Nitrogen Rates, Sources and Application Methods for No-Till Wheat

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Introduction

Wheat is one of the key crops for no-tillage rotations in Argentina. Fertilizer and water use efficiency are the two most powerful tools in production systems that optimize wheat yield, especially in environments with a long continuous agriculture history. Nitrogen (N) is the most yield-limiting nutrient for no-till wheat. N is the nutrient required in the highest amount by a wheat crop, mainly by controlling biomass production. Significant yield increases can be obtained with adequate N availability, when other limiting factors are controlled. The efficiency of the N fertilization in wheat under continuous no-tillage is affected by various factors, like N rate and utilized N source (García et al., 2001), being the most important for the Central Pampas Region of Argentina, previous crop (corn vs. soybean residues), N rate, N source, and application method (incorporated vs. broadcast) (Gambaudo and Fontanetto, 1994).

The objective of this study was to evaluate the effect of different rates and sources of N in no-till wheat, with different application methods.

Materials and Methods

The experiment was conducted in a tipic argiudoll at INTA Rafaela Research Station, in a field with double crop corn as a previous crop. The wheat cultivar used was BioINTA 3000, planted on June 7, 2006, with a seed density of 116 kg ha^{-1} and a row width of 0.168 m.

A RCBD with 4 replications was used. The experimental units were small plots of 2 m wide and 10 m long (20 m^2). Treatments were a control (N0), and a factorial design 2^3 with two N sources (urea (46% N) and UAN solution (30% N, 2.6% S)), two pre-plant application methods (broadcast and incorporated), and two N rates (40 and 80 kg N ha^{-1}). All treatments are shown in Table 1. Sulphur (S) was applied in all treatments at a rate of 15 kg S ha^{-1}. The pre-plant N fertilizer was applied 25 days before planting and was incorporated with a no-till wheat drill and the broadcast treatments were hand applied over the corn stubble.

Before treatment application, a composite soil sample (15 cores) was taken at 20-cm depth. Organic Matter (OM), Total N (Nt), N-NO_3, Bray-1 P, S-SO_4, pH, Ca, Mg, K, and Na, were determined.

General crop management practices (weed control, planting date, etc.) were the recommended ones for the agricultural region.

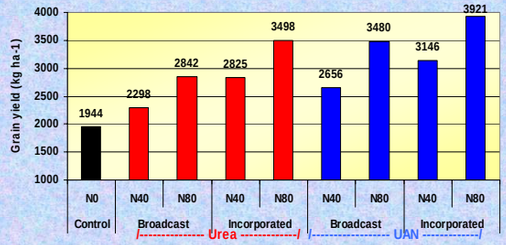
Grain yields were determined by small-plot combines, over an area of 15 m^2. Grain yields measured in each treatment were used in an ANOVA analysis, and when the differences were significant ($P \leq 0.05$), the Least Significant Difference (LSD) test was applied.

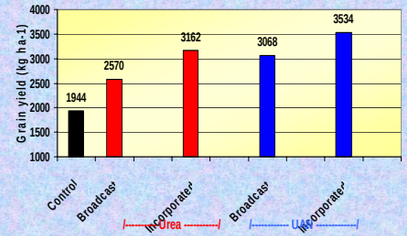
Table 1. Fertilization treatments.

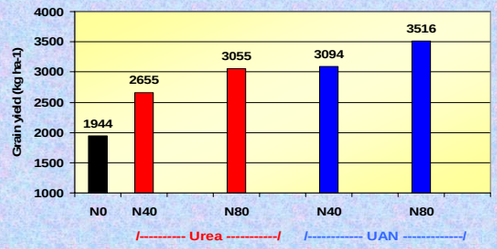
Nitrogen Source	Application Method	Nitrogen Rate (kg ha^{-1})	Treatment
Control (no N)	---------	N0	1-Control
Urea	Broadcast	N40	2-N40 preplant (40 kg N ha^{-1})
		N80	3-N80 preplant (80 kg N ha^{-1})
	Incorporated	N40	4-N40 preplant (40 kg N ha^{-1})
		N80	5-N80 preplant (80 kg N ha^{-1})
UAN	Broadcast	N40	6-N40 preplant (40 kg N ha^{-1})
		N80	7-N80 preplant (80 kg N ha^{-1})
	Incorporated	N40	8-N40 preplant (40 kg N ha^{-1})
		N80	9-N80 preplant (80 kg N ha^{-1})

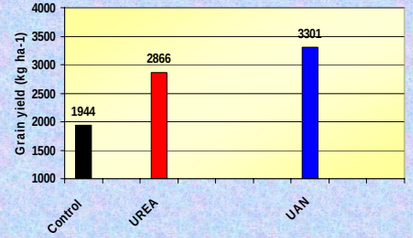
Table 2. Soil test results at planting.

O. M.	Nt	N-NO_3	P	S-SO_4	pH	Ca	Mg	K	Na
-- mg kg^{-1} --		-------- mg kg^{-1} --------				-------- cmol / kg --------			
29.8	1.5	6.1	40	5.3	5.9	9.9	1.3	1.4	0.2









Results and Discussion

The soil test results (Table 2) show that OM levels were around the average for the area, Bray 1 P was above the critical level considered for wheat (18-20 mg kg^{-1}). Ca, Mg and K levels were above the critical levels, and Na was below the levels that cause growth limitations to wheat crops.

Significant wheat yield differences ($P \leq 0.05$) between the control (1944 kg ha^{-1}) and the average of the fertilized treatments (3083 kg ha^{-1}) were found.
The interactions between the N sources and application methods and between N rates and sources were significant ($P \leq 0.05$). The different factors were also significant.
Even with the existence of interaction, there was a significant effect of the N fertilization on the wheat production, the UAN solution was more efficient than the urea, and the fertilizer incorporation was better than the broadcast applications.
The interaction between N rates and sources was significant, however, the average grain yields with 80 kg N ha^{-1} were always higher than with 40 kg ha^{-1}, and the plots with UAN were always higher than those with urea.
The incorporation of urea (compared to the broadcast application) and UAN produced a grain yield increase of 24.2%, and 14.9%, respectively. These results demonstrate that the urea was more affected to N losses than UAN.
The broadcast application of UAN produced similar grain yields than the incorporated urea, when the 2 N rates were averaged. These results give wheat farmers interesting tools to increase the fertilizer N use efficiency.

Conclusions

- There was a significant grain yield response to N.
- The UAN solution performed better that urea.
- The incorporated application of N was more efficient than the broadcast, and the difference was larger when urea was utilized.

Acknowledgments

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