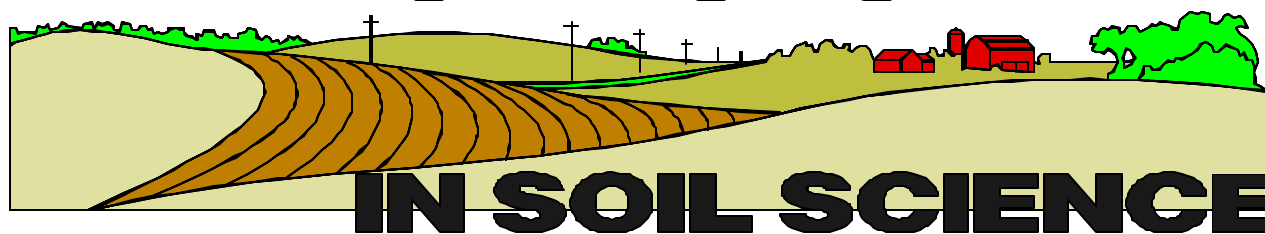


NEW HORIZONS



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FOLIAR FERTILIZATION OF SOYBEANS

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Since the early 1970s, substantial interest has existed in the potential benefits associated with applying nutrients foliarly to soybeans. The opportunities for applying nutrients foliarly to soybeans include (1) early season (V4 to V6) applications of a complete fertilizer; (2) the application of a complete fertilizer during podfill (R2 to R5); and (3) the application of micronutrients during the vegetative stages of growth.

Responses to Early-Season Applications

Foliar fertilization at early stages of soybean growth could increase P and K supplies at the time when the root system is not well developed. Also, a small amount of foliar-applied N is not likely to inhibit N_2 fixation and could increase plant development and grain yield. However, research has generally shown few or inconsistent benefits from this practice. For example, Rosolem et al. (1982) showed no yield differences when two N-P-K formulations were sprayed at 45 and 60 days after seedling emergence. More recently, research in Iowa (Haq and Mallarino, 1998) showed that foliar fertilization with various rates of a commercial 3-8-15 fertilizer applied at the V5 growth stage increased soybean grain yield in only 7 of 48 trials and reduced yields slightly in two trials, with a mean yield increase of 1 bushel/acre across all trials. In subsequent work, Haq and Mallarino (2000) showed that N-P-K foliar fertilization of relatively small amounts sprayed at the V5 stage affected yields significantly at 6 or 27 sites. Some or all treatments either increased yield in some sites or decreased yield by a similar amount at other sites. Leaf damage was not related to yield decreases. Although no simple relationship between yield response and site variables occurred in the two studies, multivariate factor regression analyses suggested that responses tended to occur in soils with high cation exchange capacity when plant-available P was low and/or when rainfall in spring and mid-summer was low.

The conclusion that these researchers reached was that soybean response to early-season foliar fertilization across all production conditions will seldom offset fertilization costs. However, the probability of economic yield response could be increased if the fertilizer is mixed with a post-emergence herbicide

because application costs are reduced.

Foliar Fertilization at Podfill

Extensive research has addressed foliar fertilization of soybean during reproductive stages. The soybean plant has been characterized by markedly reduced root activity during late seed development and increased translocation of nutrients and metabolites from other tissue into the seed (Hanway, 1976). Researchers hypothesized that this depletion of nutrients from leaves could result in decreased photosynthesis, leaf senescence, and lower grain yields, and nutrients applied directly to the foliage at this time could cause a delay in leaf senescence and increased grain yields. Unfortunately, research conducted to test this hypothesis has yielded inconsistent results. Garcia and Hanway (1976) examined various combinations of N, P, K, and S for foliar application at the R2 to R7 growth stages and found that a 10-1-3-0.5 ratio increased yields by 8 to 9 bushels/acre. They concluded that all four of the nutrients are needed and that the optimum time of application is between growth stages R5 and R6.

