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Applied N At R3 Stage Bumps Soybean Yields

Nitrogen applications at R3 growth stage produce 11.8 percent average yield increase in two-year Kansas study.

Summary: *Results from a two-year study at four irrigated sites in Kansas show that late-season application of N to soybeans at the R3 growth stage will increase soybean yields. These results, coupled with similar results in other states (the work of Flannery and Gascho), suggest that public and private labs and consultants who make fertilizer recommendations should consider N applications on irrigated soybeans with high-yield potential. Combined analysis of all sites revealed that soybean grain protein and oil concentrations were not consistently affected by late-season N fertilization. Likewise, leaf N concentration in samples taken two to three weeks after N application were not affected by late-season N fertilization.*

Previous research on N fertilization of soybeans has produced inconsistent results, showing both increased and decreased soybean yields. While irrigated soybean producers have routinely achieved yields of 60 bu/A, few studies have evaluated the impact of late-season N application on irrigated soybeans with high yield potential. In much of the past work evaluated, N was applied either preplant, at planting time, or early in the growing season.

We know that a soybean crop that yields 70 bu/A must translocate 242 lbs/A of N into the seeds during pod fill. This period of high N requirement for soybeans is from the R3 to R6 growth stages. With the high-yield potential of irrigated soybeans, the question is can N fixation supply enough N to meet demand? Or can a late-season supplemental N fertilization increase yields? Little of this work has been conducted in the Midwest.

Changes in soybean marketing strategies have also renewed interest in late-season N fertilization to increase grain protein and/or oil concentrations. The USDA Federal Grain Inspection Service has discussed implementation of oil and protein testing as official soybean marketing criteria. Soybean pricing structures in the future may well be influenced by these parameters. The question then naturally arises as to what effects late-season N fertilization might have on protein and oil contents of irrigated soybeans.

The objective of the research in this discussion, therefore, was to evaluate the effects of late-season supplemental N on soybean grain yield, protein, and oil content of irrigated soybeans with high yield potential.

Table 1. Location and cultural practices for research sites, Wesley, et al., Kansas State University, 1994-95.

Location	Site	Row spacing inch	Cultivar	Seeding rate Seeds/A
Johnson County	JO94	30	Asgrow A4138	160,000
Brucker Farm	JO95	30	Asgrow A4138	160,000
Shawnnee County	SN94	36	Asgrow A3935	180,000
Parr Farm	SN95	36	Asgrow A3935	180,000
Reno County	RN94	7.5	Asgrow A3935	200,000
Sock Farm	RN95	7.5	Asgrow A3834	200,000
Stafford County	SF94	30	Resnick	150,000
Sandyland field	SF95	30	KS3494	125,000

Yield up

During the two years of this research, late-season N fertilization significantly increased soybean grain yield at six of eight sites (Figure 1).

Visual inspection of soybean root systems at all locations revealed excellent nodulation at the time of N fertilization. Leaf N concentrations of the check treatments, ranging from 4.96 to 5.70 percent, verify that soybean plants were not severely N stressed and suggest that nodules were effectively fixing N for the plant.

The two non-responsive sites were at the Stafford County location, which was also the lowest yielding location. The soybeans there would have had a lower

N demand than at the other three locations because of lower yields (below 50 bu/A).

The six responsive sites showed an average soybean yield increase of 6.9 bu/A or 11.8 percent with late-season N fertilization. Yields at these six sites ranged from a low of 56 bu/A to a high of 83 bu/A.

Even though soybean grain yields were increased by late-season N application, differences between the 20 and 40-lb/A rates of N were minimal. When averaged across all site years, the 20-lb/A rate produced a yield of 62.4 bu/A compared to 61.9 bu/A for the 40-lb/A rate.

Results also corroborate other work suggesting that soil N is crucial during periods of peak N demand such as pod fill.

The study shows that producers of high yielding soybeans (greater than 55 bu/A) would benefit from a late-season application of N at the 20-lb/A rate of N. Assuming a $7/bu soybean price, the 6.9 bu/A yield increase would bring an added return of $48.30/A. Assuming an N cost of $0.30/lb, applying N at rate of 20 lbs/A would cost $6/A, leaving a net economic benefit of $42.30/A.

Table 2. Selected soil characteristics of research sites, Wesley, et al., Kansas State University, 1994-95.

