Energy Beet Performance in a Saline Environment and Comparison to Other Cash Crops

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Introduction

Energy beets are one of the most saline tolerant crop species available in the Northern Great Plains. Because it is rare to find suitable fields with uniform soil salinity gradients, most research to determine crop salinity tolerance levels are limited to laboratory studies. This means very little research has been conducted to quantify this level of tolerance under field conditions.

Materials and Methods

Four plant species including energy beet, barley, wheat, and soybean, were evaluated for their relative tolerance to a saline environment two miles south of the Carrington Research Extension Center, near Carrington (ND) in 2012. This study was conducted with collaboration from Betaseed. The site chosen had electrical conductivity (EC) values ranging from suitable (0.5-1) for the species planted, to moderately or highly phytotoxic (>5) levels to most crop species. Soil EC is a measure of salt (salinity) levels. Soybean, wheat and barley were included in this study due to their low, intermediate, and relatively high salt tolerance, respectively. The study was planted on May 18. The four crop species were each randomly planted in strips along a salinity gradient within each of three replicates. Along each crop strip in each replicate, 25 foot plots of fairly uniform gradients were measured. From each plot, composite soil samples and four averaged EC measurements were taken. Plant population, biomass, and yield were measured. Wheat and barley were harvested on August 9 while energy beets were harvested on October 30.

Results

Figure 1 shows the EC values in four different zones of replicate one and two throughout the growing season. The gradient zones identified clearly show increasing saline conditions in each progressive area. Throughout the year, the salinity did not greatly change within each zone.

