

# SOIL AND MOISTURE FACTORS AFFECTING SUGAR BEET ROOT APHID AND THEIR IMPACT ON SUGAR BEET YIELD

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## Introduction

The sugar beet root aphid is commonly seen throughout many of the sugar beet growing areas in the United States. Resistant varieties are relied upon as a major aphid management tool; however, sugar beet varieties vary greatly in the level of resistance to root aphid feeding. Other options are required to improve management for the aphid. Irrigation and soil cracking have been identified as possible factors in the establishment and rapid increase of sugar beet root aphid populations. Soil cracking that results from moderate compaction over the row at planting may allow for heavy aphid populations to build up on these roots. Dry conditions or severe water stress has often been identified as a major reason for severe late season aphid infestations. As a result, recommendations call for irrigation management to reduce the potential for infestation and to minimize the impact of root aphids. However, we do not know what factors influence aphid establishment during mid summer or how irrigation may influence aphid populations or yield impact. These relationships need to be much better understood to allow us to develop recommendations that may improve our effectiveness at reducing aphid presence and impact. The objectives for this study were: 1) to determine the factors that influence mid-season establishment of sugar beet root aphids in sugar beets and 2) to determine the effect of late season watering practices on sugar beet root aphid populations and damage potential.

## Materials and Methods

**Mid-season establishment of aphids:** Four treatments were tested in a randomized complete block design and replicated six times. The four treatments were:

1. heavy irrigation during the establishment period with moderate soil compaction in the sugar beet row causing in-row cracking between the beets
2. minimal irrigation during the establishment period with moderate soil compaction in the sugar beet row causing in-row cracking between the beets
3. heavy irrigation during the establishment period with normal soil conditions with limited soil cracking between beets
4. minimal irrigation during the establishment period with normal soil conditions with limited soil cracking between beets.

All plots were planted to Beta 6863, a root aphid susceptible variety, on April 15-18, 2002 and April 21-23, 2003. Four row plots of Beta 6863 were used with two rows of Monohikari (aphid resistant) between each plot. Individual plots were 25 feet long with small alleys between the plots. After planting the 'normal' plots, the plot area was watered and the 'compacted' plots were moderately compacted while still wet with a small roller/packer. The 'compacted' plots were then planted. Readings from a soil penetrometer were taken to establish that differences in compaction were seen. In addition, readings on the width and depth of soil cracking indicated

that we did see significant differences between the compaction and no-compaction treatments.

Aphids were reared in the greenhouse and natural aphid infestations were supplemented by infesting greenhouse-grown aphids three separate times from late June through early July. Mid-season watering was carried out beginning in late June and continuing through late July with 1.5 inches applied to each watered plot weekly via a drip tube system. About a week after the final watering (8 August, 2002; 11 August 2003) the first aphid sampling was carried out by digging and rating 5 roots from each of the middle four rows of the plot for aphid presence on the 0-5 ratings scale. After this time all plots received similar watering until the final aphid sampling between 15-18 September when the plots were sampled for aphids again.

**Effect of late season watering practices:** Treatments were arranged in a split-plot within a randomized complete block design and replicated six times. All plots were planted on April 15 (2002) or April 21 (2003) to Beta 6863, a root aphid susceptible variety. Four row plots of Beta 6863 were used with two rows of Monohikari (aphid resistant) between each plot. Individual main plots were 50 feet long with small alleys between the plots. All main plots were watered identically via combined sprinkler and furrow irrigation procedures until 15 August. Beginning on 15 August the following main plot treatments were initiated:

1. No additional watering after 15 August.
2. No additional watering after 1 September.
3. No additional watering after 15 September.
4. Continued watering according to crop needs throughout September.

Each main plot was divided into two subplots (25 feet long each) for aphid infested and non-infested treatments. In late June and early July, three infestations of greenhouse-grown aphids were added to the aphid infested plots to supplement the natural infestations in the plot area. No-aphid plots were treated with Aphistar in mid August to eliminate aphid infestations. Thus, the yield results for all infested plots will be compared to paired plots that do not support any aphids. Plots were sampled for root aphid presence between 20-25 September and maintained until harvest in early October. Root and sugar yields were obtained for all plots.

