A Look At Increasing Late N Availability In Soybeans

Better synchronization with N demand sought via better timing of N availability to crop.

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Summary: *Given the development of fluid fertilization and availability of fluid application equipment in particular, there is the possibility of delivering specialty fluid nitrogen (N) fertilizers by dribbling or knifing at a phenological moment when soybean canopy is small enough to allow the traffic of terrestrial applicators without jeopardizing the proper biological fixation mechanisms. A study of using slow/controlled release fertilizers is therefore in order to determine a timing of N availability that offers better synchronization with N demand.*

Nitrogen requirement of legumes can be met by both mineral assimilation and symbiotic N fixation. The plant N requirement may not be met during early vegetative and later productive phases by N_2 fixation. Symbiotic fixation begins only after nodule formation, which is preceded by the colonization of the rhizosphere and the infection of legume roots by Rhizobium. Thus, mineral N may be a critical source of N for grain legumes during both the early vegetative and late reproductive periods. The period of high N requirement for soybeans is from the R3 to R6 growth stages. A 1974 study reported that 25 to 60 percent of the N in a mature soybean comes from N fixation and the other 40 to 75 percent comes from the soil.

The contributions of symbiotic and mineral N sources to total plant N are determined by legume N requirement and mineral N supply, provided an effective Rhizobium symbiosis is ensured. When mineral N uptake is less than the N requirement, N_2 fixation potential can be considered to be equal to the aggregate of per day deficits in mineral N uptake during the legume growth cycle.

Although controversial, N applications to soybeans could be a possibility to improve grain yields. Although many studies have not shown responses, several studies have indicated positive responses. Nitrogen applied at the R1 to R5 growth stages has been shown to increase soybean yields. A study in Kansas reported significant yield increases to N fertilizer supplied as urea or UAN in soybeans under irrigation. In the Pampean region of Argentina, we had some small but consistent responses to ready-available N applied by hand at R1 (data not presented).

"N on Soybeans Could Improve Yields"

While evidence exists for late application responses, operationally it is difficult to manage when fertilizer has to be applied on a dense soybean crop. Under Argentinean conditions, broadcasting urea is difficult because of lack of appropriate machinery. Spreaders of large working capability are not common. Other sources like ammonium nitrate are prohibited by law. However, some increasing use of UAN and NS solutions is occurring among farmers.

Fluid potential

Given the development of fluid fertilization and availability of fluid application equipment in particular, there is the possibility of delivering fluid N fertilizers by dribbling or knifing at a phenological moment when the soybean canopy is small enough to allow the traffic of terrestrial applicators. However, that moment may be too early if ready-available applied N stops or slows down severely the symbiotic fixation process.

Further product development by industry may help to improve allocation of fluid N products at a time of planting or shortly afterwards when farm equipment can move over fields. Excepting fertigation, it would be more cost efficient than foliar or aircraft

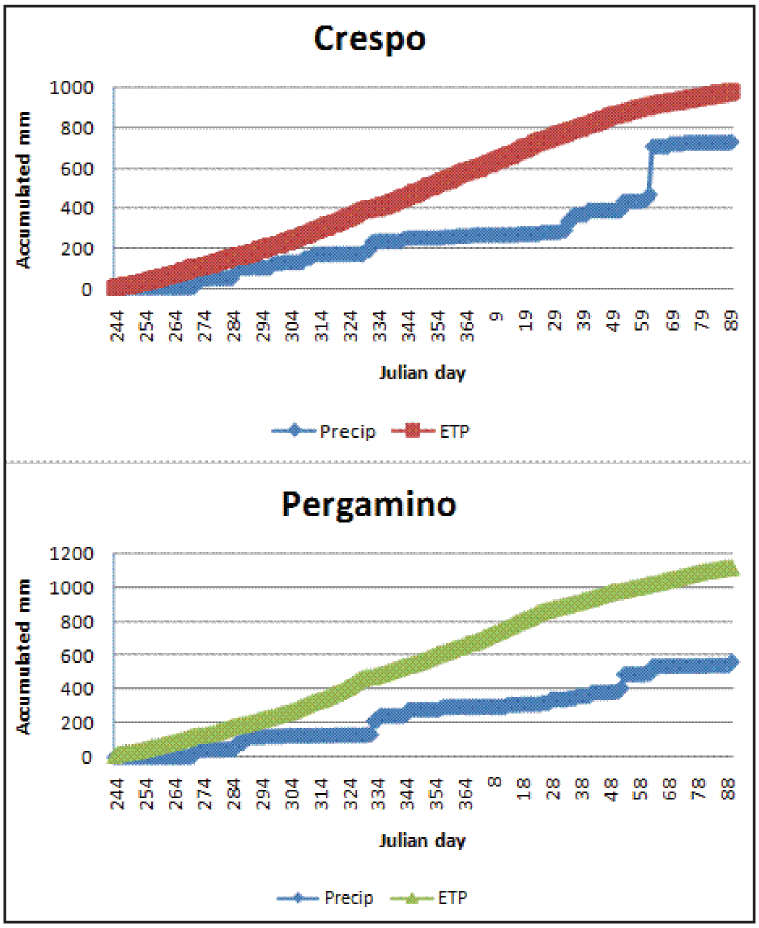

Figure 1. *Accumulated precipitation and evapotranspiration from September 1, 2008 to March 31, 2009 at INTA Exp. Stations of Parana (Crespo), and Pergamino.*

