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Long-term Evaluation of Hybrid, Nitrogen, and Potassium Interactions in Continuous Corn

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Abstract
A long-term experiment was established in 2009 to study continuous corn responses to potassium (K), nitrogen (N), and hybrid rootworm resistance. Previous research suggested a need for this study. A long-term trial conducted until 2001 at the ISU Northern Research Farm showed that the maximum corn yield level and the N rate that maximized yield was higher when K was optimal or greater. In contrast, the relative yield response to N and the N rate that maximized yield were similar for soil-test phosphorus (P) levels ranging from very low to very high. Other studies have shown that rootworm resistance often increases yield compared with untreated susceptible hybrids. Also, that rootworm resistance does not consistently affect the K rate that maximizes yield, but increases K removal because of the higher yield levels. Therefore, this new study evaluates possible interactions between rootworm resistance and N and K fertilization in corn.

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Introduction

A long-term experiment was established in 2009 to study continuous corn responses to potassium (K), nitrogen (N), and hybrid rootworm resistance. Previous research suggested a need for this study. A long-term trial conducted until 2001 at the ISU Northern Research Farm showed that the maximum corn yield level and the N rate that maximized yield was higher when K was optimal or greater. In contrast, the relative yield response to N and the N rate that maximized yield were similar for soil-test phosphorus (P) levels ranging from very low to very high. Other studies have shown that rootworm resistance often increases yield compared with untreated susceptible hybrids. Also, that rootworm resistance does not consistently affect the K rate that maximizes yield, but increases K removal because of the higher yield levels. Therefore, this new study evaluates possible interactions between rootworm resistance and N and K fertilization in corn.

Treatments and Procedures

The experiment was established in Mahaska soil, which had a history of light to moderate rootworm infestation and a soil-test K level of 170 ppm. The plots were managed with continuous corn, chisel-plow/disk tillage, a target population of 35,000 plants/acre, and 30-in. row spacing. Treatments were all the combinations of two hybrids, four annual K rates, and five annual N rates. Hybrids have been DKC63-42 VT3 (RR2-YGRW/YGCB, rootworm resistant) and the susceptible isoline DKC63-46 RR2/YGCB. The K rates were 0, 24, 48, and 72 lb K_2O/acre. The N rates were 0, 75, 150, 225, and 300 lb N/acre applied in the spring. The N source was granulated urea in 2009 but injected UAN in recent years. The K source has been potassium chloride, which was broadcast in the fall before chisel-plowing. No rootworm insecticide was applied.

Measurements for all plots were N-P-K concentrations of ear leaves at the silking, grain yield, grain nutrient concentrations and removal, and post-harvest soil-test K. Rootworm root injury ratings, aboveground plant weight, and plant N-P-K concentrations were measured at the silking stage for both hybrids in plots of four contrasting N and K treatments. Rootworm injury is rated according to the Iowa State University node injury scale (NIS). This report summarizes results for grain yield and rootworm injury.

Results and Discussion

Rootworm injury ratings. Table 1 shows average rootworm injury ratings for the four treatments sampled in the last two years of the study. The resistant hybrid showed very light injury, but for the susceptible hybrid the injury was light to moderate. Both N and K fertilization for the susceptible hybrid reduced rootworm injury compared with no fertilization. The effect was greater for N than for K, and this was consistent for the three years of the study.

Grain yields and responses. The yield response to N fertilization was very large each year, which is expected for continuous corn. Potassium fertilization did not affect yield the

first year, probably because the initial soil-test K value was borderline between the Optimum and High categories. Small responses to K application were observed in 2010 and were larger in 2011, as soil-test K of the plots receiving no K began to decline. There was no clear difference between the three annual K rates in any year. Grain yield for the two hybrids was similar in 2009, but the rootworm resistant hybrid yielded more than the susceptible hybrid in 2010 and 2011.

The most interesting result observed in the last two years was that K fertilization strongly influenced the corn response to rootworm resistance and N fertilization, even when the response to K was small.

Figure 1 summarizes yield responses by showing effects of the five N fertilization rates for each corn hybrid for plots with or without K fertilization. The graph for plots that received no K fertilization (1A) shows a large response to N, a moderate yield advantage for the resistant hybrid (about 10 bu/acre on average), and a maximum yield level of about 150 bushels/acre. The graph for plots that were fertilized with K (1B) looks very different, however. With K fertilization, the resistant hybrid yielded more than the susceptible hybrid, the difference became larger as the N rate increased, and there was a higher maximum yield level for the resistant hybrid (25 bu/acre higher).

Figure 2 shows the same data as in Figure 1 in a different way to better visualize the N by K interaction for the resistant hybrid. The graph for the resistant hybrid (2A) shows a large response to N that was higher with K than without K, and a higher maximum yield level with K (15 bu/acre higher). The graph for the susceptible hybrid (2B) shows a large response to N but no difference between K levels in the yield level or response to N fertilization. Therefore, there was a clear N by K interaction for the resistant hybrid but not for the susceptible hybrid.

