Early-season competition for nitrogen by sugarbeet and volunteer corn

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Introduction

- Michigan research has shown that volunteer glyphosate-resistant corn populations of 1.7 plants m^{-2} can significantly reduce glyphosate-resistant sugarbeet yield and recoverable white sugar per hectare, especially if they are not controlled by V4 v. corn.
- Replacement series research designs are often used to examine the affects of a competitive factor on a crop: weed relationship.
- Blackshaw and Brandt (2008)[a] used a replacement series design to evaluate the aggressivity for nitrogen of Persian darnel, Russian thistle, redroot pigweed, and wild oat when grown in mixture with wheat.

Objective

- Determine if competition for nitrogen may be contributing to the sugarbeet yield losses associated with volunteer corn.

Materials and Methods

- Greenhouse research conducted at East Lansing, MI, in 2014
- RCB design with factorial arrangement, 4 replications
- Replacement series experimental design
- Sugarbeet to v. corn proportions of 100:0, 75:25, 50:50, 25:75, 0:100 (8 plants pot^{-1})
  - Sugarbeet seed: 'HM 173 RR'
  - 'F2' glyphosate-resistant volunteer corn
- Nitrogen fertilizer rates of 0, 67, 101, 134, and 168 kg N ha^{-1} were applied in aqueous solution of urea (46-0-0), 1 WAP
- Measurements:
  - Soil samples at planting
  - Dry weight $species^{-1}$ pot^{-1} [Yield]
  - Soil nitrogen of 50:50 mixtures (n=20)
  - Total nitrogen concentration of plant tissue (n=160)
- Relative Yield (RY), Relative Nitrogen assimilation (RN), and Aggressivity Indices (AI) were calculated
- Equations:

[1] RY or RN = Yield or N assimilation in mixture/ Yield or N assimilation in monoculture

[2] AI = (RY or RN of v. corn) – (RY or RN of sugarbeet)

- Analyzed with PROC MIXED in SAS
  - Interactions were tested
  - Means separated with Fisher's Protected LSD ($p \leq 0.05$)

[a] Blackshaw, R. E. and R. N. Brandt. 2008. Nitrogen fertilizer rate effects on weed competitiveness is species dependent. Weed Sci. 56:743-747

Results and Discussion

- The nitrogen concentration of sugarbeet grown in monoculture was higher than the nitrogen concentration of v. corn grown in monoculture with 1.47% and 0.84%, respectively, when data were combined over nitrogen rates. The nitrogen concentration of sugarbeet was also greater in each mixture (data not shown).
- Volunteer corn was more competitive for nitrogen than sugarbeet at the proportion of 25:75 (sugarbeet:corn) ratio when nitrogen was applied. When no nitrogen was applied, sugarbeet were able to outcompete v. corn (Table 1). This may help sugarbeet compete with v. corn clumps in the field because of the high density and increased demand for nitrogen (Figure 1).
- Sugarbeet was more aggressive for nitrogen than v. corn in the 50:50 mixture (Table 1, Figure 2). Sugarbeet acquire the most nitrogen early in the growing season whereas the peak nitrogen uptake of corn occurs prior to the reproductive stages. The lack of overlap in nitrogen uptake growth habits may lessen the pressure applied by v. corn to sugarbeet early in the season (Figure 1).
- Relative yield of sugarbeet was greater than relative yield of corn at proportions of 75:25 and 50:50 at all nitrogen rates (Table 1).
- In a 25:75 mixture, v. corn was more aggressive at all nitrogen rates, but was significantly less aggressive when no nitrogen was applied (Table 1).

