Watch potassium management—It also effects corn response to nitrogen and soybean diseases

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Potassium for crop production in Iowa

Potassium (K) fertilization effects on corn and soybean grain yield have been studied for many years in Iowa. Research results summarized for this and other conferences included calibration of soil-test methods and study of soil-test K spatial and temporal variability, recycling with crop residues, K placement methods for various tillage systems, soil sampling methods, and variable-rate fertilization. The research has shown the importance of proper K fertilization practices for profitable crop production, which mainly include appropriate use of soil sampling and testing, fertilizing low-testing soils, maintaining soil-test K levels in the optimum interpretation category, and avoiding fertilization of high-testing soils. However, recent or ongoing significant research with K has not been shared. This research relates to interactions of K fertilization with other inputs or growing conditions. This article summarizes results of research on the interaction of K with nitrogen (N) fertilization of corn and incidence of soybean diseases.

Potassium and nitrogen Interactions

An interaction between two nutrients exists when the crop response to application rates of one nutrient is affected by the rate or the soil-test level of the other nutrient. The yield increase from different rates of a nutrient and/or the rate that produces the maximum yield can change. Nutrient interactions can be evaluated by including several rates of two or more nutrients and measuring grain yield or tissue nutrient concentrations or uptake. However, the majority of experiments conducted to study the crop response to one nutrient include application of non-limiting but not excessive levels of others. An Iowa long-term study with continuous corn in northern Iowa that evaluated several combinations of N, K, phosphorus (P), and lime showed a positive interaction between N and K but not among the other nutrients (Mallarino and Rueber, 2003). In that study, the corn yield response to N fertilization and the N rate needed to maximize yield were greater with adequate K supply than with a deficient K supply. Potassium application rates that increased soil-test K levels above those recommended for corn did not affect corn yield or the response to N fertilizer.

Two 4-year trials with continuous corn were established in 2013 to provided additional information about N and K interactions at the Northern Iowa Research Farm (NIRF) on an area with Webster soil and at the Southeast Iowa Research Farm (SERF) on an area with Mahaska soil. The plots were managed with chisel-plow/disk tillage and a 30-inch row spacing. Annual fertilization treatments replicated three times at both sites included the combinations of five N rates (0, 75, 150, 225, and 300 lb N/acre) and four K rates (0, 24, 48, 72 lb K_2O/acre). At NIRF, granulated urea was broadcast and incorporated into the soil in the spring before planting corn. At SERF, urea ammonium nitrate solution (UAN) was injected between the corn rows at the V4 to V5 growth stages. The K source at both sites was potash (potassium chloride) fertilizer, which was broadcast in the spring before the last disking or field cultivation prior to planting corn. Corn ear-leaf blades were sampled at the R1 growth stage (silking), grain was sampled at harvest, and the samples were analyzed for total N and K concentrations.

The most relevant results are summarized by showing averages across years at each site. The corn grain yield varied over time mainly in response to weather conditions. At NIRF, the average yield for the two highest N rates and plots receiving K fertilizer was 181, 158, 202, and 217 bu/acre in 2013, 2014, 2015, and 2016, respectively. Excessive rainfall limited yield below its potential mainly in 2013. At SERF, the average yield for similar treatments was 128, 206, 228, and 211 bu/acre in 2013, 2014, 2015, and 2016, respectively. The very low yield in 2013 was due to excessive spring rainfall, which also caused very large variability among the replications. Therefore, the 2013 results for the SERF site are not included and three-year averages are shown.

Results of chemical analyses of ear leaves and grain showed that N fertilization increased tissue N concentrations and K fertilization increased K concentrations at both sites and that K fertilization did not affect the N concentration of either tissue at any site (not shown). However, data in Figures 1 and 2 show that N and K fertilization interacted at affecting the K concentrations of both tissues at both sites. At NIRF, Figure 1 shows that N fertilization decreased the ear-leaf K concentration when K was not applied and the soil K supply limited yield but did not affect it when K was applied, and that N fertilization slightly decreased the grain K concentration with or without K fertilization. At SERF, Figure 2 shows that N fertilization did not affect the ear-leaf K concentration when K was not applied but increased it when K was applied, and that N fertilization decreased the grain K concentration with or without K application but the decrease was less pronounced when K was applied.

