YIELD AND N CONCENTRATION OF CORN WITH DIFFERENT N SOURCES APPLIED AT DIFFERENT TIMES[1]

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A number of recent investigations have produced evidence that the ionic form of N taken up by roots affects the growth of plants. While soil-grown plants generally take up most of their N as nitrate, there is evidence that increasing the relative proportion of ammonium in the culture (or soil) solution can enhance growth and yield. Owing to difficulties in preventing the rapid microbial conversion of ammonium to nitrate in soil, this response has not been well demonstrated in a field situation.

The objective of this study was to evaluate the effect of varying ammonium to nitrate ratios applied at varying times on the yield and nitrogen concentration in corn. A small study was also included in 1988 to assess the response of three hybrids to different N forms.

METHODS AND MATERIALS:

The experiment was conducted on a Drummer sicl on the Agronomy South Farm, Urbana, IL during the 1987 and 1988 growing seasons. Prior to planting, drip hose was buried at a depth of 7 inches on 30 inch centers directly under the center two corn rows of those plots which were to receive nitrogen during the growing season. Pioneer Brand 3377 was planted on 1 May, 1987 and 27 April, 1988, and after emergence was thinned to a final stand of 27,000 and 25,000 plants per acre in 1987 and 1988, respectively. Anhydrous ammonia was applied at growth stage V_5 (late May) at rates of 80, 160, 240, and 320 lbs N/acre with and without nitrapyrin at a rate of 1 lb/acre. The remaining 10 treatments consisted of application of 160 lbs N/acre through the drip tubes using urea, ammonium nitrate, potassium nitrate, or combinations as shown in Table 1. Treatments were arranged in a randomized complete block design with three replicates.

In 1988, three Pioneer Brand hybrids -- 3378, 3343, and 3377 -- were planted under the same conditions as the larger study. Two N forms -- KNO_3 and urea -- were supplied throughout the growing season (six applications totaling 160 lb N/acre) by way of buried drip tubes.

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Due to the extremely dry weather in 1988, the study was irrigated twice, on 10 June (V8) and 27 June (V14). About two inches of water were applied each time through a portable, overhed sprinkler system.

Plant samples consisting of the whole plant and the lower 4 inches of the stalk were collected at V10. Ear leaf and lower 4 inches of stalk samples were collected at R2 and R4. Whole plant samples were collected at harvest. All samples were analyzed for total N, and in additon the stalk samples were analyzed for ammonium and nitrate N. Only ear leaf and lower stalk total N concentrations at R2 will be discussed here. Plots were harvested by hand, and grain yield was determined.

RESULTS AND DISCUSSION

The design of the study allows for comparison of three distinct factors. These include the effect of rate of sidedressed ammonia applied with and without nitrapyrin, the effect of nitrogen source, and the effect of time of application of different nitrogen sources.

Rate of Ammonia Application With and Without Nitrapyrin:

Since the year by treatment interaction for yield was not significant, yield data were averaged across years (Fig. 1). Without nitrapyrin, maximum yield was produced by 160 lb N/acre, and yields declined somewhat at higher rates. With nitrapyrin, yields increased with N rate in a linear fashion. Both years were quite dry, especailly 1988, and this differential response to N may have resulted from nitrapyrin causing more retention of N in the dry, upper layer of soil where roots were not growing or were less active than roots deeper in the soil.

Nitrogen concentration of leaves and stalks increased when N rate was increased from 80 to 160 lb/acre, and increased rather slowly and inconsistently at higher rates (Fig. 2). Nitrapyrin decreased stalk N concentration at the lowest N rate, probably by contributing to positional unavailability as discussed above. At higher N rates, there was no consistent effect of nitrapyrin.

Nitrogen Source

Averaged across years, nitrate produced a significantly lower grain yield than either urea or ammonia without nitrapyrin (Fig 3). This may be interpreted as supportive of similar results reported from various greenhouse and hydroponic studies showing the deleterious effects of using only nitrate as the N source. The decrease in yield associated with nitrapyrin was mostly due to large yield decreases in 1988 (data not shown). As discussed above, the extremely dry weather may have contributed to this phenomenon.