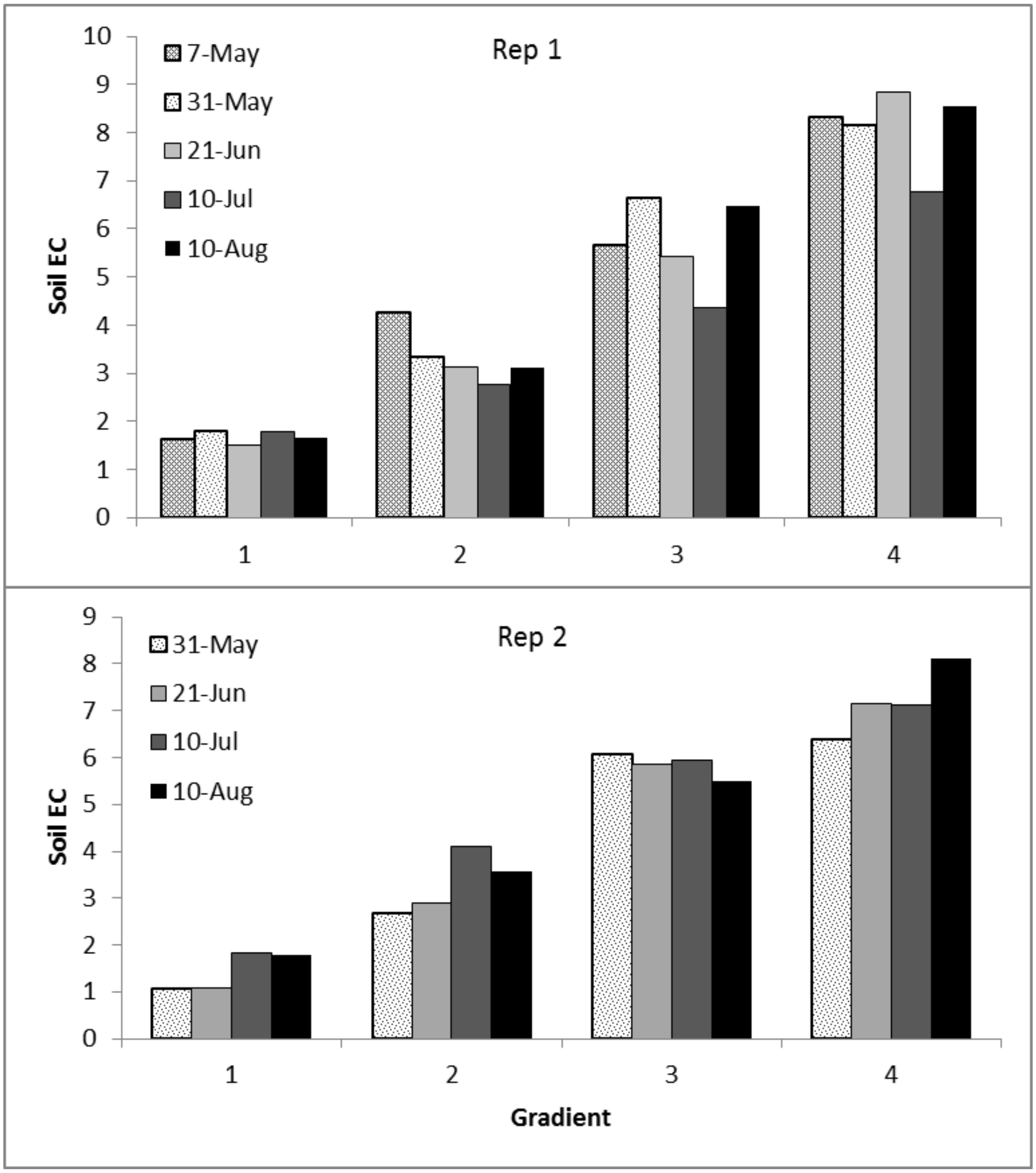

Figure 1. Change in EC values during the 2012 growing season.

Exponential decay models were applied to barley, soybean, and wheat stand count data across the saline gradient (Figure 2). Soybean populations were reduced rapidly when EC levels increased, but closely followed the same trend as wheat. Barley populations decreased the least and followed a much more gradual trend. Energy beets could not be modeled since no stand reduction occurred even at the highest EC levels measured.

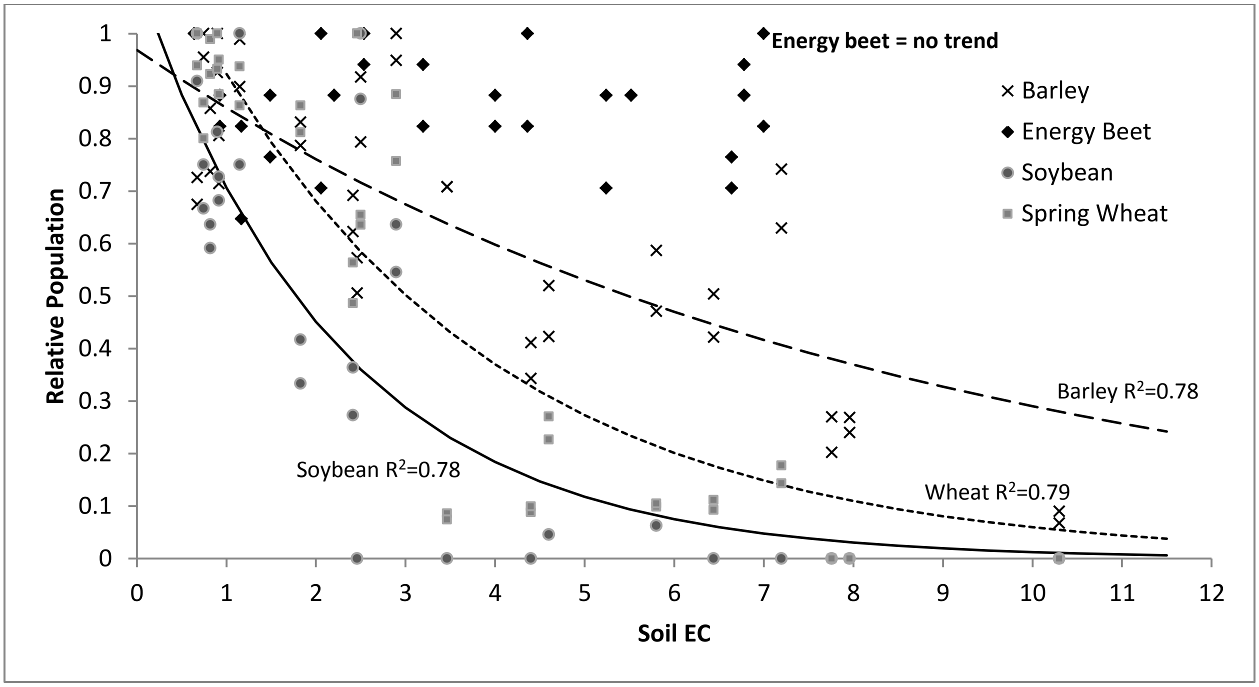

Figure 2. Stand density of several cash crops across a saline gradient.

