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Late-Season Foliar Sprays Boost Soybean Yields

Yield increases as high as 9 bu/A achieved in Georgia experiments.

Summary: *The ability of soybeans to attain high yields from traditional soil fertilization is accepted in most cases. However, many reports have indicated increased yields from supplemental foliar fertilizer applications. Studies spanning 1988 to 1992 show important responses to sprays and fertigations made at reproductive stages are possible. Applications of N, B, Mg, and Mn were made on several cultivars. Yield responses from 6 to 9 bu/A have been attained in most experiments on irrigated, deep, sandy soils in the Coastal Plain of Georgia. Yield increases on loamy soils ranged from 0 to 5 bit/A. Best responses to sprays were attained with 40 lbs of N as low-biuret urea together with 0.4 lb B as sodium borate. The greatest potential for yield response is in soils with low abilities to retain anions such as nitrate and borate and where yield potential is not limited by other factors.*

Objectives of our studies were to determine if foliar applications of N, B, Mg, Mn and combinations thereof would result in yield increases if applied during the reproductive stages of soybean growth. Additionally, we intended to determine the conditions for the greatest possible response and also determine the gross physiological reason for increased yield.

Sprinkler irrigated field plots were established on either sand or sandy loam soils. Either no fertilizer or combinations of N, B, Mg or Mn were applied from R3 (first pod development) to early R5 (first bean development in pod) stages of growth (Table 1).

Positive response

Slight leaf burn occurred along the tips when N was applied alone. However, there was no observable bum when soluble sodium borate (0.4 lb B/A) was added to the urea in the N+B treatment. This unexpected observation may have contributed to the increased yields shown in Figure 1. An additional observation was that Mg application, with or without other elements, tended to delay senescence by about two days. Applying N+B, B+Mg and N+B+Mg at the Bonifay site generally resulted in increased branching. The number of pods was greatest when Mg or a combination of N, B, and Mg were applied at the Bonifay sand site and for B application at the Greenville sandy loam site. Total pods per plant exceeded the untreated control when Mg, N+B, N+Mg or B+Mg were applied at the Bonifay site but were not different from the untreated control at the Greenville site.

Interaction of cultivar and spray treatment on bean weight at the Bonifay site was not always consistent. But, the N+B application was always among the higher bean weights, regardless of the cultivar, and was the only treatment with bean weights significantly greater than the untreated control. It is important to mention that the two highest yielding treatments (N+B and B+Mg) also had the greatest bean weights.

Correlation analysis by cultivar indicated that yield is more closely related to bean weight than other components measured in these studies. Pods on the main sterns and total pods per plant were significantly correlated with yield for four or five cultivars. Branching and pods on branches were less correlated with yields.

Conclusions from previous studies indicated that important yield responses resulted, regardless of method of application (Table 2). Fertigation is possible in only a limited number of soybean fields and dribbling is impractical in fields where there are larger soybean plants. Therefore,

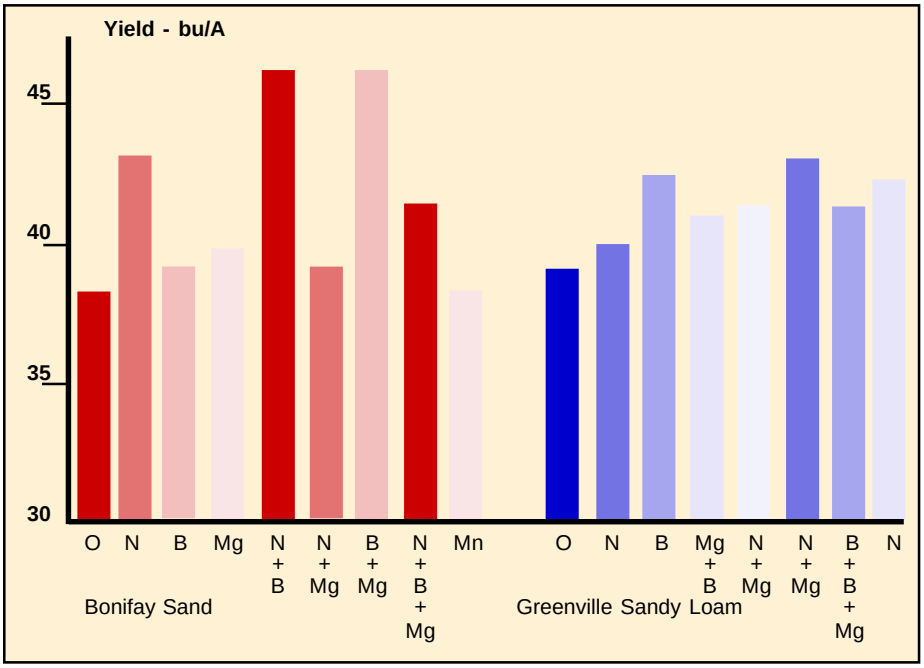

Figure 1. Yield effects from 1992 soybean spray treatments.