There was no consistent effect of N source on ear leaf or lower stalk N concentration at R2 (Fig. 4). Though stalk N concentrations from ammonia and nitrate treatments were higher than those from other treatments in 1988, this effect was not seen in 1987. Nitrapyrin had no effect on either leaf or stalk N concentration in either year. Data on the relative proportions of nitrate and reduced N are not yet fully analyzed, but early indictions are that the lower stalk N forms do reflect the form supplied through the drip tubes, thus providing evidence that this system of supplying N is effective.

Time of Application of Two Nitrogen Sources

When averaged across years, there were few significant yield differences caused by timing of nitrate and ammonium nitrate applications (Fig. 5). The lowest yields were produced with nitrate as the only N source, and when only nitrate was provided after V12. Thus, while it appears that corn plants may benefit from some ammonium during reproductive stages, this effect is not large, nor is it clear how much ammonium is needed to provide this effect. Nitrapyrin did not contribute to yield, and in fact tended to cause yield decreases. Such decreases were, however, noted primarily in 1988 (data not shown), and may well have been a result of N position in the soil rather than nitrapyrin's effect on the form of N taken up.

There was no consistent effect of either timing of the two N sources or of nitrapyrin on N concentration of ear leaves or lower stalks at R2. Again, preliminary data (not shown) indicate that the N source affected the nitrate: reduced N ratio in the lower stalk in a predictable way. There is no evidence, however, that overall N nutrition of the corn plants was affected in a quantitative way by these treatments.

Corn Hybrid x Nitrogen Source

There was no effect of N source on ear leaf N concentration averaged across hybrids (Table 2). The interaction between hybrid and N source was significant for this parameter; however, with urea produced higher leaf N concentration in hybrid P3343, but lower concentrations in the other two hybrids. These differences were not large, and it is not clear whether they might have been related to the lower yield of P3343.

Lower stalk N concentration at R2 was affected by N source, with urea causing lower N concentrations (Table 2). This was also noted in the stalks sampled at V10 and R4 (data not shown). Reasons for this are not clear.

Even though N source influenced plant N concentration to some extent, there was no effect of source on grain yield. Hybrid P3343 yielded significantly less than the other two hybrids, but there is no evidence that the hybrids were affected differently by N form. These hybrids were chosen in part because they differ in growth characteristics, with P3378 a relatively prolific, "stay-green" hybrid compared to the other two. In this study, N source effects on such characteristics were not obvious. It must be emphasized that this was a single year, and an unusually dry one, so caution must be used in interpretation.

Table 1. N source materials and stage of growth they were applied through drip tubes.

Treatment Number	Time of Application V2-V6*	V12-R1	R2-R4
		N Source	
9	KNO_3	KNO_3	KNO_3
10	NH_4NO_3	NH_4NO_3	NH_4NO_3
11	NH_4NO_3 + Ni**	NH_4NO_3 + Ni	NH_4NO_3 + Ni
12	Urea	Urea	Urea
13	NH_4NO_3	KNO_3	KNO_3
14	NH_4NO_3 + Ni	KNO_3	KNO_3
15	KNO_3	NH_4NO_3	KNO_3
16	KNO_3	NH_4NO_3 + Ni	KNO_3
17	KNO_3	KNO_3	NH_4NO_3
18	KNO_3	KNO_3	NH_4NO_3 + Ni

*In 1987, one-third of the seasonal N was applied at V6. In 1988, this was split, with one-sixth at V2 and one-sixth at V6.

**Ni = Nitrapyrin

Table 2. Effect of N source on N concentration and yield of three corn hybrids.