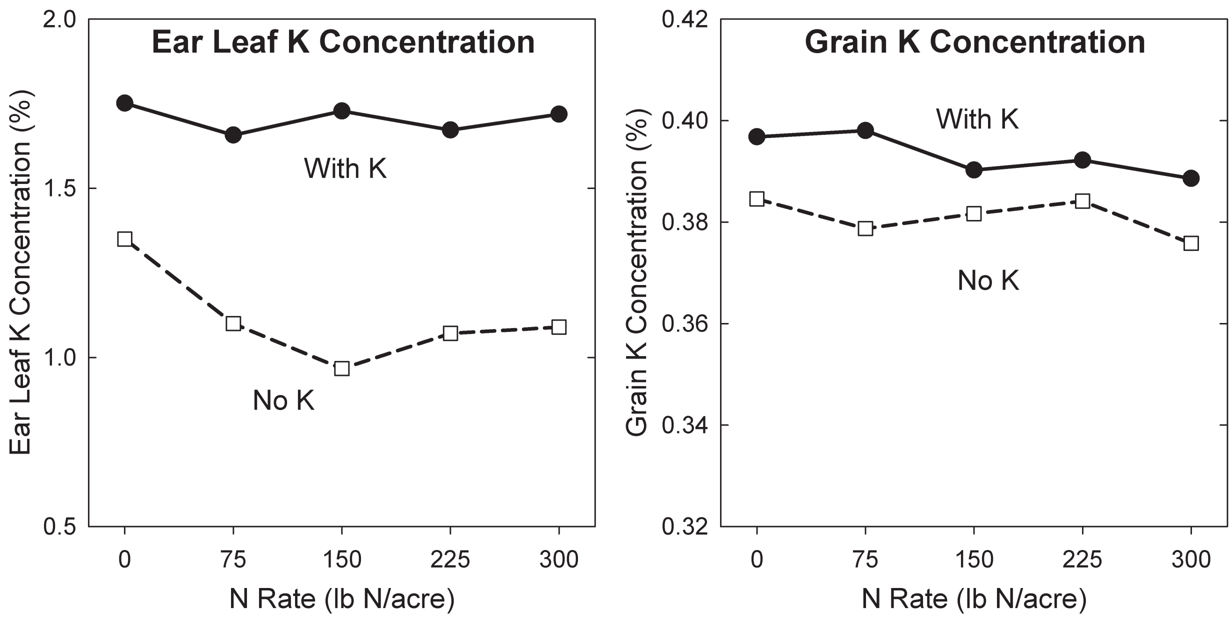

Figure 1. Nitrogen fertilization effects on corn ear-leaf and grain concentrations as affected by K fertilization at NIRF (averages across 4 years).