Site	pH	Bray–1P	K	Organic Matter 0-6 in.	Profile N 0-6 in.	Profile N 6-24 in.
	——ppm——			%	——ppm——	
JO94	6.9	41	125	0.7	4.1	- -
JO95	6.8	44	165	0.8	3.0	5.5
SN94	7.3	65	305	2.8	6.7	- -
SN95	7.7	67	240	3.1	7.9	6.3
RN94	6.8	50	210	1.2	2.7	- -
RN95	6.8	48	190	1.7	3.0	2.2
SF94	6.9	31	140	0.9	3.1	- -
SF95	6.7	52	130	1.3	7.8	4.5

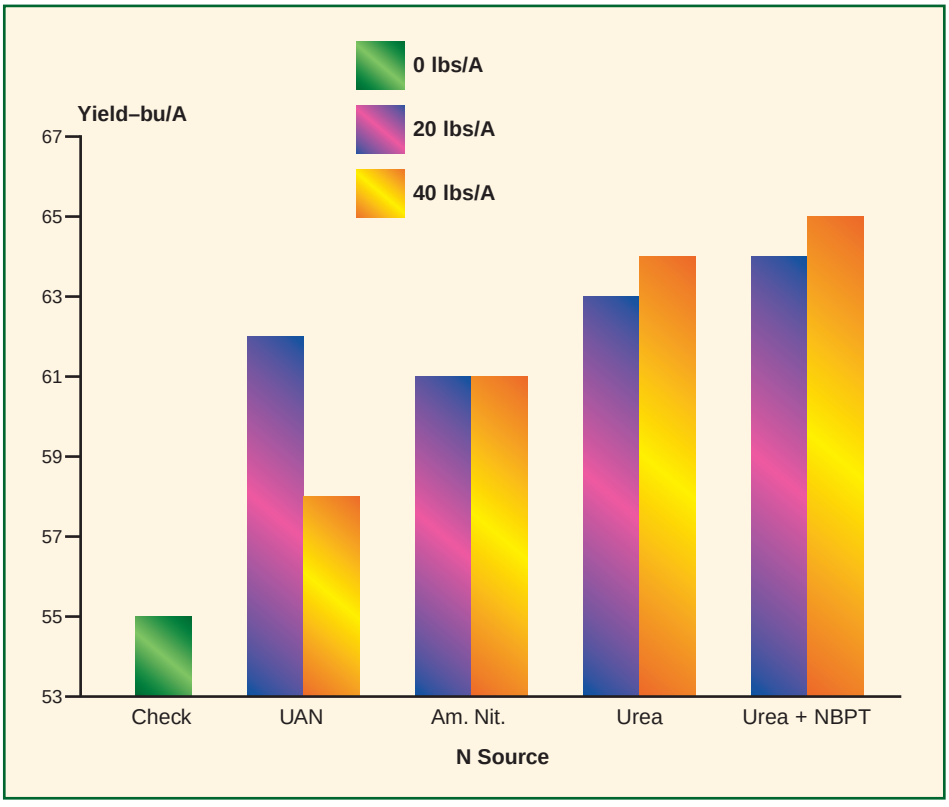

Figure 1. Effect of late-season N application on irrigated soybean yield, Wesley, et al., Kansas State University, 1994-95.

Content unaffected

Protein. Although soybean protein content was increased significantly by late-season N fertilization at four of eight sites, combined analysis indicated non-significant effects (Figure 2). At the responsive sites, protein increases were about 1 percent. Over the course of this two-year research project, N rate had no significant effect on soybean seed protein at any of the eight sites.

Oil. Late-season N fertilization significantly increased soybean oil content at three sites, but combined analysis indicated overall effects were non-significant (Figure 3). At the responsive sites, oil content was increased by 0.3 to 0.5 percent. (This contrasts with other work that has found that N fertilization tends to lower oil levels.) Nitrogen rate effects on oil content at any of the other study sites were not significant.

If soybean marketing eventually requires a minimum protein plus oil level, late-season N fertilization may have to be further evaluated. Currently, significant premiums are not offered for increased protein or oil in soybeans.

Leaf N concentration. Soybean leaf N concentrations at two to three weeks after late-season N applications were not

affected significantly. The fact that late-season N applications had no impact on leaf N concentration suggests that fertilizer N taken up by the plant was translocated directly to the forming soybean seed and not stored in the leaf.