		HYBRID			
Parameter	N Source	P3378	P3343	P3377	Average
Ear Leaf N Concentration@	KNO_3	2.18	2.04	2.08	2.10
					ns
	Urea	2.11	2.29	1.94	2.11
Lower Stalk N concentration@	KNO_3	0.88	0.72	1.11	0.91
					*
	Urea	0.68	0.63	0.65	0.65
		bu/acre			
Grain Yield	KNO_3	162	154	167	161
					ns
	Urea	172	154	171	166

@ Measured at R2
ns,* not statistically significant and significant at P=0.1, respectively.

Figure 1. Corn yield as affected by N rate (as anhydrous ammonia) and nitrapyrin. Data are averages of 1987 & 1988.

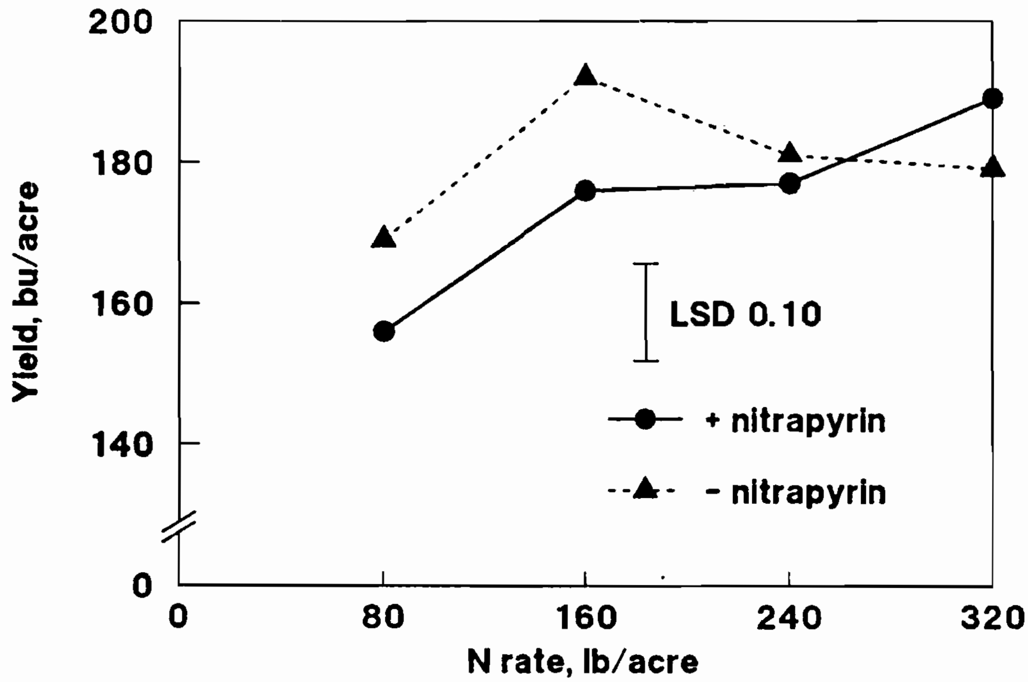


Figure 2. Corn ear leaf & lower stalk N content at growth stage R2 as affected by rate of N (as anhydrous ammonia) & nitrapyrin.