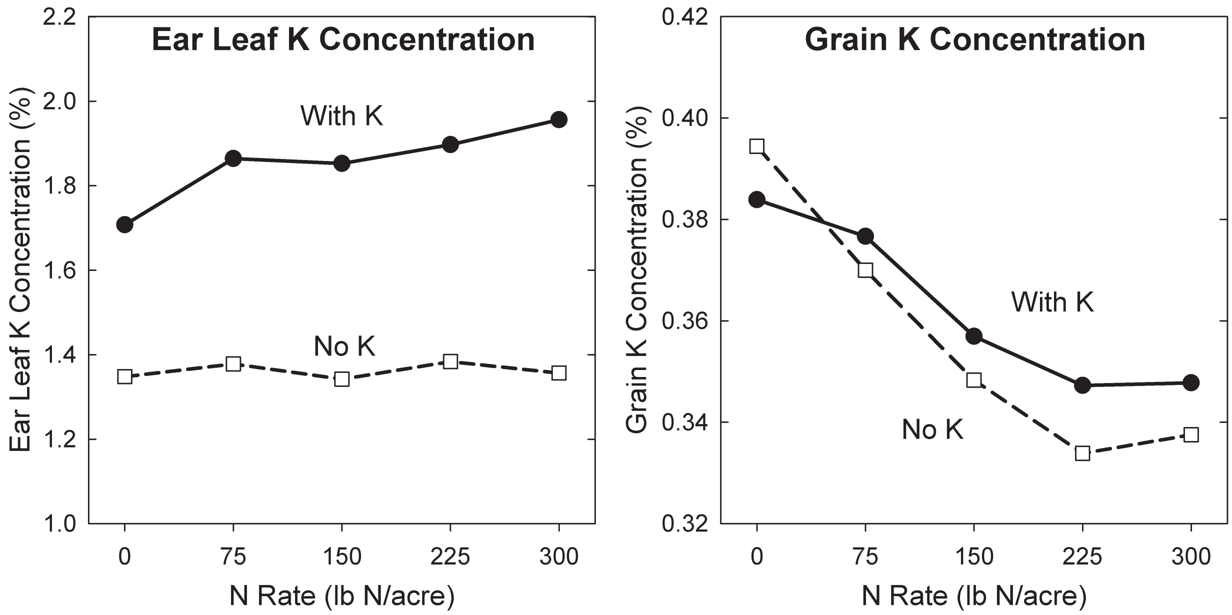

Figure 2. Nitrogen fertilization effects on corn ear-leaf and grain concentrations as affected by K fertilization at SERF (averages across 3 years).

There were large grain yield increases from N fertilization every year at both sites. At NIRF, there were small to moderate yield increases from K fertilization that did not differ statistically for annual rates of 24, 48, or 72 lb K_2O/acre. At SERF, there was a larger yield response to K fertilization, which on average across the three years occurred up to the 48-lb application rate. Initial soil-test K levels (6-inch depth) at both sites were within the Low soil-test interpretation category according to Iowa State University soil-test interpretations (Mallarino et al., 2013). Soil-test K values 121-160 and 51-85 ppm are considered Low by the dry or field-moist testing procedures, respectively, when using the ammonium-acetate or Mehlich-3 methods. By fall 2016, the soil-test K levels of plots at both sites that received no K had decreased to the Very Low category, and the 72-lb rate had increased levels into the High category.

Figure 3 shows the 4-year average grain yield and N or K removed with grain harvest at NIRF for plots that received no K and the average of plots that received K since there were no K rate differences. Figure 4 shows the 3-year average yield response to N fertilizer at SERF for plots that received no K and the average of plots that received the 48- and 72-lb K rates because these rates produced yield higher than the 24-lb rate. The results from both sites show a very large response to N with or without K applied and a smaller response to K. There were significant interactions at both sites, because the corn yield and the response to N was higher when K was applied. At NIRF (Figure 3), the 225-lb N rate maximized yield without K, but with K applied the highest N rate applied (300 lb/acre) increased yield further and seems that a higher N rate would have produced even higher yield. The response to K was very small and not statistically significant for N rates of 225 lb or less, but the combination of K with the 300-lb N rate produced the highest yield. At SERF (Figure 4), K fertilization did not clearly affect the N rate needed to maximize yield but yield with K application was much higher than without K for the three highest N rates. The fertilization effects on N and K removed with grain harvest were approximately similar to results observed for yield, although at SERF (Figure 4) the interaction was more pronounced for the K removed than for yield.

