

IMPACT OF SOIL, HYDROLOGIC, AND PRODUCTION-SYSTEM VARIABILITY ON SUGARBEET ROOT APHIDS

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Introduction:

Sugarbeet root aphids (*Pemphigus betae*) are a key pest of sugarbeet in the Central High Plains, but rarely in other production areas of the U.S. This is partly due to the abundance of their winter hosts in this region, primarily narrowleaf cottonwood (*Populus angustifolia*), from which they migrate to sugarbeets each spring. This region is also known for its highly variable soil types on which there are both dryland and irrigated agricultural production systems. Here we document some of the soil, hydrologic, and production variability that can be associated with sugarbeets in this region and the resulting impact on root aphid populations.

Materials and methods:

A compilation of three separate experiments in which sugarbeet root aphid infestation was measured are shown. *Experiment 1*) The interaction of dryland sugarbeets and root aphid resistance, *Experiment 2*) The interaction of deficit irrigation and root aphid resistance, and *Experiment 3*) the interaction of tillage practice and root aphid resistance. For the analyses, the PROC MIXED procedure in SAS is used as appropriate to each experiment below ($\alpha \leq 0.05$). For all studies a rating system (0—5) was used to estimate sugarbeet root aphid population density: 0 = No aphids or colonies, 1 = 1+ colonies <1" diameter equivalence, 2 = 1+, 1" colony or equivalent, 3 = 2 +1+, 1" colonies or equivalent, 4 = colonies/wax on 50+% of root area, 5 = colonies/wax on 75+% of root area. Abbreviate methods for these three experiments follow.

Experiment 1). Two glyphosate-tolerant sugarbeet varieties were planted in 2009 and 2010 that are known to be moderately resistant (Betaseed 66RR70) or susceptible (Hilleshog 9024RR) to root aphids under laboratory conditions. Plot sizes were 12.2 by 3 m, replicated 18 (Dalton, NE), 30 (High Plains Ag Lab, Sidney, NE), or 15 (Hemingford, NE) times per variety. Target plant population densities ranged from 1.48 to 5.93 plants m⁻² and were planted into fields that previously were winter wheat. One location (Sidney, NE) was planted into no-till winter wheat stubble with dense cover because it had been harvest with a stripper head. (Wheat harvested using a stripper head removes only the wheat head leaving behind the entire, upright stem.) Chemical control practices included; seeds treated with clothianidin plus beta-cyfluthrin, an application of lambda-cyhalothrin, and two applications of glyphosate.

Experiment 2). Two glyphosate-tolerant sugarbeet varieties were planted in 2010 that are known to be moderately resistant (Betaseed 66RR70) or susceptible (Hilleshog 9027RR) to root aphids under laboratory conditions. A small-plot sprinkler system was used to set up the following treatments: 1) 100% of full irrigation, 2) % of full irrigation, 3) 50% of full irrigation, 4) 25% of full irrigation, 5) Full irrigation until August 13 then 50% of full irrigation, 6) 75% of full irrigation until August 13 then 25% of full irrigation, 7) 50% of full irrigation until August 13 then full irrigation, 8) 25% of full irrigation until August 13 then 75% of full irrigation, and 9)

No irrigation season long. Treatments were established in plots of 13.4 x 6.7 m and seeded at 148, 257 seeds per ha. Chemical control practices included; seeds treated with clothianidin plus beta-cyfluthrin and two applications of glyphosate.

Experiment 3). Seven glyphosate-tolerant sugarbeet varieties were planted in 2010 that range from moderate (Betaseed 66RR50) to moderately susceptible (Betaseed 66RR60 and Hilleshog 9042RR) to susceptible (Hilleshog 9027RR, Hilleshog 9024RR, HM 4093RR, and Crystal RR714) levels of root-aphid resistance under laboratory conditions. The design was a split split-plot with tillage type in 4 randomized blocks of 2 plots (zone tillage and conventional tillage), the seven, aforementioned varieties, and systematically infested with four differing levels of aphid density per variety. The main tillage plots were 121.92 x 23.45 m with variety plots of 30.48 x 3.35 m. Plots were irrigated under the same linear-move system with full irrigation. The outer two rows of each six-row variety plot were planted to an aphid-resistant variety, Betaseed 66RR50, to try to reduce the spread of root aphids between variety plots.

