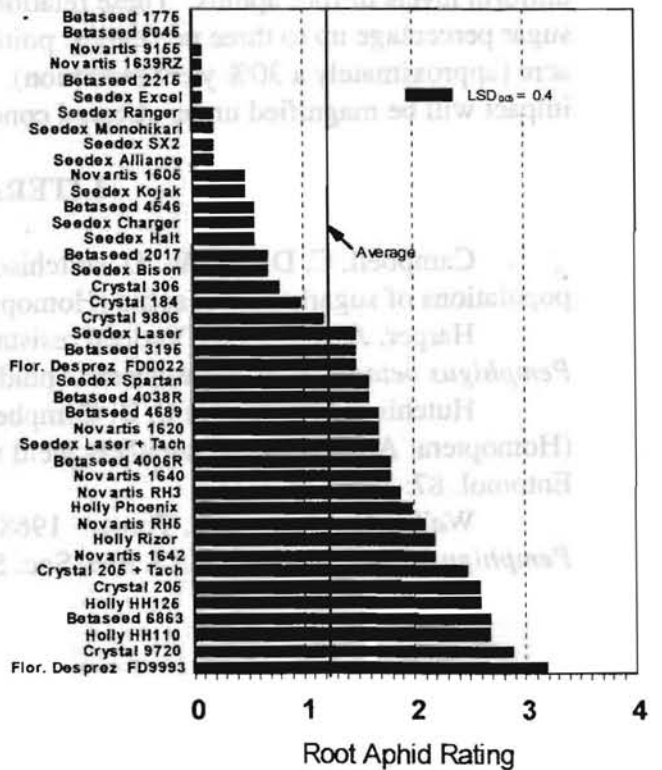


Figure 5. Average sugar beet root aphid ratings, Greeley, CO sites, 2000.

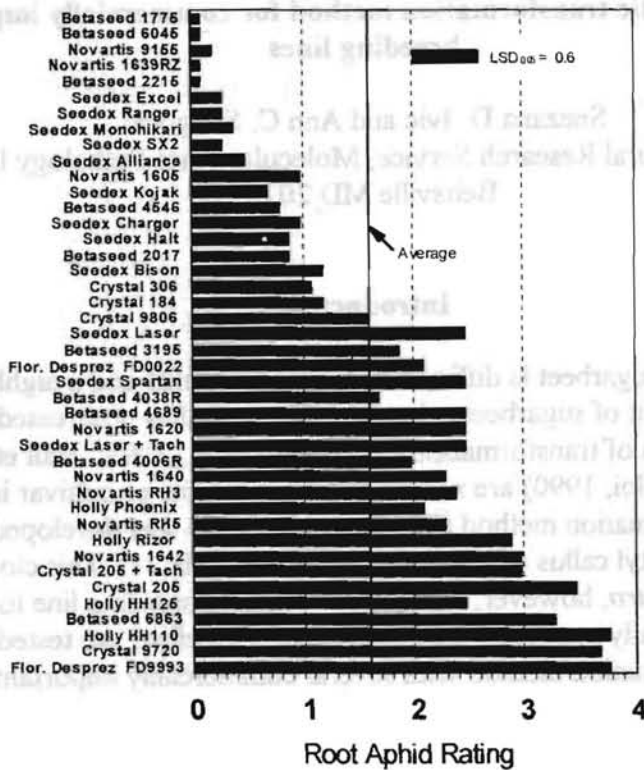


Figure 7. Linear regression relationships between total sugar yield and sugarbeet root aphid ratings (0-5 scale) across all varieties tested at six trial locations (R²'s range from 0.21-0.71).

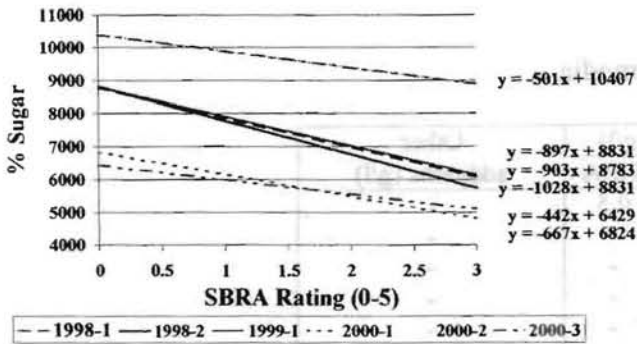


Figure 6. Linear regression relationships between % sugar and sugarbeet root aphid ratings (0-5 scale) across all varieties tested at six trial locations (R²'s range from 0.25-0.60).