Table 1. Fertilizer treatments applied (1988 to 1992).

1	None		
2	N	40 lbs/A	Urea or UAN[1]
3	B	0.4 lb/A	Soluble Sodium Borate
4	Mg	0.25 lbs/A	Epsom salts
5	N+B		
6	N+Mg		
7	B+Mg		
8	N+Mg+B		
9	Mn	0.15 lb/A	Mn EDTA

Several different soybean cultivars were examined over four years. Plots were sprayed in the early evening to maximize the length of absorption time and minimize foliar burn. Spray volume was 25 gal/A

[1] Low biuret urea used for sprays and UAN in some fertigations.

emphasis was placed on sprays in the 1992 studies.

Economic response

Determining the probability of receiving an economic response to N and/or B application can only be accomplished by analysis of results over several years.

In general terms, the costs for ferrigated and spray applications should be less than $10/A. Therefore, yield increases of two bushels/A or greater should be economical. Such response was obtained in each of the four years we have fertigated N on soybeans at R3 to R5.

Economic responses were also obtained over the last three years from applications of B and combinations of N and B—both fertigated and sprayed.

The problem with recommendation of these applications is that mean increases often have not been economical (Table 2). In particular, cultivars have been an important response variable. However, improved application technology, developed during this research, has contributed to economically significant results obtained in 1992 (Figure 1). Using this technology, we are optimistic that economically important results can be attained.

High N demand

Soybean plants have high nitrogen requirements for seed production. The major part of nitrogen is accumulated in the seed during the pod-filling stages. As much as 95 percent of the total N is found in the seeds at harvesttime. To satisfy this high nitrogen demand, N_2 fixation increases during reproductive growth and a portion of the N is remobilized from vegetative parts. The proportion of the accumulated or remobilized N depends on the cultivar, the rhizobium strain and growing conditions. Nutrient shortage in the pod-filling stages may contribute to nutrient deficiency and early senescence. Duration of the grain-filling period is one of the main factors limiting soybean productivity.

A well-established soybean rhizobium symbiosis may be effective in providing enough N for high grain yield, but a number of cultural factorsinfluence N_2 fixation and can influence yield. So, the quantity of nitrogen in the soybean derived from atmospheric nitrogen near the end of the plant's growth cycle may vary substantially. The amount depends on soil N availability, cultivar, rhizobium strain, fertilizer applied and environmental conditions. A small quantity of combined nitrogen may promote overall accumulation as well as plant growth and yield. Soybean responses to soil fertilizer applications have not been consistent.

The effect of N fertilizer application during vegetative stages on nodulation and N_2 fixation is complex and variable. Large N applications have a tendency to decrease nodulation as well as N-fixation and have not generally resulted in significant increases. In recent years, many studies have shown foliar-N applied with other nutrients, such as boron, holds some promise.

Foliar applications have resulted in leaf bums and inconsistent results. Studies on sandy soils in Georgia, however, have demonstrated that UAN or urea via sprinkler irrigation or dribbling at R3 to R5 showed no foliar bum and often resulted in yield increase. Studies in Missouri also suggest that yield may be enhanced by B applications either by infusion or foliar sprays. The yield increase was due to increased branching. Since fertigation is not a possibility in most soybean systems, it is important to develop foliar application methods as well as fertigation methods.

Practice promising

The following conclusions on the value of adding nitrogen to soybeans could be reached only after several years of compiling data on trials.

1. Spray application of N, B, Mg and combinations thereof during the reproductive stages of soybean growth, as well as fertigations and dribble applications, have resulted in significant and economic yield responses.

2. Responses greater than *5* bu/A have been limited to irrigated, sandy soils and responses on loamy soils have generally been less than *5* bu/A, in studies over a five-year period.

Table 2. Greatest and mean ( ) annual yield increases from late-season N and B applications.

Application	1988	1989	1990	1991
Fertigate N	9 (5)	6 (3)	5 (2)	2 (0)
Fertigate N+B	——	——	6 (2)	3 (0)
Dribble N	——	——	——	5 (0)
Dribble N+B	——	——	6 (1)	3 (0)
Dribble B	——	——	——	5 (0)
Spray N	——	——	4 (2)	6 (0)
Spray N+B	——	——	2 (1)	7 (3)
Spray B	——	——	3 (1)	3 (1)

3. Greatest response has been due to application of 40 lbs N and 0.4 lb B. However, the 1992 study suggests some response to Mg, particularly when applied together with B.

4. Spraying plants late in the day using B, together with N, eliminated a slight foliar burn sometimes observed with N sprayed alone.

5. Yield was correlated with larger (heavier) seeds and less correlated with seed number.

6. Best responses occurred in beans managed for high yield. This practice should not be considered when water or other cultural factors are limiting.

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