IRRIGATED SOYBEAN RESPONSE TO NITROGEN APPLIED DURING EARLY POD FORMATION

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Abstract

High yield soybean (*Glycine max* L.) has a high rate of N uptake during grain fill with maybe 2/3 of the N derived from the atmosphere. The remaining needs to come from the soil. Previous research has found that the probability of response to N applied at early pod development (R3) for yield < 60 bu/A is low but results for higher yields have been inconsistent. Fifty six irrigated trials, including 44 with mean yield >60 bu/A, were conducted in Nebraska to determine effect on soybean yield of applying N and S to the soil at R3. With 27 lb/A N applied and >60 bu/A yield, mean yield increases were 2.5 bu/A in south central, 1.6 bu/A in northeast, and not significant in southeast Nebraska. Yield was not further increased by application of 27 lb/A more N or with the addition of 4.5 lb/A S. Variations in response were not accounted for by soil properties or leaf N and S concentrations. Depending on the grain to fertilizer price ratio, N fertigation at R3 may be profitable in south central Nebraska.

Introduction

Soybean N uptake during grainfill is great (Fig. 1). Biological N fixation may supply 65% of soybean N uptake but the remaining must be soil derived (Salvagiotti et al., 2008). Previous research results have found a low probability of profitable soybean yield response to soil applied N at beginning pod (R3) growth stage when yields were <60 bu/A. Yield responses were inconsistent, however, for yields >60 bu/A with evidence of potential for substantial soybean yield increases resulting from N application at R3 (Wesley et al., 1998).

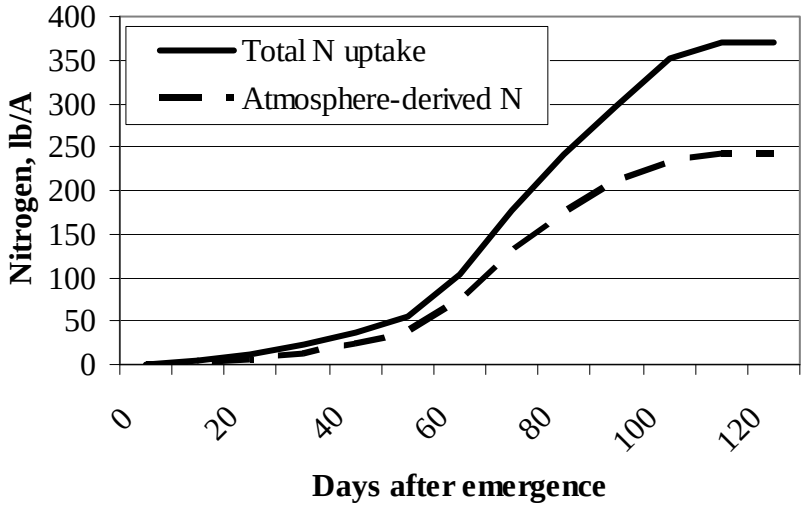
Materials and Methods

All sites were irrigated with deep medium or fine texture soils and had a history of >60 bu/A soybean yield. Sites were in commercial production fields in south central (6), northeast (20) and southeast Nebraska (30). The previous crop was corn and management practices were decided by the cooperating producer.

The four R3 treatments were soil application of N and S: no fertilizer applied; 27 or 54 lb/A N surface applied; and 27 lb/A N and 4.5 lb S applied. Trials had six replications. Irrigation or rainfall events occurred within three days of fertilizer application for most but not all sites. Grain yield and moisture content were determined from the harvest of two rows x 20 ft or longer. Leaf samples were taken at time of fertilizer application. The upper most fully expanded trifoliate was taken from 12 plants.

The data were analyzed for individual trials and combined for geographic areas using Statistix 9.0 (Analytical Software, Tallahassee FL). Yield and yield response was related to soil test properties and leaf N and S concentrations.

Figure 1. A representation of soybean N uptake and N derived from the atmosphere, assuming 65% of total N is from biological N fixation (Salvagiotti et al., 2008), for 75 bu/A yield.



Results

Soil properties and leaf N and S concentrations varied (Table 1). No soil or leaf properties were related to mean yield or response to applied N and S.

Table 1. Soil and leaf test properties for 44 of 55 trials where yield was >60 bu/A.

Soil and leaf test level	Soil test at R3, 0- to 20-cm depth							Leaf	
	SOM	pH	M3 P	K	SO4-S	Zn	NO3-N	N	S
	%				ppm			%	
Median	3.3	6.2	34	348	13	2.1	4	5.2	0.28
Lowest	1.8	5.0	7	193	4	0.4	1	3.6	0.23
Highest	5.2	8.1	258	667	50	8.9	130	7.3	0.38

Grain yield was significantly increased with fertilizer application for 2 of 20, 1 of 6, and 0 of 30 trials in northeast, south central, and southeast Nebraska, respectively. Yield was not affected by treatment x site-year interactions. In the combined analyses limited to trials with >60 bu/A yield, application of 27 lb/A N resulted in a mean yield increase of 2.5 and 1.6 bu/A in south central and northeast Nebraska, respectively, but no yield increase in southeast Nebraska (Table 2). Yield was similar with the 54 and 27 lb/A N rates, and with application of 4.5 lb/A S plus 27 lb/A N. The results were mostly consistent when trials with <60 bu/A were included in or excluded from the analysis. The differences in response to applied N according to area of the

state were small and could not be explained with the available data. The yield responses to applied N were much less than found by Wesley et al. (1998) for >60 bu/A soybean yields. Leaf S concentration indicated adequate S uptake and the lack of soybean yield response to S application is consistent with findings for grain sorghum and corn on medium texture soils of Nebraska. The greater yield response to applied N in south central was associated with application of NBPT treated urea compared with ammonium nitrate in the other areas, but there was no reason to expect different response due to fertilizer compound.

Table 2. Yield response in three areas of Nebraska to N and S applied at R3 for 44 of 55 trials where yield was >60 bu/A.

Area of Nebraska	**0 lb/A**	**27 lb/A N**	**54 lb/A N**	**27 N + 4.5 S lb/A**
			Yield, bu/A	
Northeast (17)	69.5a	71.1b	71.1b	70.4ab
Southeast (22)	72.3	72.6	72.6	72.6
South central (5	69.6a	72.1b	73.5b	70.4ab

Different letters in the same row indicate significant effect of nutrient application at P≤0.05 with means separation by ANOVA-protected LSD.

Summary

Mean yield increases due to application of N at R3 were small (0 to 2.5 bu/A). Assuming a fertigation cost of 10% of the purchase price of urea ammonium nitrate, the results indicated that N application at R3 is on average profitable when the ratio of soybean grain price ($/bu) to fertilizer N price ($/lb) is >12 in south central Nebraska and >19 in northeast Nebraska. There was no indication of profitability in southeast Nebraska. Soil test properties and leaf tissue N and S concentrations were not related to response and are not likely to be useful in predicting response. A more detailed reporting of this research is to be published in the Journal of Crop Management.

References

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