Results and discussion:

The sugarbeet root aphid can survive under dryland conditions (Fig. 1). This insect's annual migration from the numerous acres of alternate host (found throughout the front range of the Rocky Mountains in Colorado), certainly facilitates the species ability to locate sugarbeet fields even in remote, dryland habitats (e.g., Dalton, NE, Fig. 1). However, its establishment in the sugarbeet crop is dependant on the variety, soil moisture, and soil type. Typically, moist but well-drained soils are the best environment for the production of this aphid. Environmental stresses can lead to a reduced capacity to resist pests and pathogens. In the dryland sugarbeet experiment, the root aphid populations were, on average, very low (Fig. 1). However, even with these low densities, there was still a significantly reduced root aphid density in resistant as compared to susceptible sugarbeet varieties.

The sugarbeet root aphid is not affected by irrigation (Fig. 2). Additionally, regardless of irrigation level, the root-aphid resistant sugarbeet variety had significantly fewer aphids than the susceptible. In fact, there was no significant relationship between irrigation level and root aphid population density. However, although ratings were not affected, plots that had high amounts of moisture tended to have more aphids near the soil surface. This could, in turn, alter the accessibility of root aphids to predatory arthropods.

Lastly, in the third experiment, there were some significant interactions between tillage, root aphid density, and yield. Aphid infestations that developed in the plots were variable with the heaviest infested plot (CRR714) averaging a rating of 3.4 and the least infested plot (Beta 66RR50) averaging 0 (Fig. 3). There were significant differences by aphid infestation level and tillage intensity for some varieties. The variety by aphid infestation interaction was not significant for any independent variable, this indicates that varieties responded similarly to aphid infestation level. However, the overall response to aphids did vary between varieties. Zone tillage resulted in higher root aphid numbers for varieties with low aphid resistance (Fig. 3). The one exception might be HM9042RR; it had a slightly higher number of aphids in the full tillage plots.

Because of the higher aphid infestation levels for most varieties within the reduced tillage plots, varieties under those conditions showed the most dramatic response to aphid infestation (Fig. 4). There was a significant increase in pounds of sugar in the moderately-resistant aphid varieties Beta66RR60 and Beta66RR50, in part due to their much lower aphid pressure (Fig. 3).

The aphid-infested plots for CRR714, in the higher-yielding reduced tillage plots, yielded about 1600 pounds of sugar per acre less and loss about 0.19% more sugar to molasses than the non-infested plots. Aphid infestations exceeding a rating of 1.5 to 2.0 result in significant yield losses in previous experiments. Therefore, this yield loss is not surprising for CRR714 as a result of the presence of aphids represented by a rating of 3.4.

The results from these experiments indicate that while irrigation may not influence root aphid abundance, season-long moisture availability can impact aphid numbers. This is particularly highlighted by the dryland sugarbeet experiment, *Experiment 1*. Neither irrigation nor semi-arid conditions seem to influence the ability of resistant sugarbeet varieties to suppress root aphids. Regarding the influence of tillage, overall, moderately resistant lines (e.g., Beta6RR50) are not affected by tillage; however, some susceptible or moderately susceptible lines may be. Root aphid population density apparently is not governed by irrigation as much as season-long moisture availability; therefore, it may be that the soil structure under zone-tillage improves season-long moisture-holding capacity and thereby increases root aphid populations. However, there could be other physical soil properties that cause this increase in aphid population under zone-tillage conditions. Additionally, work is underway to understand how tillage impacts beneficial, edaphic arthropod communities that may regulate root aphid populations.

