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What About Foliar Fertilization Of Soybeans?

Though a practice not widely used by growers, renewed interest by researchers has producted some positive yield responses in Iowa studies.

Summary: *Foliar fertilization of soybeans with macronutrients at early vegetative stages is likely to increase yields under some conditions, even in high testing soils. There were no consistent differences between products, rates, or frequencies of application except for two considerations. The high rate (6 gal/A) of 10-10-10 did not affect or reduce yield. A single application of 3 gal/A of 3-18-18 usually produced the highest yield increases.*

No simple set of measurements can be used to predict responses. Results suggest, however, that responses will be more likely when effective early nutrient availability is low (which does not necessarily mean a low-testing soil) and/or when climatic factors limit plant growth in late spring or summer. Results for one year also suggest that responses are more likely in ridge-till or no-till fields. In these instances, responses as high as 10 bu/A are possible. Across all conditions, especially with predominantly high-testing soils as those used in this study, expected average response is about 1 bu/A.

Little effort has been dedicated to the study of foliar fertilization of soybeans during the early vegetative stages. Fertilization at early stages could increase yields by different mechanisms compared with fertilization at reproductive stages. Field observations and research with P and K in Iowa suggest that nutrient deficiencies may occur during early growth of corn or soybeans when topsoil is dry in late spring or early summer, even for fields that have been fertilized. Because fertilizers are usually incorporated into the first 4 to 6 inches of soil with chisel/disk tillage, or are not incorporated with no-till, deficiency symptoms may be partly explained by inhibited activity of roots when this layer is dry. This situation may occur often in soils with low P and K below the 6-inch soil layer. In these situations, foliar fertilization could result in increased growth and higher yield.

There are also physiological reasons for expecting positive responses of soybeans to foliar N fertilization during early vegetative stages. Although soil N uptake and N fixation can occur simultaneously, the development over time of these processes is different. Measurable amounts of N fixation are usually first evident several weeks after emergence. The fixed N increases slowly until a maximum is reached during pod set and early seed filling, and then declines sharply. Soil N uptake reaches a peak at early- to mid-flowering and usually declines rapidly afterwards. Responses to soil-applied N have been ineffective in well nodulated soybeans. It has been shown that as soil nitrate increases nodule weight and size, N fixation decreases. Although high rates of foliar-applied N would cause serious leaf damage, small rates could stimulate growth without inhibiting nodulation. Thus, small amounts of N, P, and K applied at early critical periods could be effective if foliar fertilization is viewed as a complement for soil P and K

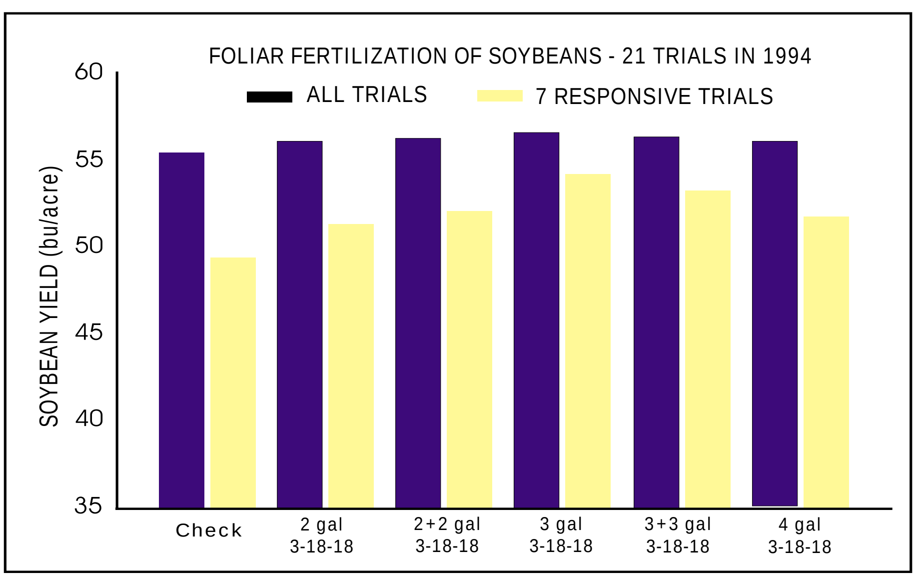

Figure 1. Soybean yield response to early foliar fertilization 21 trials, Mallarino, et al., Iowa State University, 1994.

fertilization and symbiotic N fixation.