Based on these models, a GR_{50} can be calculated. In this case, GR_{50} represents the EC value causing a 50 percent reduction in stand. This gives an idea of the relative saline tolerance of each species. Based on plant population, barley, with a GR_{50} of 5.48 dS/m, is roughly 3x more tolerant to this saline environment than soybean at 1.77 (Table 1). Barley is also almost twice as tolerant as wheat. Again, energy beet could not be calculated since the EC did not reach a high enough level to cause a stand reduction.

Table 1. Relative growth reduction due to EC for 2012.

	-------------- GR_{50} --------------		
	Wheat	Barley	Soybean
	--------- mmho/cm -----------		
Stand	3.01	5.48	1.77
Biomass	1.17	3.92	-
Yield	1.01	3.22	-

Plant height was also affected by salinity (Figure 3). Wheat and barley were measured for this effect with a significant downward trend in both cases. However, once again the slope of the barley trend was less severe than that of wheat.

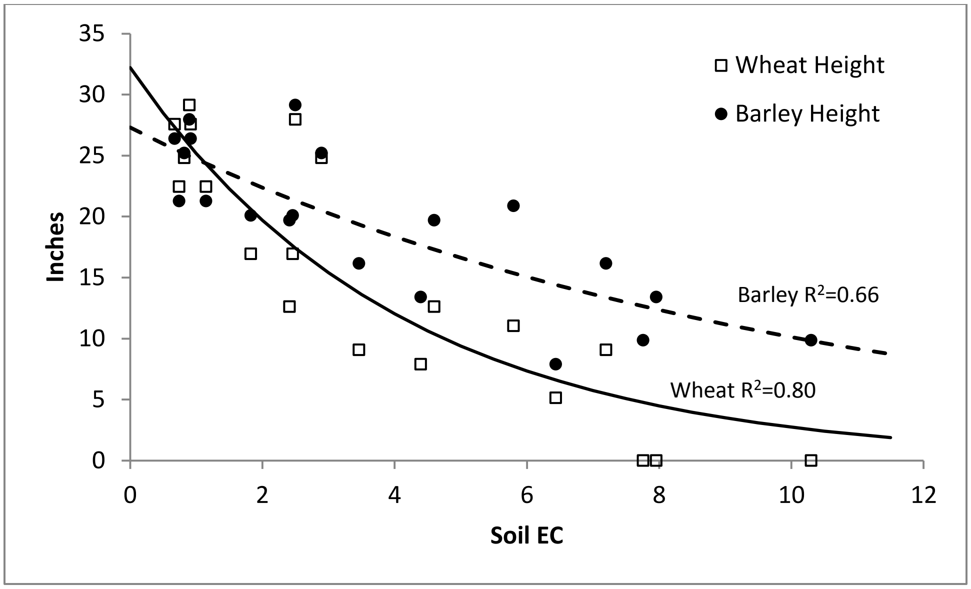

Figure 3. Height of wheat and barley across a saline gradient.

Wheat and barley biomass and yields were collected (Figure 4). In each case, wheat was reduced at a greater rate than barley. No wheat survived until harvest past an EC of 4 in this study. On the other hand, barley continued to produce some yield and biomass until close to an EC of 10. Even at EC 10, there was a small amount of barley biomass collected, but no yield. This is reflected in the GR_{50} values for each species (Table 1). In each case, barley was three to four times more tolerant to saline conditions of this environment.

Energy beets in a high-salinity plot.