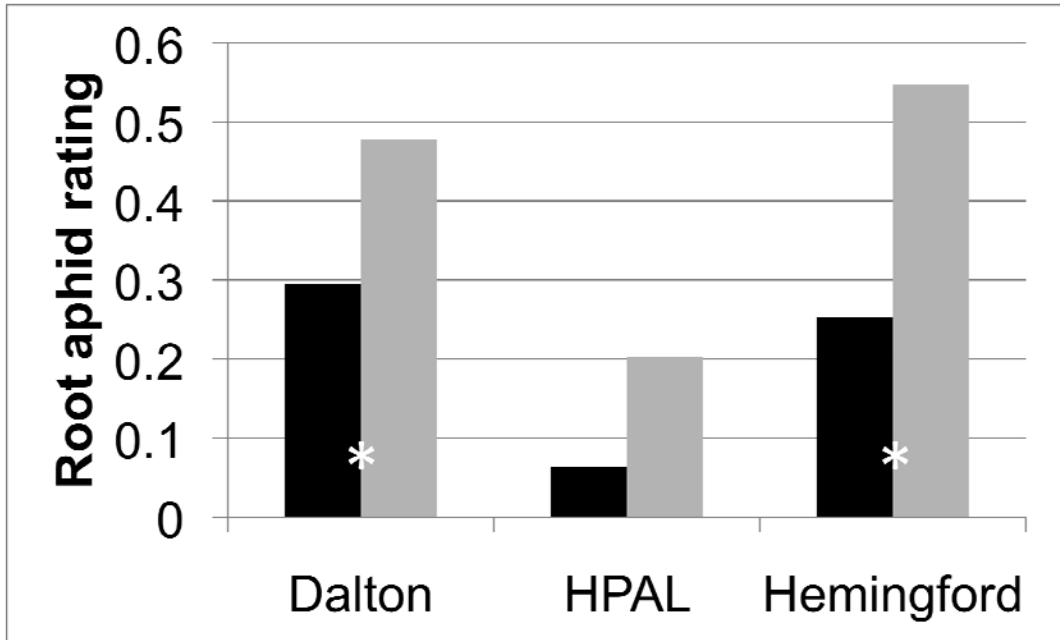


Figure 1. Sugarbeet root aphid ratings for three dryland sugarbeet locations in Nebraska (Dalton, High Plains Agricultural Lab [near Sidney], and Hemingford (averaged for 2009 and 2010). Black bars are root-aphid sugarbeet moderately resistant variety (Beta66RR70) and gray bars are a variety susceptible (HM9024RR). An asterisk denotes significant differences ($p=0.05$) between resistant and susceptible varieties.

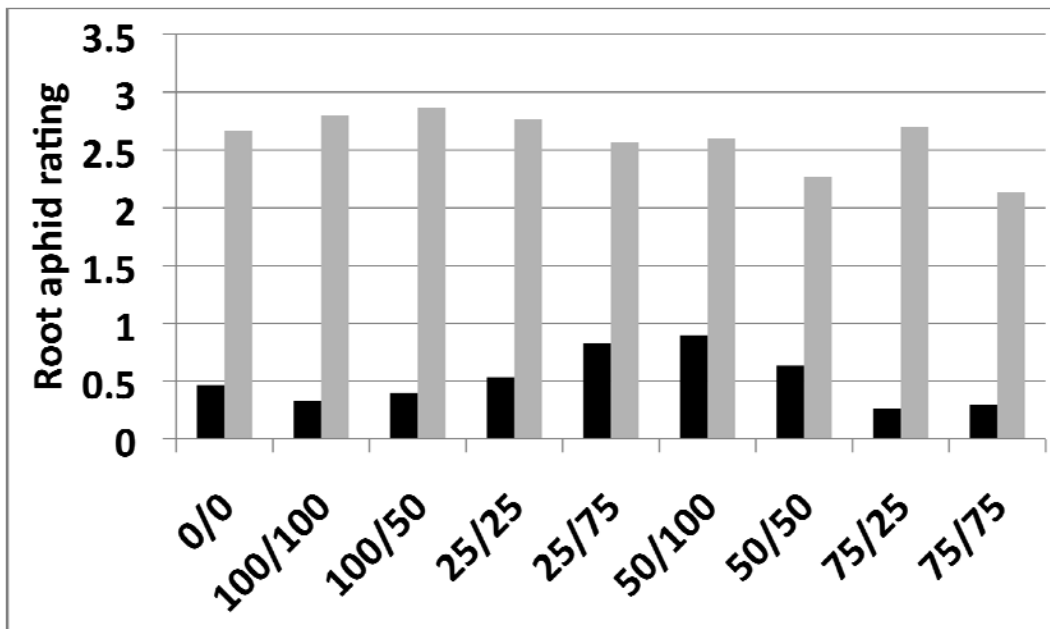


Figure 2. Sugarbeet root aphid ratings for nine irrigation treatments in Scottsbluff, Nebraska in 2010. Treatments were applied as a combination of (X% early/X% late), or a percent of full early irrigation and percent of full late irrigation. Black bars are root-aphid sugarbeet moderately resistant variety (Beta66RR70) and gray bars are a variety susceptible (HM9027RR).