This presentation will discuss results of recent Iowa studies (1994-1996) evaluating soybean response to foliar fertilization with macronutrients during early vegetative stages under a variety of growing conditions.

Mixed results

Twenty-one trials. Figure 1 shows the mean grain yields for the six 3-18-18 treatments used in 1994 at responsive sites, and across the 21 sites. There were statistically significant responses (P<0.1) at seven sites. At four sites, all fertilization treatments increased yield. At two sites, some treatments increased yield, others decreased yields slightly, and others did not affect yield. The differences between treatments were not consistent across sites and could not be explained satisfactorily. At one site, treatments decreased yield (3.8 bu/A). It must be noted that the results for this site are included in the means for the responsive sites shown in Figure 1, so the mean yield increases were actually higher than those represented in the figure. The yield decreases could not be explained by leaf damage (no treatments caused visible damage), rates, or frequency of application.

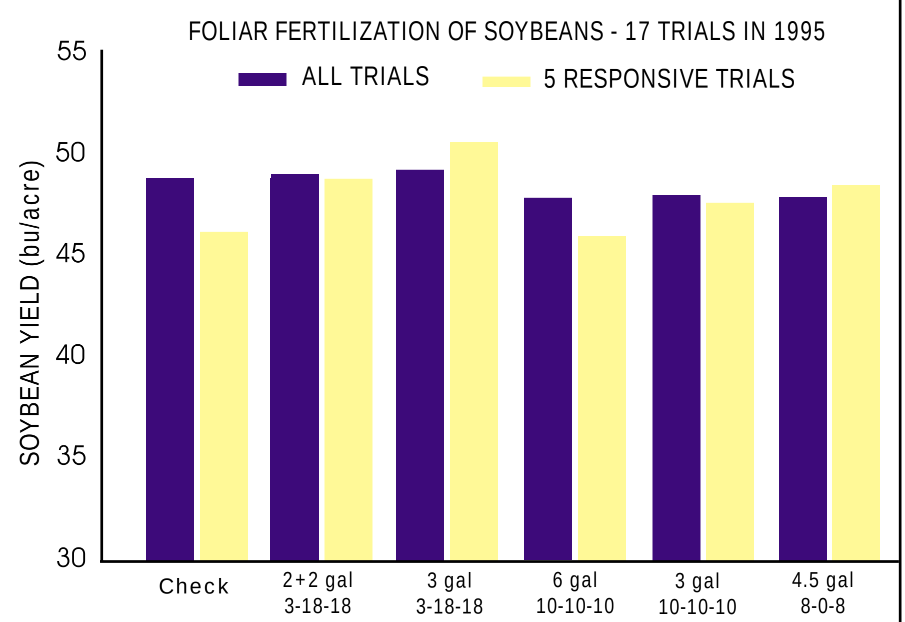

Figure 2. Soybean yield response to early foliar fertilization for 17 trails, Mallarino, et al., Iowa State University, 1995.