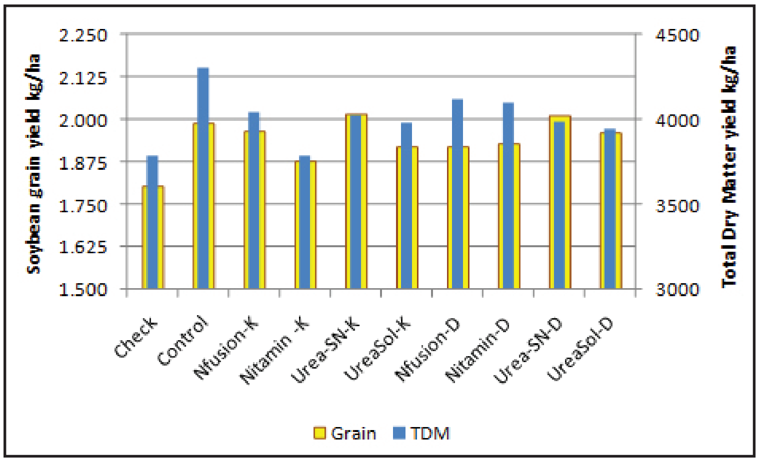

Figure 2. *Treatment means pooling locations for grain and total dry matter yields.*

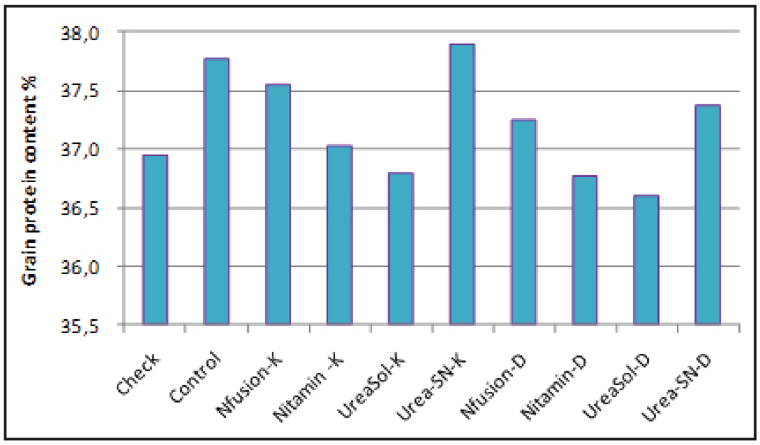

Figure 3. *Treatment means pooling locations for protein content in soybean.*

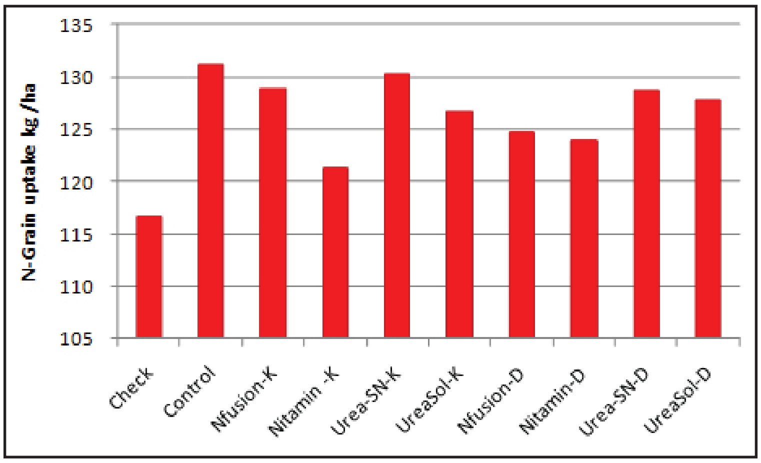

Figure 4. *Treatment means pooling locations for grain N uptake in soybean.*

spraying.

By using slow/controlled release fertilizer, which may delay between 30 to 60 days its rendering of mineral N to crops (coupled with that early moment), the timing of N availability may offer a better synchronization with N demand without jeopardizing N fixation. Also, urea with a urease inhibitor like n-BTPT would prevent N losses by volatilization as NH_3 but also at the same time avoid adding readily to available N as in the case of UAN.

Having fertilizer-N available at late stages of soybean growth when fixed N would not be enough to support high yields on soybeans would boost grain yields without affecting symbiotically fixed N.

The objective of this work was to evaluate the effect of increasing late N availability by improving placement/product combinations of fluid N sources on soybean grain yields and N uptake.

Factoring weather

In the 2008-09 season the whole region was affected by one of our worst droughts ever seen. Yields and treatment performance were hampered. Figure 1 shows the accumulated precipitation and evapotranspiration (ETP) from September 1, 2008 to March 31, 2009 during the growing season of the soybean crops.