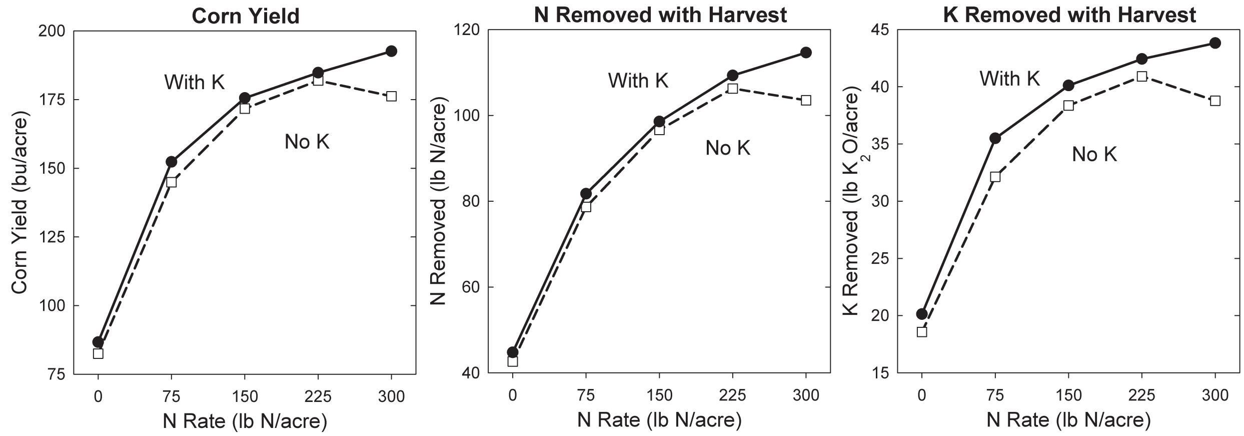

Figure 3. Nitrogen fertilization effects on corn grain yield and on N and K removed with grain harvest as affected by K fertilization at NIRF (averages across 4 years).

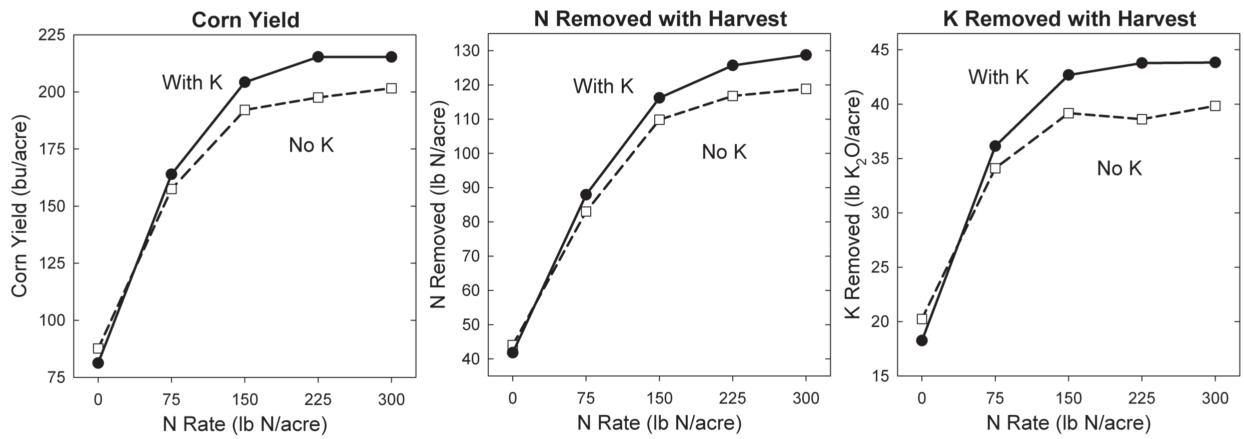

Figure 4. Nitrogen fertilization effects on corn grain yield and on N and K removed with grain harvest as affected by K fertilization at SERF (averages across 3 years).

