Georgia

Late-Season Fertilization of Soybeans with Nitrogen and Boron

By Gary J. Gascho

Most fertilization for soybeans is prior to planting. Basic research has shown that modern soybean cultivars require much of their nutrition late in the season, in reproductive stages, for optimum seed set and development. Sandy soils in the Southern Coastal Plain do not retain nutrients well. Therefore, fertilization prior to planting may not result in optimum nutrition throughout the reproductive cycle. Research indicates increased yield due to late-season foliar applications and fertigation with nitrogen (N) and boron (B)

NITROGEN needs of the soybean plant during pod-fill are great. Nitrogen availability to the developing seed comes via the vegetative plant from symbiotically fixed N, residual soil N or fertilizer N. The majority of the mineral N in soils exists as nitrates under good growing conditions. Southern Coastal Plain soils retain only small amounts of residual nitrate-N against leaching due to their porosity and lack of anion exchange capacity. Also, little or no fertilizer N is applied. Therefore the primary N source must be N fixation. Modern cultivars have high yield potentials which require N nutrition throughout pod-fill, and N fixation may not be adequate to supply all of the N. If the N supply is not adequate during pod-fill, there may be several consequences:

- Seed number and seed size will be reduced, possibly due to early senescence;
- Yield potential of the cultivar will not be achieved;
- Protein content of the seed may be reduced.

Recently, the value of B applications to soybeans following vegetative growth has been shown in several studies. Boron injected directly into soybean plants increased pod numbers on lateral branches and increased yield in studies conducted in Missouri. Follow up studies indicate that similar responses are often obtainable with foliar B applications. The physiological cause(s) of responses to B applications are not clear, but several mechanisms are under consideration:

- Boron increases the plasticity of cell walls of flower parts, thus decreasing pod abortion;
- Boron changes membrane activity which affects ion transport for essential nutrients such as potassium (K), calcium (Ca) and magnesium (Mg);
- Boron improves translocation of sugars in the plant, possibly as sucrose-borate complexes;
- Greater B concentrations in flowers increase pollen germination.

Georgia Coastal Plain Studies

Late-season N applications to soybeans have been studied at the Coastal Plain Experiment Station, University of Georgia, since 1988. Earlier research clearly indicated that no yield or gross physiological responses were obtained from N applications before flowering. Field studies were conducted with fertigation (0.1 to 0.2 in. water/A) from 1988 to 1991 and with foliar sprays from 1988 to present. Boron and N + B combinations have been applied since 1990. Responses were

Dr. Gascho is Professor, Dept. of Crop and Soil Sciences, Coastal Plain Exp. Station, University of Georgia, Tifton, GA 31793.

recorded for the fertigation application method. However, since few farmers have the necessary equipment to fertigate soybeans, emphasis has now been placed on foliar sprays.

Application technology for foliar sprays has evolved during the studies, increasing the consistency of responses by that method. Presently, 10 to 20 lb N/A is applied as low-biuret, feed-grade urea and 0.25 to 0.4 lb B/A is applied as a soluble sodium borate. Water volume has been 20 to 25 gal/A. Sprays are made late in the day in order to minimize rapid drying on the leaf surface, maximize absorption time and minimize leaf burns. Field observations indicated that inclusion of B with N eliminated a slight leaf burn associated with applications of N alone.

Table 1 shows that yield responses were recorded for foliar applications of N, B and N + B during pod development (R4) on both a sand and a sandy loam in 1992. The Bonifay soil has much less nutrient and water retention than the Greenville soil. Responses on the Bonifay were greater than on the Greenville, a result consistent with the lesser ability of the sand to retain N and B. Yield responses greater than 5 bu/A have often been recorded on sands and loamy sands, while responses on loamy soils have generally been less than 2 bu/A. Greatest response in 1992 was to foliar sprays of N + B at the sand site. Modest seed protein responses are also noted, a result consistent with other years in which late-season N was applied.

Table 1. Soybean yield and protein concentration in seed from spray treatments made during pod development (R4) at two sites in 1992[1].

Nutrients applied	Yield,bu/A		Protein,%	
	Bonifay[2]	Greenville[3]	Bonifay	Greenville
None	37.8	38.3	31	36
N	44.3	40.7	–	–
B	38.9	43.6	–	–
N + B	46.0	42.2	34	37

[1]Means for 5 cultivars. [2]Bonifay is a sand. [3]Greenville is a sandy loam.

Separate studies with only B applied foliarly were also conducted in 1992 at the Bonifay and Greenville soil sites, **Table 2.** Initial sprays were applied at first bloom at 0.25 lb B/A for the 0.25, 0.50 and the 1 lb/A rates. A second application at the same rate was applied to the 0.5 and 1 lb treatments 2 weeks later and two additional applications to the 1 lb treatment were made at 2-week intervals. Yield responses of 2 to 9 bu/A were attained on the sand site. No yield response was found on the sandy loam. Lateral branching and seed weight were increased by B applications.

Summary

Research has indicated a fairly wide time-window of opportunity for fertigated and foliar N and B application during reproductive development. Most of the soybeans grown in the Southeast must be sprayed at least once during this period for either diseases or insect pests. And because application is a major cost of N and B foliar feeding, continued research is planned to combine N, B and N + B with pesticides. Pesticide-nutrient mixtures will be sprayed at the timing needed for the pesticide. Such combinations, if effective, may reduce costs for nutrient applications to only the material costs for fertilizer materials. ■

Table 2. Soybean yield, lateral branching and seed weight on two soils as affected by foliar B application, 1992.[1]

B rate, lb/A	Yield,bu/A		Branches, no./plant		Seed weight,g/100 seed	
	Greenville	Bonifay	Greenville	Bonifay	Greenville	Bonifay
0	55	48	9.0	5.4	18.1	16.2
0.25	56	54	9.3	6.1	19.1	17.7
0.50	56	50	9.8	6.9	18.5	17.1
1.00	55	57	9.4	6.8	18.8	17.3

[1]Means for 5 cultivars.