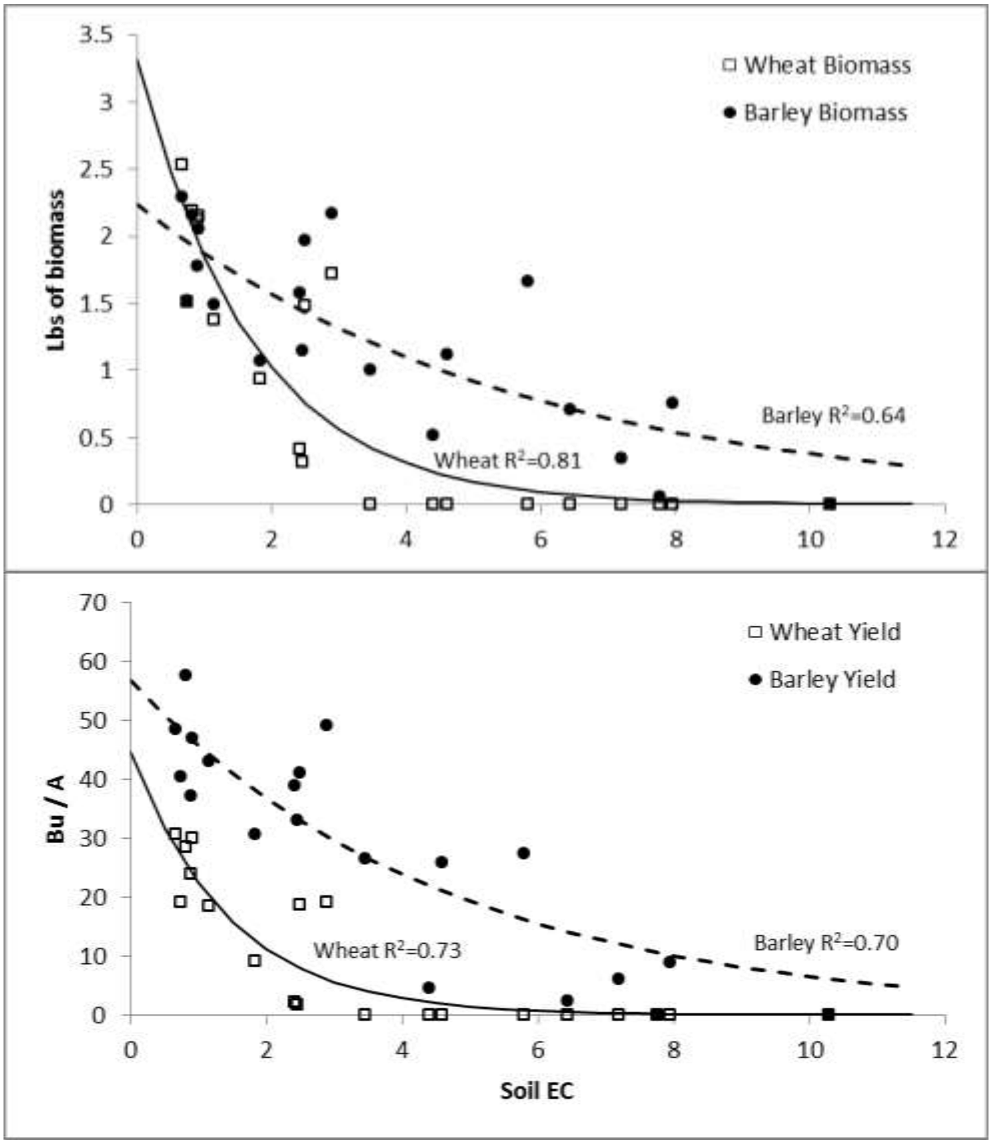

Figure 4. Biomass and yield of wheat and barley across a saline gradient.

Energy beet was unique in its response to the saline gradient. As the EC values increased, so did the yield (Figure 5). Both above and below ground portions of the energy beet had upward yield trends. This can partially be explained by the increase in lb/beet shown in Figure 5. In this case, the size of each beet increased fairly rapidly with increasing EC. One likely reason for this is due to the below-average moisture for the year. The energy beets growing in the highest EC areas also corresponds to the lowest points in the area, where soil organic matter is higher and the beets are more likely to gain access to the limited water. Another reason for this trend would be that there was sometimes more space for growth and sunlight acquisition at higher ECs. Even though there was not a noticeable drop in plant population with increasing EC, even a small opening will allow the potential for much greater biomass accumulation per energy beet. Overall, the yield spread was quite large, ranging from 5 to 30 tons/ac. But once again, a GR_{50} could not be calculated since no yield reducing trend was observed.