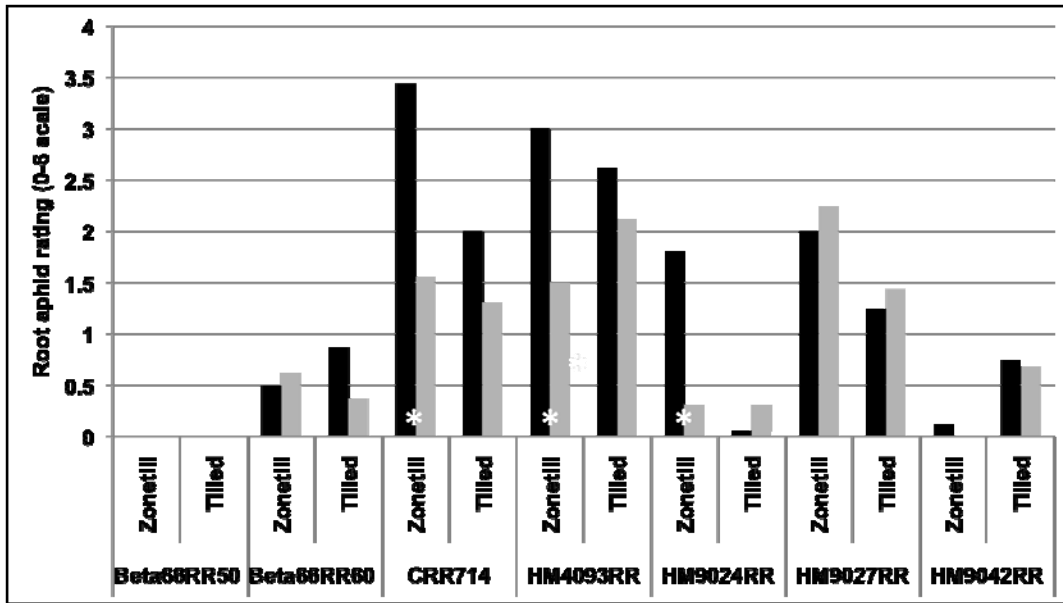


Figure 3. Effect of the tillage on 'high' (black bars) and no artificial field infestations (gray bars) of sugarbeet root aphid on sugarbeets of various levels of aphid resistance, PREC, Scottsbluff, 2009. An asterisk denotes significant differences ($p=0.05$) between infestation levels within variety, within tillage.

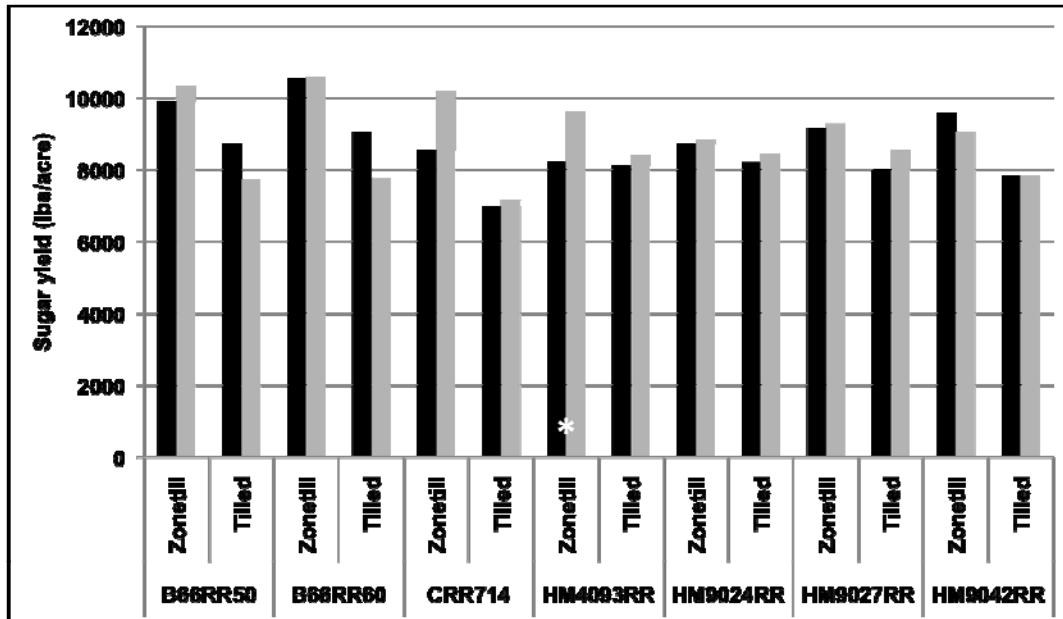


Figure 4. Effect of tillage on 'high' (black bars) and no artificial field infestations (gray bars) of sugarbeet root aphid on pounds sugar per acre, PREC, Scottsbluff, 2010. An asterisk denotes significant differences ($p=0.05$) between infestation levels within variety, within tillage.