## Results

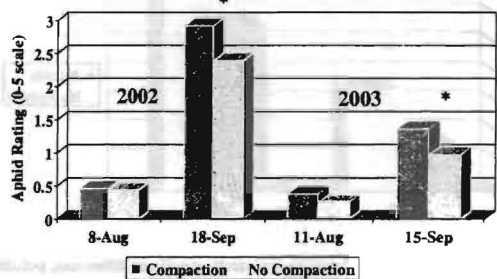
**Mid-season establishment of aphids:** We were able to establish differences in compaction between the plots and watering individual plots via custom drip procedures worked well to maintain the plots under different watering regimes. Compaction readings indicated differences at planting between the plots and care was taken to insure that plant emergence and early development was minimally impacted by these differences by providing adequate watering during plant establishment. In mid-summer 2002, penetrometer measurements indicated differences between the compaction and no compaction plots. Later measures of soil crack width and depth indicated a substantial increase in cracking in 2002 but not in 2003.

The results from this trial are shown in Figures 1-2. Figure 1 shows that the impact of compaction on aphids could not be seen during the early establishment period (August sampling). However, the late season sampling (September) did show a significant increase in aphid presence in the compacted plots in both years. In 2002, this increase was only a 0.5 rating, and both compacted and non-compacted plots had very high root aphid populations by the end of the season. These ratings would represent economic aphid populations for both compaction and non-compaction plots. In 2003, overall aphid ratings were much lower for all plots, and the

increased ratings for the compaction plots to about a rating of 1.4 may have increased the aphid density to a level of concern.

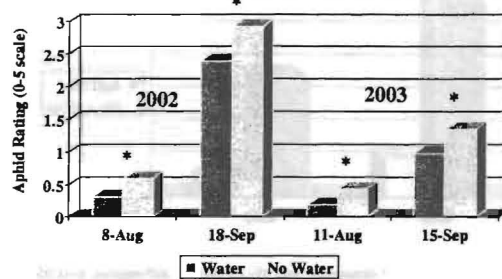
The impact of the mid-season watering is shown in Figure 2. Watering reduced root aphid infestation levels on both early and late sampling dates. The August aphid populations were reduced about 50% by the mid-season watering. But by September 2002, the mid-season watering had only reduced the rating by a 0.5 rating, and both treatments had quite high aphid numbers. Similar results were seen in 2003, but the ratings were not as extreme as in 2002, averaging just under half the aphid ratings. A significant interaction between compaction and watering was seen only in 2003 for aphid rating. The highest ratings were seen for the non-watered and compacted plots compared to all the others. Apparently, the conditions during this mid-season time period do impact aphid establishment, but conditions later in the season may have an even more important effect on the ultimate aphid populations.

**Figure 1. Impact of compaction (increased soil cracking) on sugar beet root aphid population establishment and buildup, Scottsbluff, NE 2002-03.**



\* denotes statistically significant differences, p<0.05.

**Figure 2. Impact of mid-season watering on sugar beet root aphid population establishment and buildup, Scottsbluff, NE 2002-03.**



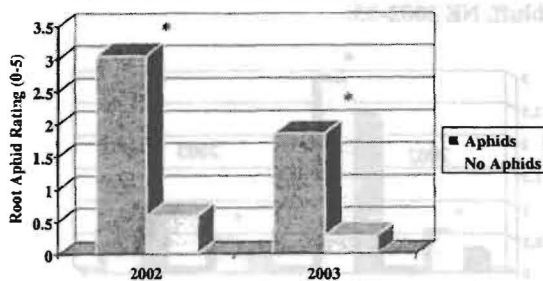
\* denotes statistically significant differences, p<0.1.