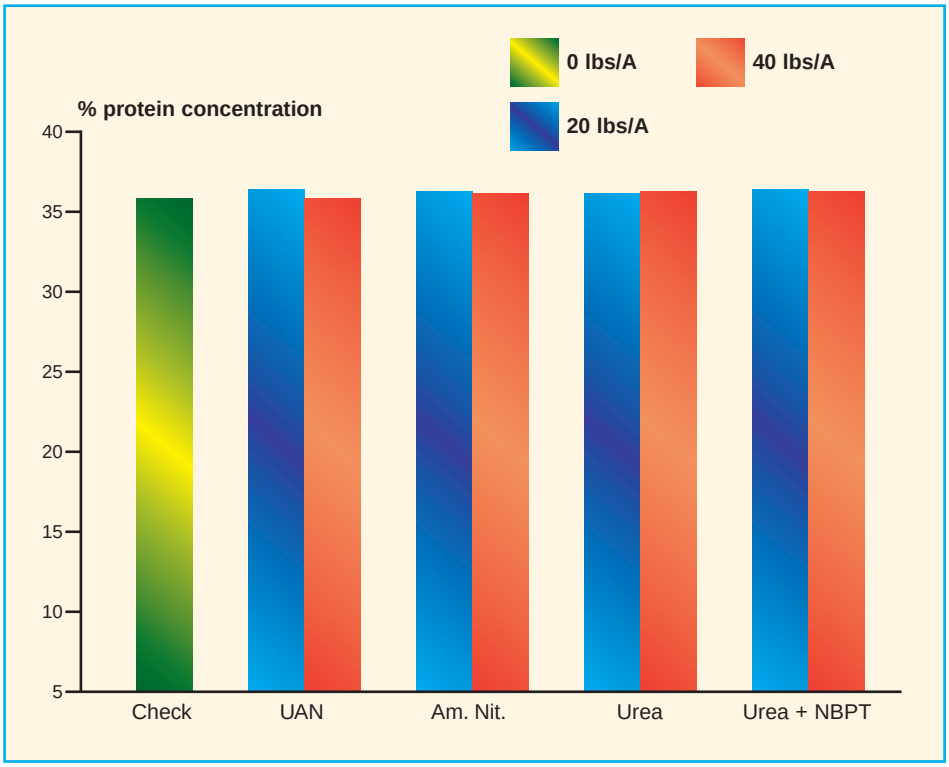

Figure 2. Effect of late-season N application on irrigated soybean protein concentration, Wesley, et al., Kansas State University, 1994-95.

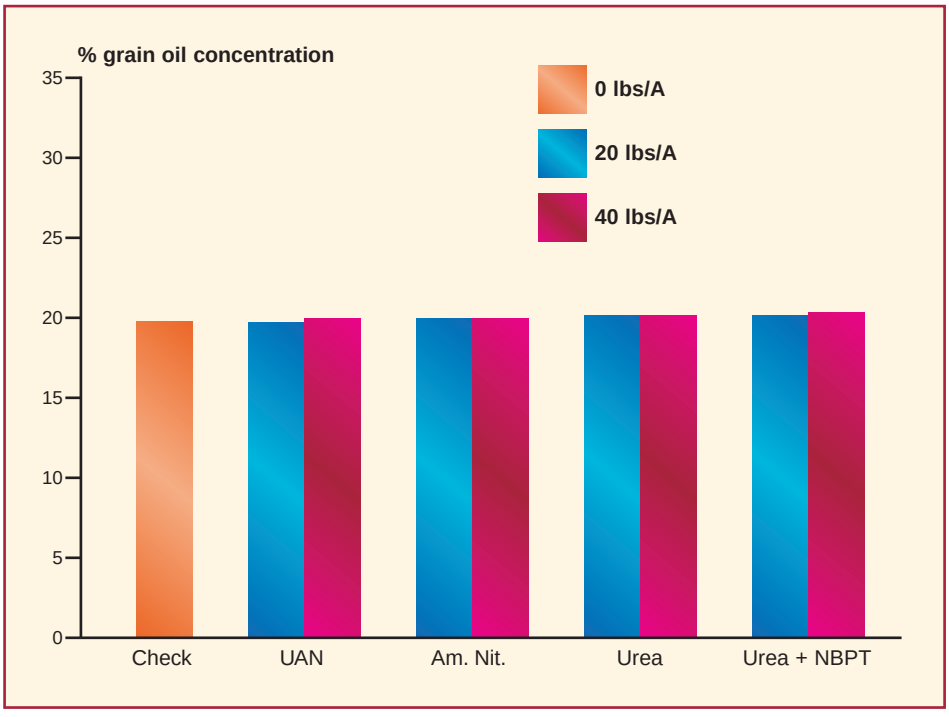

Figure 3. Effect of late-season N application on irrigated soybean oil concentration, Wesley, et al., Kansas State University, 1994-95.

Methodology

Locations. Studies were initiated in 1994 and repeated in 1995 at four Kansas locations in Shawnee, Johnson, Reno, and Stafford counties.

Soil types were Muir silt loam, fine-silty, mixed, superactive, mesic Cumulic Haplustolls in Shawnee County; Eudora silt loam, coarse-silty, mixed, superactive, mesic Fluventic Hapludolls in Johnson County; Naron fine sandy loam, fine-loamy, mixed, mesic Udic Argiustolls in Reno County; and Pratt loamy fine sand, sandy, mixed, mesic Psammentic Haplustalfs in Stafford County.

Cultural practices used at each location are summarized in Table 1. At all sites, soybeans followed corn and cooperators applied needed P and K in the corn year of rotation.

Plots. All sites were irrigated. Each included four replications and nine treatments arranged in a randomized complete block design. Individual plots usually measured 10 by 20 ft. When 36-inch rows were used they measured 12 by 20 ft.

Treatments included UAN, urea, urea + NBPT, and ammonium nitrate, applied at rates of 20 and 40 lbs/A. Applications were foliar- or broadcast-applied between the R3 and R4 stages of growth. A check (no-N) treatment was included.

Soil samples were taken at each site and analyzed for pH, P, K, and organic matter (Table 2). Profile N (nitrate N) was determined to a depth of 6 inches in 1994 and 24 inches in 1995.

Plant tissue samples were taken two to three weeks after late-season N application by collecting the last fully developed trifoliate leaf from 10 to 12 plants in each plot.

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