Potassium and soybean diseases incidence

Decades old research in other states or countries has shown that K deficiency sometimes causes physiological changes in plants that facilitate disease infection, and that chloride (Cl) included in potash fertilizer probably reduces fungal diseases. However, this type of research has been conducted only recently in Iowa. Therefore, scouting for diseases was conducted occasionally in several field experiments since the late 2000s to see if P or K fertilization influence the incidence and severity of soybean leaf, stem, or pod diseases. The experiments were located in different regions of the state with different soils and in several years to include diverse weather conditions. A single soybean variety was used at each trial with similar disease and weed control, and the varieties varied across trials to include those adapted to local conditions. Soybean was always planted using a 30-inch row spacing and recommended seeding rates. Plant pathologists or trained ISU agronomy extension specialists scouted the plots three to four times from the R2 to R6 soybean growth stages. We targeted common or expected soybean diseases in Iowa such as sudden death syndrome (SDS), brown spot, bacterial blight, frog eye leaf spot, downy mildew, and Cercospora leaf blight.

In the vast majority of experiments and years there was no significant disease pressure. In a handful of occasions the fungal or bacterial disease pressure was sufficiently high, however. In these conditions, studies showed that the P deficiency or fertilization did not influence disease incidence, but K deficiency and fertilization did. The disease incidence or severity was greater with K deficiency than when soil K was in the optimum interpretation category or higher, or when low-testing soils were fertilized. The following are examples of the observed responses.

Figures 5 and 6 show results from years with high disease pressure of two long-term field experiments. The experiments were managed with no-tillage, treatments were four (northern research farm) or three (northeast farm) annual broadcast K application rates (potash fertilizer), and the plots receiving no K fertilizer tested very low or low in soil-test K. Soybean yield responded greatly to the 35-lb annual K rate, moderately to the 70-lb annual rate, and at the northern site very little (one bu/acre) to the 140-lb annual rate. Potassium application decreased the incidence of frogeye leaf spot, Septoria brown spot, and Cercospora leaf blight at both sites. The 35-lb rate was sufficient to eliminate incidence of Cercospora leaf blight at both sites and of frogeye leaf spot at the northeast farm site. Higher K rates, which resulted in small to moderate additional grain yield increases, further decreased the incidence of brown spot at both sites.

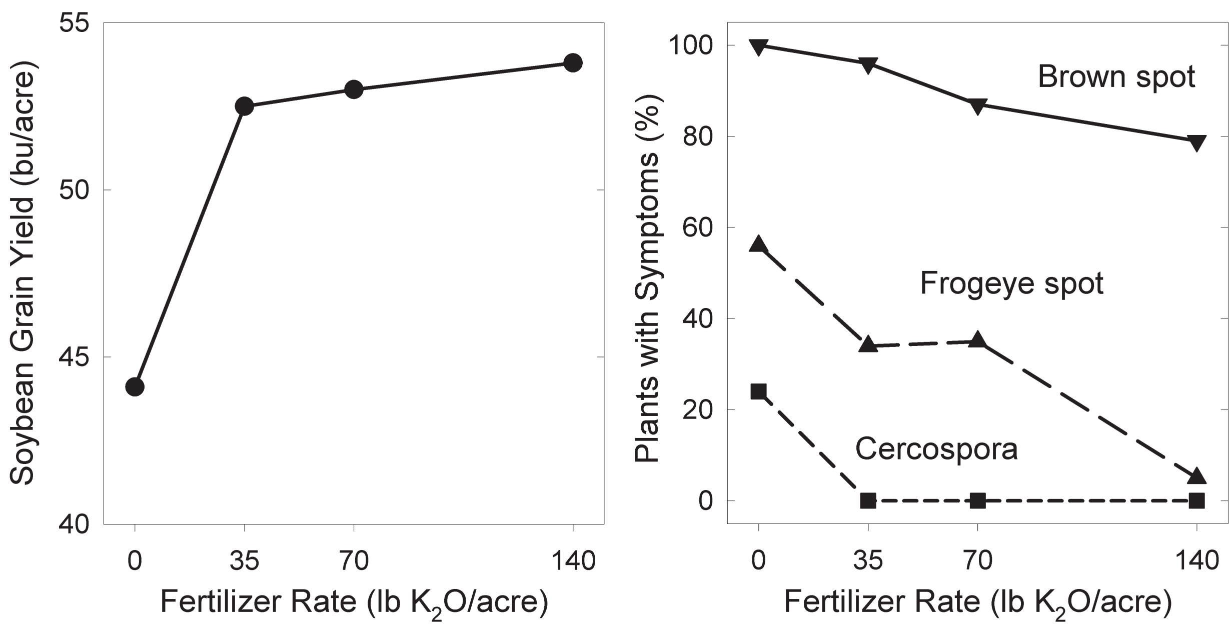

Figure 5. Soybean grain yield and disease incidence as affected by four annual K fertilization rates in a year with high disease pressure of a long-term trial at the northern research farm.