**Effect of late season watering practices:** The results of these trials are shown in Figures 3-6. Through our infestation process and the Aphistar treatment, we were able to create high aphid infestations (Figure 3) and establish large differences between the aphid infested and non-infested plots. As in the previous study, aphid populations were lower in 2003 than in 2002. No differences in aphid ratings were seen between the various irrigation treatments, indicating limited impact of late season irrigation on aphid populations. However, data from the sampling of aphids in the soil show the highest number of live aphids in the soil were found in the continuous irrigation. These results are probably due to the fact that aphid populations, especially large aphid populations, tend to decline as plants and soil dry and roots die back in the upper soil layers. Because the aphid rating system also considers the presence of the waxy material produced by the aphids, the aphid rating system also measures the level of past populations. The important point is that all irrigation plots had significant and comparable aphid populations within each year.

Yield impacts from the aphids are demonstrated by the large reduction in sugar percentage (Figure 4). The reduction in sugar percentage for the aphid-infested plots in 2002 was nearly 2 percentage points and nearly 1.5 percentage points in 2003. These differences between years correspond to the different aphid infestation levels that were observed. The difference in

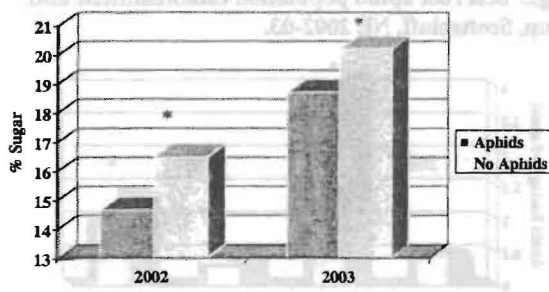
sugar yield between the aphid infested and un-infested plots is shown in Figure 5 for 2002 and Figure 6 for 2003. As would be expected, sugar yield increase with increasing late season irrigation. In 2002, there was a significant reduction in sugar yield for the aphid-infested plots when irrigation was stopped on August 15 and August 30, but they were not different when irrigation was stopped on September 14 or for complete season irrigation. In 2003, the only difference in sugar yield between the infested and un-infested plots was seen when irrigation was stopped on August 15. Considering the aphid rating data that indicate comparable populations between these various irrigation treatments, it can be assumed that the elimination of irrigation after mid and late August dramatically increased the impact of the aphids that are present. These data support previous work that indicates that plant stress during this late season period is critical to eventual impact of the aphids on yield. Consequently, late season irrigation is an important

**Figure 3. Impact of late season irrigation on sugar beet root aphid population rating, Scottsbluff, NE 2002-03.**



\* denotes statistically significant differences,  $p < 0.05$ .

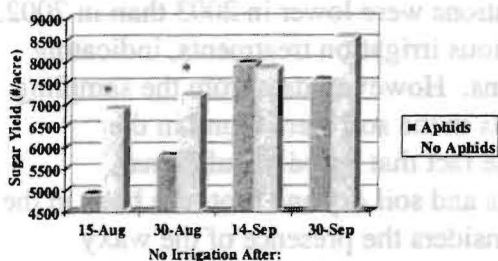
**Figure 4. Impact of sugar beet root aphid population on sugar percentage, Scottsbluff, NE 2002-03.**



\* denotes statistically significant differences,  $p < 0.05$ .

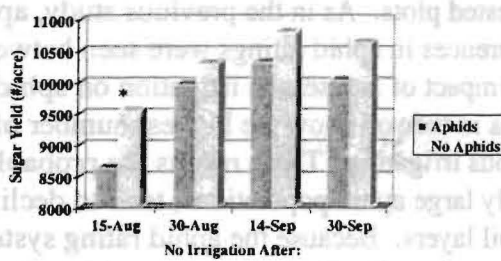
factor in minimizing the impact of the aphid on susceptible varieties.

**Figure 5. Impact of sugar beet root aphids on sugar yields with varying late season irrigation regimes, Scottsbluff, NE 2002.**



\* denotes statistically significant differences,  $LSD\ p = 0.05$ .

**Figure 6. Impact of sugar beet root aphids on sugar yields with varying late season irrigation regimes, Scottsbluff, NE 2003.**



\* denotes statistically significant differences,  $LSD\ p = 0.05$ .