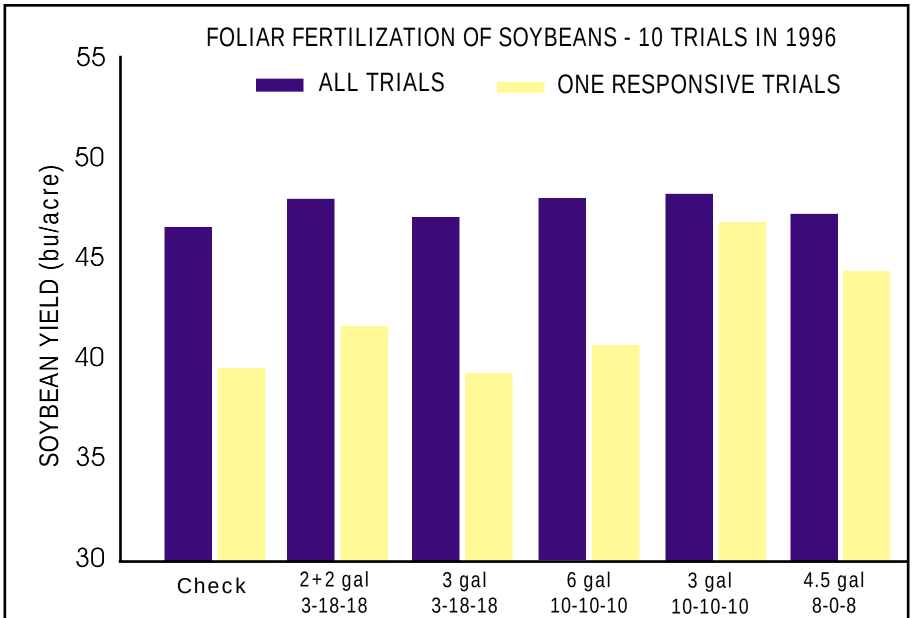

Figure 3. Soybean yield response to early foliar fertilization for 10 trails, Mallarino, et al., Iowa State University, 1996.

Fertilization had no statistically significant effects across the 21 sites and the mean effect of all treatments was less than 1 bu/A. The 3-gal/A rate produced higher yields than the other treatments, increasing yield by about 2 bu/A, although this increase was not statistically significant. At responsive sites, this treatment increased yield by an average of 6 bu/A. There was no advantage for the highest single rate (4 gal/A) or the double applications when compared with the single 3-gal/A rate.

Seventeen trials. Figure 2 shows the mean grain yields for all sites for the new set of treatments applied in 1995. Five sites showed statistically significant response to treatments, but differences between treatments were inconsistent across trials. All treatments increased yield at one site (a 6-bu/A mean increase). Most treatments, except for the double application of 3-18-18 and the 6-gal/A rate of 10-10-10, increased yield at another site (a 5-bu/A mean increase). At two sites, 3-18-18 increased yield an average of 3 bu/A but the other mixtures either had no effect or decreased yield slightly. At one site all treatments decreased yields (a 4-bu/A mean decrease). Average response across all sites and treatments was essentially zero, although fertilization with 3 gal/A of 3-18-18 (treatment that produced the highest yields in 1994) increased yields by about 1 bu/A. When means for only the responsive sites were calculated, yield advantage for the 3-gal/A rate of 3-18-18 was about 5 bu/A.

Application of 3-18-18 caused no leaf damage. Although 10-10-10 and 8-0-8 caused slight leaf damage, the only meaningful burning occurred for the 6 gal/A rate of 10-10-10. This may explain the yield decrease observed for this treatment at several sites. The fact that 8-0-8 has no P, and the 6-gal/A rate of 10-10-10 applies the same P and K as the 3-gal/A rate of 3-18-18 but also applies more N, did not help explain the responses.

Ten trials. Figure 3 shows the mean grain yields for all 1996 sites, as well as for the responsive site. There were statistically significant treatment effects at only one site where a 3-gal/A rate of 10-10-10 and *4.5* gal/A rate of 8-0-8 increased yields (a 6-bu/A mean increase). This greater response to the low rate of 10-10-10 and 8-0-8 (which produced insignificant burning this year compared with the 3-18-18) was not observed in 1995.

The high rate of 10-10-10 (6 gal/A) did not reduce or increase yield, but produced significant leaf damage. There was no leaf damage due to the application of 3-1 8-18. The lack of response to this fertilizer in 1996, compared to the others, cannot be explained. Response across all sites was not statistically significant although there was an average yield advantage of about 1 bu/A over all treatments.

In search of answers

The study of relationships between yield response and site variables such as variety, soil type, and others were of no help in explaining the occurrence of responses. The only apparent relationship observed, which cannot be statistically confirmed, was observed in 1994. This year, responses were higher and more frequent at ridge-till and no-till fields compared with fields managed with chisel or disk tillage. The average increase over all trials was 3 bu/A in ridge-till and 2 bu/A in no-till. There was no increase at fields managed with chisel or disk tillage. It is likely that foliar fertilization alleviated problems with early nutrient uptake, which sometimes occur even in high-testing soils managed with these systems.

Data analysis in 1995 and 1996 showed that three groups of strongly correlated site variables explained 37 percent of the observed yield responses. One group included soil P and K, small plant P and K concentrations, and leaf K concentration. Another group included total plant weight, N uptake, and P uptake at the R2 to R3 stage. The third group included leaf P and rainfall during July. Study of these relationships suggests that yield responses were higher or more frequent when soil P and K availability, nutrient uptake, plant weight, and rainfall in the late spring or summer were low.

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