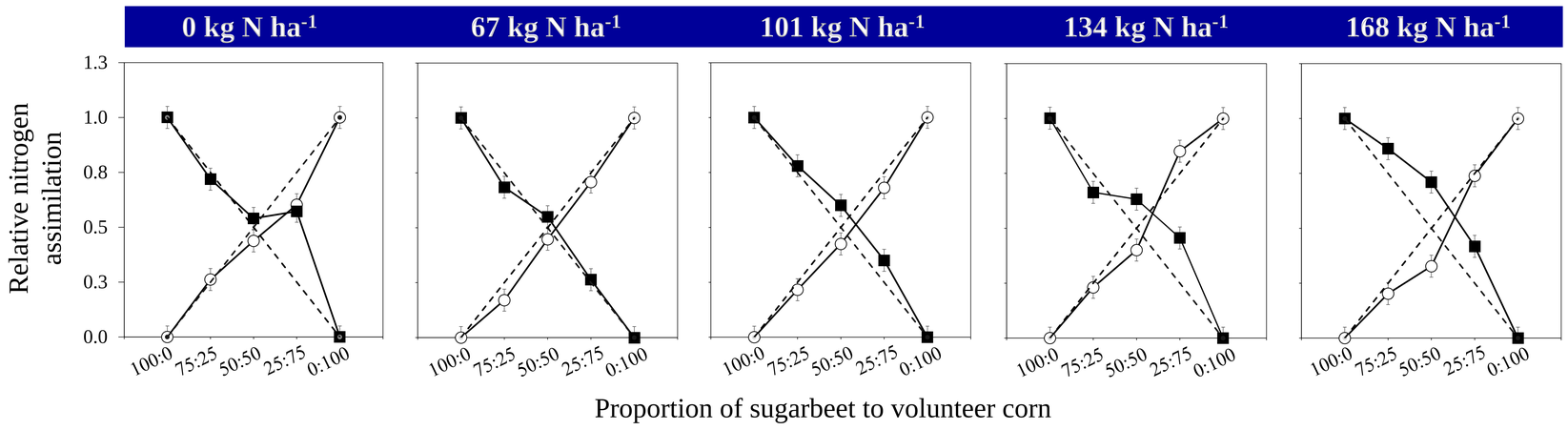

Figure 1. Relative nitrogen uptake of glyphosate-resistant sugarbeet (■) and glyphosate-resistant volunteer corn (○) grown in competitive mixtures at five nitrogen rates. Vertical bars represent standard error of the mean.

Table 1. Effect of nitrogen rate on volunteer corn aggressivity index values when competing with sugarbeet at proportions of 100:0, 75:25, 50:50, 25:75, 0:100 (sugarbeet: v. corn).

Nitrogen fertilizer rate	Nitrogen Aggressivity Index			Yield Aggressivity Index		
	75:25	50:50	25:75	75:25	50:50	25:75
0 kg N ha^{-1}	-0.43 a	- 0.13 a	- 0.03 a	-0.50 a	- 0.23 a	0.18 a
67 kg N ha^{-1}	-0.48 a	- 0.14 a	0.45 b	-0.48 a	- 0.11 a	0.52 b
101 kg N ha^{-1}	-0.65 a	- 0.17 a	0.31 b	-0.50 a	- 0.01 a	0.40 b
134 kg N ha^{-1}	-0.45 a	- 0.23 ab	0.40 b	-0.46 a	- 0.15 a	0.42 b
168 kg N ha^{-1}	-0.52 a	- 0.40 b	0.32 b	-0.46 a	- 0.25 a	0.38 b

[a] Positive and negative AI values of v. corn indicated that the weed was more and less competitive with sugarbeet, respectively.
[b] Yield or nitrogen assimilation of corn in mixture and of corn and sugarbeet in monoculture were used to calculate AI values.
[c] Means followed by the same letter within a column are not statistically different at the $\alpha \leq 0.05$ level of significance.

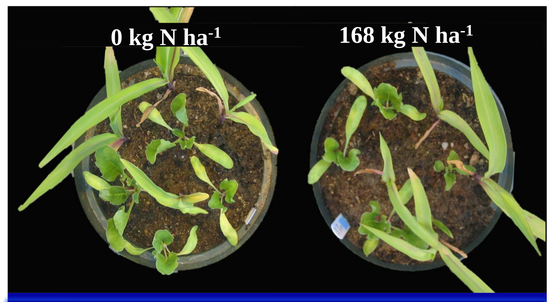

Figure 2. Sugarbeet and v. corn grown in 50:50 mixture with 0 kg N ha^{-1} and 168 kg N ha^{-1}.

Conclusions

- Volunteer corn is capable of reducing the yield and quality of sugarbeet.
- Sugarbeet competes effectively for nitrogen (early in the growing season) when the density of v. corn is less than or equal to that of sugarbeet. At greater densities, sugarbeet can outcompete v. corn only in nitrogen-limited growing conditions.
- In terms of relative yield, v. corn growing at greater densities than sugarbeet are more aggressive than sugarbeet from 0 kg N ha^{-1} to 150 kg N ha^{-1}.
- Sugarbeet nitrogen uptake and growth were not reduced by v. corn in balanced mixtures.
- Results indicate that early-season competition for nitrogen is not the primary yield-reducing pressure applied by v. corn on the growth and development of sugarbeet. Shading may be the most detrimental impact.