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In-Season Nitrogen Fertilization of Soybean

John E. Sawyer
Iowa State University, jsawyer@iastate.edu

Daniel W. Barker
Iowa State University, dbarker@iastate.edu

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Abstract
Nitrogen (N) fertilization is not a traditional nutrient management practice for soybean production in Iowa. Soybean is a legume plant and is assumed to adequately obtain needed N through symbiotic fixation. However, there is interest in using N fertilization to increase yield and grain protein due to the recognition of the large N requirement associated with high yields. Despite the fact that soybean is a legume, it readily utilizes soil inorganic N and will do so preferentially to symbiotic N_2 fixation. Depending on the residual inorganic N level and soil N mineralization characteristics, approximately 40 to 75% of the N in a mature soybean plant is derived from the soil. Also, soybean seems to require this soil derived N for high yield. The overall objectives of this research were to determine the impact of soil applied N fertilizer at the beginning pod stage (R3) of soybean growth on grain yield and quality components. Additional objectives were to study response to N fertilizer placement, material (N release characteristic), and rate.

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John E. Sawyer, associate professor
Daniel Barker, research associate, agronomy

Introduction

Nitrogen (N) fertilization is not a traditional nutrient management practice for soybean production in Iowa. Soybean is a legume plant and is assumed to adequately obtain needed N through symbiotic fixation. However, there is interest in using N fertilization to increase yield and grain protein due to the recognition of the large N requirement associated with high yields. Despite the fact that soybean is a legume, it readily utilizes soil inorganic N and will do so preferentially to symbiotic N_2 fixation. Depending on the residual inorganic N level and soil N mineralization characteristics, approximately 40 to 75% of the N in a mature soybean plant is derived from the soil. Also, soybean seems to require this soil derived N for high yield.

The overall objectives of this research were to determine the impact of soil applied N fertilizer at the beginning pod stage (R3) of soybean growth on grain yield and quality components. Additional objectives were to study response to N fertilizer placement, material (N release characteristic), and rate.

Methods

This study was conducted in 1999 and 2000 at five Iowa State University Research and Demonstration farms (Armstrong, Southeast, Northern, Northeast, and Northwest). Cultural practices were those typically utilized for soybean production at each research farm. Corn was the previous crop and soybeans were planted in 30-inch rows at all sites. Soil test P and K were either adequate, or fertilizer was applied as indicated by soil test. The soybean varieties were locally adapted and chosen by the farm superintendent (Pioneer P93B01, Stine 3398-8, Midwest G1912, Asgrow 1980-4 and 2301, and Kruger K2343).

Treatments were soil application of urea or poly coated urea fertilizer (PCU – POLYON®AG supplied by Pursell Technologies, Sylacauga, AL – with a polyurethane polymer coating and expected release duration of four weeks at 86º F) at approximately the late R2 to early R3 growth stage (late full bloom to beginning pod, usually applied the last week of July). Nitrogen rates were 40 and 80 lb N/acre, and the control had no applied N. Fertilizer was either broadcast by hand across the plant canopy, or banded in a narrow one to two inch deep band between every other soybean row. A complete factorial arrangement of N treatments, plus the control, was replicated four times in a randomized complete block design. Plot size was either 15 or 20 feet wide (6 or 8 rows) by 50 feet long.

Grain was machine harvested, taking 3 to 6 rows (varied by farm) the length of the plots. Reported grain yields were corrected to 13% moisture. Grain samples were analyzed by near infrared spectroscopy (NIR) for protein, oil, and fiber concentration (corrected to 13% moisture) by the Iowa State University Grain Quality Lab.

Results and Discussion

Nitrogen fertilizer application had minimal to no impact on grain yield. Average yield of N fertilized plots at each site were not significantly greater than the control. A few statistically significant differences between treatments were measured at some sites, but these were inconsistent and even though statistically significant, the yield differences were small. Averaged over all site-years (Table 1), there was no effect from N placement, material, or rate on grain yield. Rainfall amount or timing after N application did not seem to relate to yield response or lack thereof. Site-year average grain yields ranged from 34 to 61 bu/acre.

Soybean grain protein, oil, and fiber concentrations were not influenced by N application treatments (Table 1 -- some quality component data not shown). As with grain yield, a few statistically significant differences between treatments were measured at some sites, but they were small and inconsistent. Differences in soybean grain quality between sites/varieties were much larger than any N application effects. Site-year average grain protein concentrations ranged from 30.7 to 37.6 percent. The average N effect on grain quality across site-years was not different than the control.

Conclusion

The in-season application of N fertilizer at the R3 growth stage did not positively impact soybean grain yield or grain quality components. Under Iowa soil and climatic conditions it seems that in-season N application to soybean is not a yield or grain quality enhancing practice.

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Table 1. Effect of in-season N application on soybean yield and grain protein, averaged across all site-years.

Nitrogen Material	Placement	N Rate, lb N/acre 40	N Rate, lb N/acre 80	Placement Mean	Material Mean	N Rate, lb N/acre 40	N Rate, lb N/acre 80	Placement Mean	Material Mean
		grain yield, bu/acre				grain protein, %			
Urea	Broadcast	51.8	52.1	52.0		35.3	35.3	35.3	
	Band	51.5	52.2	51.8		35.2	35.3	35.3	
	Urea Mean	51.7	52.1		51.9	35.3	35.3		35.3
PCU	Broadcast	51.6	51.6	51.6		35.4	35.5	35.4	
	Band	51.1	51.2	51.2		35.4	35.4	35.4	
	PCU Mean	51.3	51.4		51.4	35.4	35.5		35.4
	Broadcast Mean	51.7	51.9	51.8		35.3	35.4	35.3	
	Band Mean	51.3	51.7	51.5		35.3	35.4	35.4	
	N Rate Mean	51.5	51.8			35.3	35.4		
	N Application Mean	51.6				35.4			
	Control (No N)	51.1				35.4			

No statistically significant treatment effects or interactions, P=0.05.

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