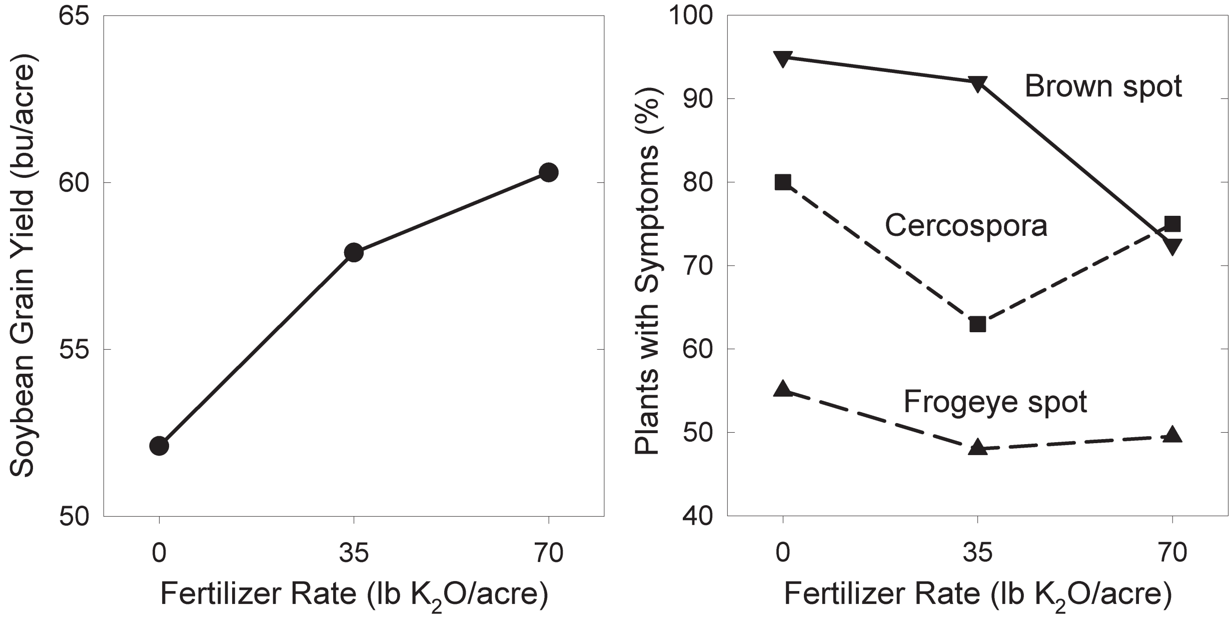

Figure 6. Soybean grain yield and disease incidence as affected by three annual K fertilization rates in a year with high disease pressure of a long-term trial at the northeast research farm.

Figure 7 shows results of a replicated strip trial in southeast Iowa for which treatments were 0 or 150 lb K_2O/acre (potash fertilizer) broadcast before planting soybean using a 30-inch row spacing and after disk tillage. There was moderate to high disease pressure for frogeye leaf spot and Cercospora leaf blight. The yields with or without K fertilization along the strips were averaged for different field areas that initially tested low, optimum, high or very high in K according to ISU soil-test interpretations. There was a moderate yield increase from applied K in areas testing low (5.5 bu/acre), little or no response in areas testing optimum or high (0.8 bu/acre), and a yield decrease compared with the non-fertilized strips in areas testing very high (5.5 bu/acre less). Data in Figure 6 shows that the incidence of both diseases decreased significantly with increasing soil-test K values. Potassium fertilization greatly decreased frogeye leaf spot incidence for all soil-test interpretation categories, including in areas testing very high when K application decreased soybean yield. Potassium fertilization greatly decreased Cercospora leaf light incidence in areas with low or optimum soil-test K levels but decreased this disease's incidence only slightly in areas testing high or very high.