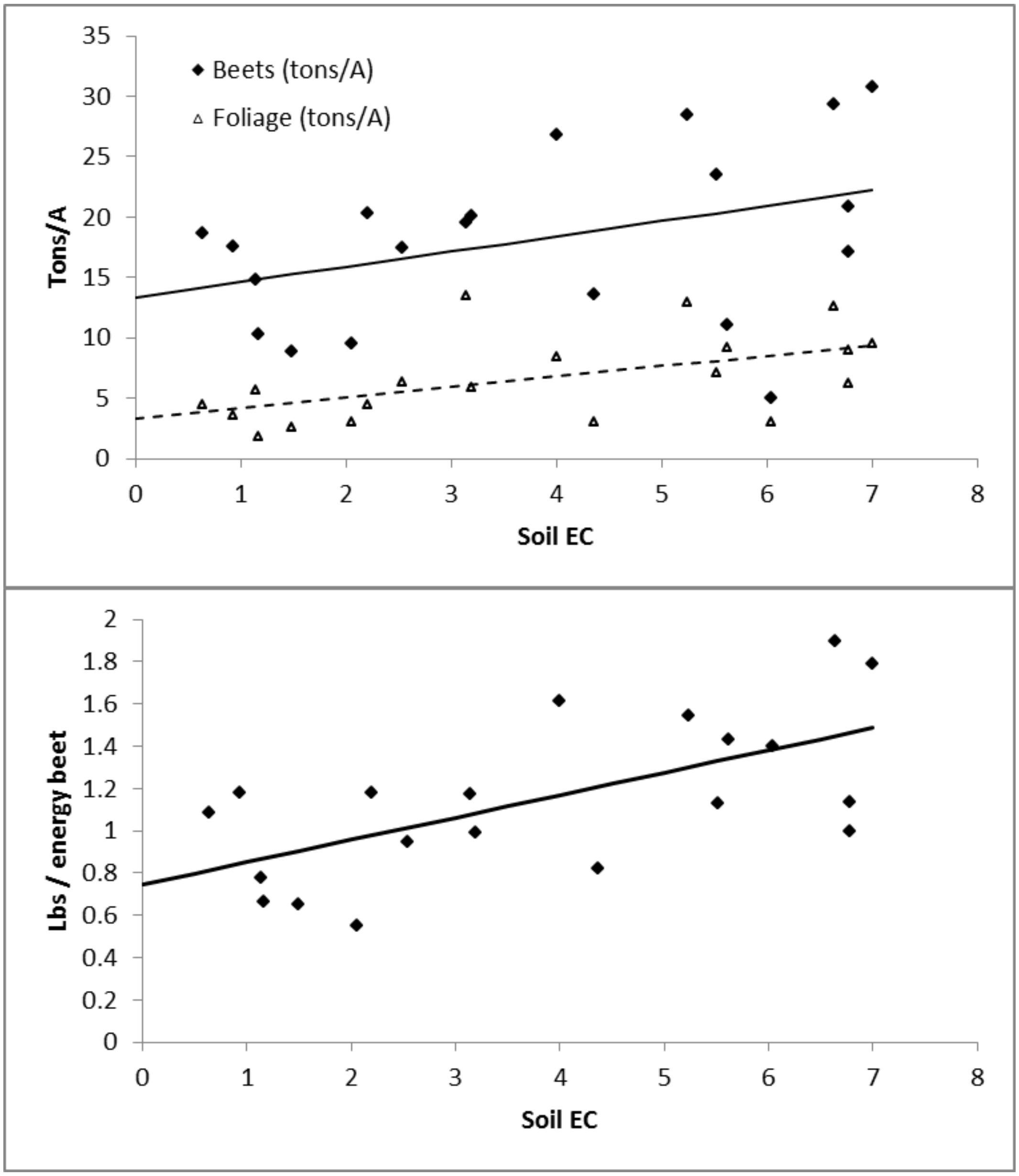

Figure 5. Above and below ground energy beet yield across a saline gradient.

The trend for increasing energy beet yield at higher EC levels was impressive. This indicates that even in a soil environment at EC levels near 8, established energy beets can not only survive, but actually thrive. As this is only a single year of observations, the results remain inconclusive and require further investigation before any conclusions can be drawn.