Notwithstanding, the soybean crop yielded some grain at all sites and showed a reasonable nodulation. It is assumed that N fixations performed according to the weather restrictions.

However, there were significant differences in yield among the sites due to the weather pattern. While the Pergamino site showed Acevedo as one the lowest ever yields (1,244 kg/ha), the yields at the other locations showed a parallel with the rainfall received during the growing cycle. Only slightly more yield than the Acevedo site was obtained at Ocampo (2,058 kg/ha) while the northern locations were in the range of 2.2 mt/ha (Mercedes and Crespo sites, respectively: 2,238 and 2,209 kg/ha).

These yield locations resulted in a different response to treatments, with a significant statistical interaction (pr>F:0.09).

Due to this differential response, Tables 1 and 2 present the grain and biomass yields by site. In spite of the differences in sites, some tendency is observed with sources and incorporation of fertilizers (Figure 2). In general, grain yields and differences due to treatments were paralleled with biomass yield and differences.

A variable trait quite more affected by fertilizer treatments was protein content in grains. Table 3 shows the treatment means of protein concentration in grain at each site. The values show a good tendency in sources for both dribbled and knifed methods of application. The control treatment that received AN shows a rather high level comparable to better treatments. On the other hand, the check depicts a rather low value (Figure 3).

"Yields Varied Significantly Due to Weather Patterns"

There was not a significant correlation between the grain yields and protein content of grains and the relationship was inverse, that is, higher protein with lower yields (r = -0.28 ns). When transforming the protein values into N%, and estimating N uptake in grains, the tendency in differences among treatments is replicated (Figure 4).

Final considerations

The severe lack of rains during the critical periods of filling grains prevented the attainment of a high yield that could stress the N symbiotic capacity to supply N to crops. Therefore, N was of ample abundance for the limited grain and biomass yields obtained.

A trial under irrigation would enhance the possibility of enlarged differences between check and fertilizer-treated soybeans.

Our hope is for a season with improved weather patterns, especially improved precipitation, which will allow reaching a more conclusive outcome.

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Treatment/Placement	Acevedo	Crespo	Mercedes	Ocampo
	Kg/ha			
Check - No N --	1.471	1.953	1.825	1.963
Control - AN Broadcast	1.265	2.250	2.255	2.171
Nfusion Knifed	1.237	2.165	2.380	2.077
Nitamin Knifed	1.014	2.318	2.268	1.898
Urea solution Knifed	1.159	2.328	2.513	2.066
Urea Sol + n-BTPT Knifed	1.037	2.188	2.333	2.116
Nfusion Dribbled	1.157	2.203	2.340	1.968
Nitamin Dribbled	1.509	2.238	1.955	2.003
Urea solution Dribbled	1.324	2.355	2.055	2.312
Urea Sol + n-BTPT Dribbled	1.272	2.385	2.170	2.007
Pr> F treatment	0.53	0.36	0.07	0.32
LSD 5%	497	337	426	314
CV %	27.5	10.37	13.3	10.5

Table 1. *Treatment means and summary of statistical analysis for soybean grain yields across sites in 2008/09.*

Treatment Placement	Acevedo	Crespo	Mercedes	Ocampo
Check - No N--	2778	4190	4048	4130
Control - AN Broadcast	2383	4980	5305	4553
Nfusion Knifed	2218	4778	5085	4100
Nitamin Knifed	1913	5335	4035	3855
Urea solution Knifed	2185	5170	4845	3900
Urea Sol + n-BTPT Knifed	1905	4775	5135	4100
Nfusion Dribbled	2183	4855	5435	4010
Nitamin Dribbled	2858	4968	4468	4125
Urea solution Dribbled	2498	5183	3748	4510
Urea Sol + n-BTPT Dribbled	2393	5335	4203	3825
Pr> F treatment	0.45	0.14	0.002	0.14
LSD 5%	919	760	887	748
CV %	27.1	10.6	13.2	12.5

Table 2. *Treatment means and summary of statistical analysis for total above-ground dry matter yields across sites in 2008/09.*

Treatment Placement	Acevedo	Ocampo	Crespo	Mercedes
	%Protein			
Nfusion Knifed	37.2	37.5	36.1	37.0
Nitamin Knifed	38.2	37.9	38.1	36.9
Urea solution Knifed	38.2	38.9	36.9	36.2
Urea Sol + n-BTPT Knifed	37.5	36.7	36.7	37.2
Nfusion Dribbled	36.2	37.8	36.8	36.4
Nitamin Dribbled	39.0	39.1	37.2	36.3
Urea solution Dribbled	38.0	38.6	36.0	36.4
Urea Sol + n-BTPT Dribbled	37.3	36.5	36.3	37.0
Nfusion Knifed	37.2	37.4	35.9	35.9
Nitamin Knifed	38.7	38.2	36.4	36.2

Table 3. *Treatment means of soybean protein content across locations. Each number is a single composite sample of grains of the four replications.*