Publication of this work stimulated a large number of studies in the late 1970s and early 1980s. For example, the Tennessee Valley Authority coordinated more than 100 foliar fertilization trials with soybean at reproductive stages in several states. Summary reports (Gray, 1977; Peele, 1977) showed that yield responses varied from increases of 0.5 bushel/acre or less to decreases as high as 8 bushels/acre. Other work (Boote et al., 1978; Sesay and Shibles, 1980; Syverud et al., 1980; Vasilas et al., 1980; Poole et al., 1983) showed similar small and inconsistent responses that could seldom be explained by leaf burning, management practices, or site characteristics.

More recently, the University of Minnesota completed a 2-year study at three locations that also showed no benefit to multiple foliar applications of N-P-K-S materials (Rehm et al., 1997). Furthermore, the substitution of 28% UAN for urea in the fertilizer mixture resulted in yield decreases at all locations. These researchers concluded that foliar fertilization is not a substitute for a program based on soil-applied fertilizers. They suggest that applications of phosphate and potash before planting, when the need is indicated by a soil test, remains the most reliable method for meeting soybean material needs. They further suggest that use of foliar fertilization for soybeans is not consistently profitable and is not recommended.

Micronutrient Fertilization

Studies by Schon and Blevins (1987; 1990) at the University of Missouri demonstrated that foliar-applied B could stimulate soybean yield by increasing pods on lateral branches, seed number, and overall seed yield. Boron treatments caused a significant 84.8% increase in the number of lateral pods per plant and a 17.6% increase in total seed weight per plant. However, the B application caused leaf burn damage on young soybean seedlings, a reduction in plant stand, and a decrease in plant height. In other research conducted in 1987 and 1988, Schon and Blevins (1990) found a significant increase in leaf N content as well as increase in leaf P, K, and S content with foliar B applications. In an attempt to more broadly assess the need for foliar B, Oplinger et al. (1993) evaluated the influence of supplemental soil and foliar-applied B across a broad range of Midwestern growing conditions and soils.

A total of 29 field studies were conducted during 1991 and 1992 in Wisconsin, Illinois, Ohio, and Missouri. Boron treatments included 0.25, 0.50, and 1.0 lb B/acre applied foliarly and 3.0 lb B/acre applied to the soil prior to planting. Boron applied at 0.25 lb/acre to the foliage at initial flowering increased grain yield from 48.1 up to 49.5 bushels/acre or 3% when averaged over all 29 environments. There was no effect on branches/plant or pods/plant. The higher foliar rates of B and the soil-applied B had no effect on soybean yield or yield components. Foliar applications of B to soybean as a single nutrient may be profitable, but application costs would need to be offset by adding the B to a herbicide, fungicide, or irrigation application. Clearly this work did not support the widespread use of foliar B.

In the early 1970s, Wisconsin research showed that on high organic matter, high pH soils, consistent responses to foliar manganese could be obtained on soybeans (Randall et al., 1976). This research clearly demonstrated (1) yield responses as large as 20 bushels/acre; (2) equivalent responses from foliar manganese sulfate or chelated manganese EDTA (not at equal rates of Mn application); (3) yield reductions from row-placed chelated Mn; and (4) substantially larger responses from multiple foliar Mn applications compared to single applications (Randall et al., 1975).

More recently, some agribusinesses have been promoting use of premium fertilizer mixes as foliar applications. Although some evidence exists for yield increases in some situations (Michalski, 2003), we continue to urge caution regarding this type of program. Our concerns include (1) the relative small amount of nutrients applied with these treatments; (2) the addition of nutrients that are likely unneeded; and (3) the lack of replicated research substantiating these programs.

The Bottom Line

There is relatively little replicated research support for foliar applications of nutrients to soybeans except where responses to micronutrients have been demonstrated. Early applications (V4 to V6) have also resulted in benefits in a few situations on high cation exchange capacity soils, when plant-available P levels are low and/or when spring or mid-summer rainfall is lower than normal. Applications of a complete fertilizer at podfill has generally not resulted in yield benefits and is not recommended. The use of foliar micronutrients can be an effective method of application; however, we continue to recommend only applying those nutrients where a need exists and that adequate amounts be applied.

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