From these results it is clear that adequate K supply and rootworm resistance increased corn grain yield levels and also the yield response to the N rates applied. The maximum yield of both hybrids was achieved with the same N rate of 300 lb N/acre. The results confirm results observed years ago at the ISU Northern Iowa Research Farm concerning an N by K interaction. This interaction sometimes has been observed for corn in other states.

The study did not include a rootworm insecticide treatment for the resistant or susceptible hybrid. We believe that there would be similar effects of rootworm control and the N by K interaction might be observed if a susceptible hybrid is treated with insecticide.

Conclusions

Adequate K fertilization levels were needed to maximize the benefits of N fertilization and rootworm resistance or control for corn. Management and climate greatly affect yield levels, rootworm incidence, and yield responses to fertilization. Therefore, we plan to continue this study to collect data over several more years.

Acknowledgements

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Table 1. Rootworm root injury as affected by the corn hybrid and N or K fertilization (averages for 2010 and 2011).

		N Rate (lb N/acre)		
Hybrid	K rate	0	300	Average
	lb K_2O/acre	-------- Injury rating† --------		
Resistant	0	0.15	0.17	0.16
	72	0.05	0.07	0.06
	Average	0.10	0.12	0.11
Susceptible	0	0.95	0.66	0.80
	72	0.87	0.41	0.64
	Average	0.91	0.51	0.71

†Iowa State University node injury rating, which ranges from 0 to 3.

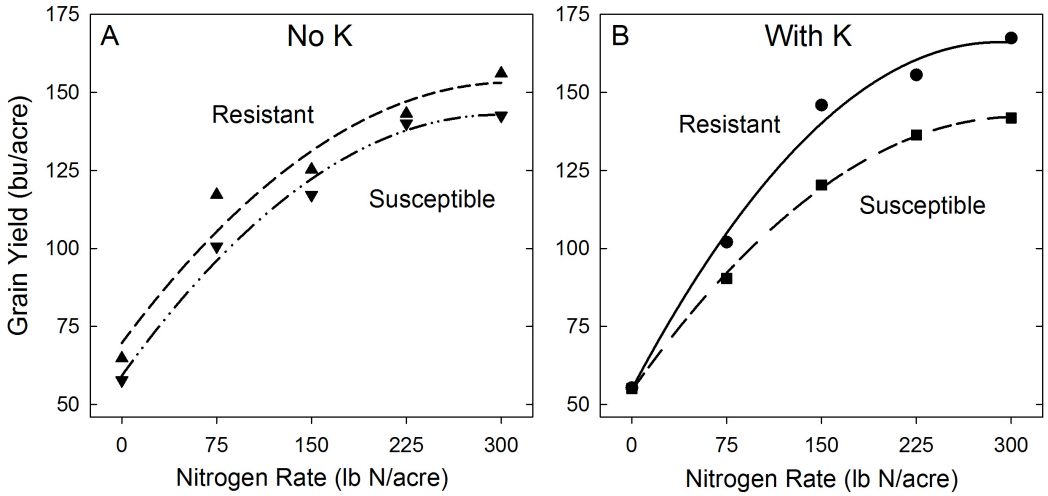

Figure 1. Corn yield for two levels of K fertilization (graph A and B) as affected by rootworm resistance and five N fertilization rates.

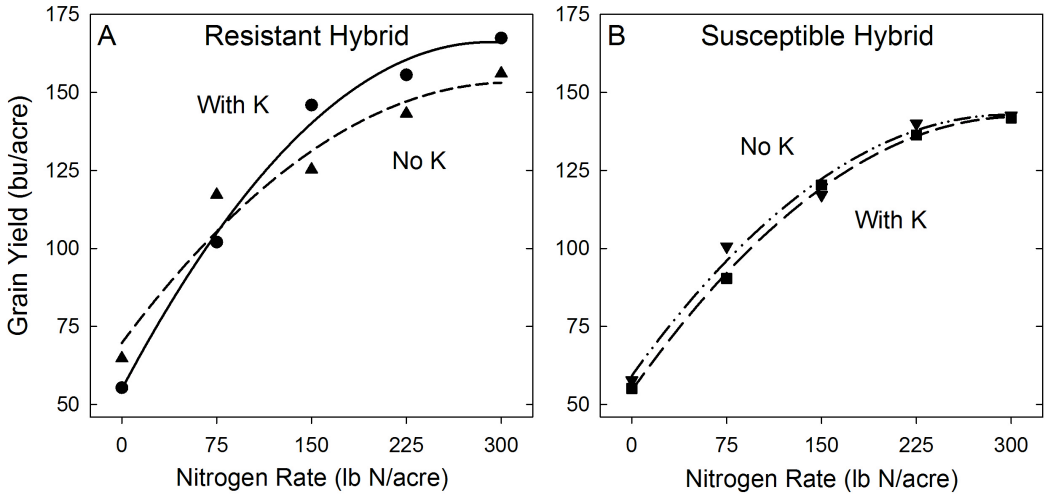

Figure 2. Corn yield for hybrids with and without rootworm resistance (A and B) as affected by two levels of K fertilization and five N fertilization rates (similar data as in Figure 1 arranged differently).