Conclusions

The studies of N and K interactions in corn confirmed that K deficiency not only limits yield but also limits its capacity to respond to N fertilization. The observed N by K interaction, larger corn yield and nutrient removal responses with applied K than with deficient K, does not imply that excess K is needed to allow corn to express all its potential capacity to respond to N fertilization.

The studies of K fertilization effects on soybean yield and diseases could not directly compare the yield increases or soybean capacity to respond to K with or without disease incidence. However, soybean well fertilized with K showed much less disease incidence and higher grain yield than soybean showing a K deficiency. Therefore, inadequate K fertilization of soybean will result in more severe yield and economic loss when conditions favor high disease pressure.

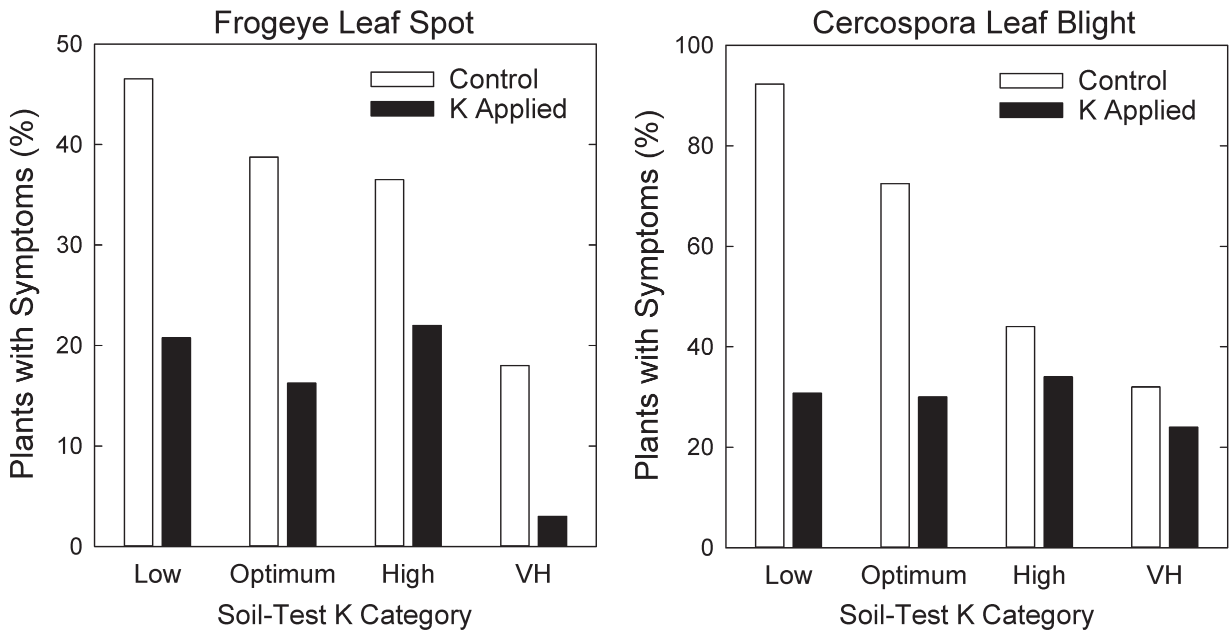

Figure 7. Effect of K fertilization (control and 150 lb K_2O/acre) on soybean disease incidence at a strip trial in southeast Iowa for field areas with initial soil-test K within different interpretation categories. The grain yield responses were 5.5, 0.8, 0.8, and -5.5 (a decrease) bu/acre for the low, optimum, high, and very high soil-test interpretation categories.

Acknowledgement

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References

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