Nitrogen Fertilization of Nitrogen-Stressed Soybeans

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Soybeans are not generally considered responsive to N fertilizer; however, there are some circumstances where this crop can benefit from addition of N. Kansas research performed several years ago and reported in this magazine showed the potential for soybean grain response to N fertilizer in high-yield irrigated conditions. This article looks at other conditions where N fertilizer can be beneficial in soybean production.

Soybeans do not normally respond to applications of N fertilizer as long as they are well nodulated with rhizobia bacteria. When soybeans are planted into ground that has no history of soybean production, or when there has been a long interval between soybean crops, adequate rhizobia may not be present for successful nodulation and N fixation. This is usually overcome by inoculating the seed with rhizobia. However, these inoculations are not always successful, and when this happens, poorly nodulated, N-deficient soybean crops can result.

In both 2009 and 2010, a number of fields planted into "virgin" soybean ground, or into returned Conservation Reserve Program (CRP) ground in north central Kansas were observed to be poorly nodulated and N-deficient even though the seed was commercially inoculated. A field study was conducted in 2009, and continued at a different location in the same area in 2010, to determine whether these poorly nodulated, N-deficient soybean crops would respond to applied N fertilizers, and if so, how much N could successfully be used.

The 2009 study was conducted on a farmer's field near Solomon, Kansas that showed noticeable N deficiency in soybean. Variety NK S39-A3 was planted (no-till) into sorghum residue from the previous year on May 20, 2009, at 140,000 seeds/A. A liquid inoculant was sprayed on the seeds as they were loaded into the planter. This field had no history of soybean production. Nitrogen fertilizer was applied on July 20, 2009, to plants displaying N deficiency symptoms at the R1 to R2 growth stages. The N was surface banded between the soybean rows in the form of urea co-granulated with a urease inhibitor (NBPT) and nitrification inhibitor (dicyandiamide). Rainfall occurred within a few hours of N application.

The 2010 study was conducted on a farmer's field near Gypsum, Kansas that had poorly nodulated, N-deficient soybean. Variety P93Y70 was planted into conventional tilled soil at 130,000 seeds/A on June 19, 2010. The seed was inoculated prior to planting. This field also had no history of soybean production. The N was broadcast-applied as urea (co-granulated with NBPT + dicyandiamide) on July 22, 2010. Rainfall did not occur until 14 days after treatments were applied.

Results

The results from both studies for 2009 and 2010 are summarized in **Table 1**. In 2009, a highly significant response to the highest N rate applied, 120 lb N/A, was obtained, with a 21 bu/A increase over the control.

Yields at Gypsum in 2010 were lower due to dry weather; however, similar trends were observed, with an 11 bu response to the first 120 lb of N/A compared to the control. There was no advantage to increasing the N rate from 120 to 150 lb/A in 2010. When averaged across years, the data show a clear response to N, with highest yields found at 120 lb N/A.

Common notes and abbreviations: N = nitrogen; NBPT = N-(n-butyl) thiophosphoric triamide.

Broad view of field plots showing impact of N fertilization of soybeans in N deficient conditions. Field had no history of soybean production. Seed was inoculated but crop was poorly nodulated.

Table 1. Effect of nitrogen fertilization on yield of N-deficient soybeans (2009-2010).

N rate, lb/A	Solomon 2009	Gypsum 2010	Average
	Yield, bu/A		
0	28d	18c	23d
30	37c	23b	30c
60	42b	26b	33cb
90	43b	26b	34b
120	49a	29a	39a
150	N/A	29a	N/A

Means within a column followed by the same letter are not significantly different at p = 0.05.

The data from these studies show that applying N fertilizer to poorly nodulated, N-deficient soybean can significantly enhance yield. Applying up to 120 lb N/A was effective in each of the 2 years of this study. At current fertilizer and commodity prices these responses would provide a good return on investment, even on the modest yields obtained in 2010. The results of this work were previously published in the Kansas Fertilizer Research Report (Asebedo and Mengel, 2010).

Conclusions

While N applied to N-deficient soybeans at the pod development or early pod fill stages of growth can increase yields, it should be noted that there are risks:

Leaf burn – It would be much safer to apply urea than UAN solution.

Volatilization – Urea applied to the soil surface under warm, damp, windy conditions may volatilize if it is not moved into the soil by rainfall. This risk can be minimized by having the urea treated with NBPT.

Dry weather after application – If it does not rain after application, the N may not get down into the soil in time to benefit the crop.

Plant damage during the application process – At this time of year, making a fertilizer application with ground equipment could damage some of the plants. Whether the benefits would outweigh the amount of plant damage is a case-by-case judgment call.

This article has reported on one set of conditions where soybeans have the potential to respond to N fertilization. It should also be noted that irrigated soybeans with high yield potential may respond to N applications, even if they are not N deficient. Research was conducted several years ago at Kansas State on late-season application of N to soybeans (Lamond and Wesley, 2001). This research was on irrigated soybeans with high yield potential, and the plants were not showing N deficiency at the time of application. Lamond applied 20 and 40 lb N/A to the beans at the R3 stage, using UAN, ammonium nitrate, urea, and urea + NBPT. The N increased yields at most locations. The yield increases ranged from about 6 to 10 bu/A—or about 5 to 10%. The high rate (40 lb N/A) of UAN caused severe leaf burn. It was concluded that late-season supplemental N at a rate of 20 lb/A should be applied to irrigated soybeans with high yield potential at the R3 growth stage. BC

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References

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Close-up of field plot showing N deficiency where no N was applied to soybeans (top) and the effect of N application to soybeans (bottom). Field had no history of soybean production. Seed was inoculated but crop was poorly nodulated.