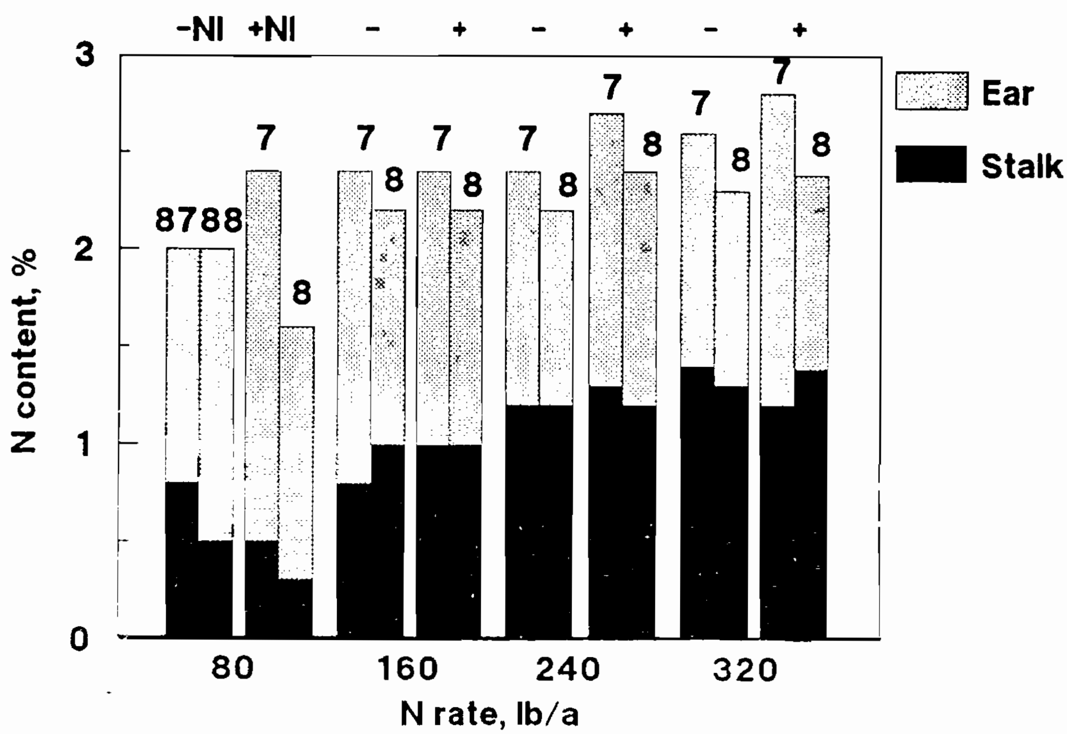


Figure 3. N source and nitrapyrin effects on corn yield. Data are averages of 1987 and 1988.

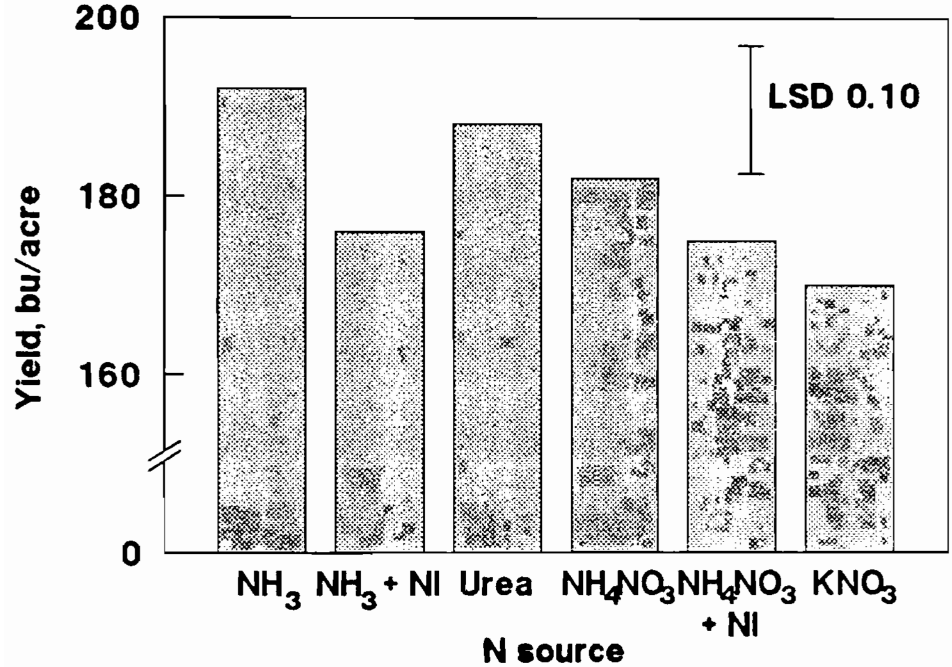


Figure 4. N source and nitrapyrin effects on corn ear leaf and lower stalk N contents at growth stage R2.

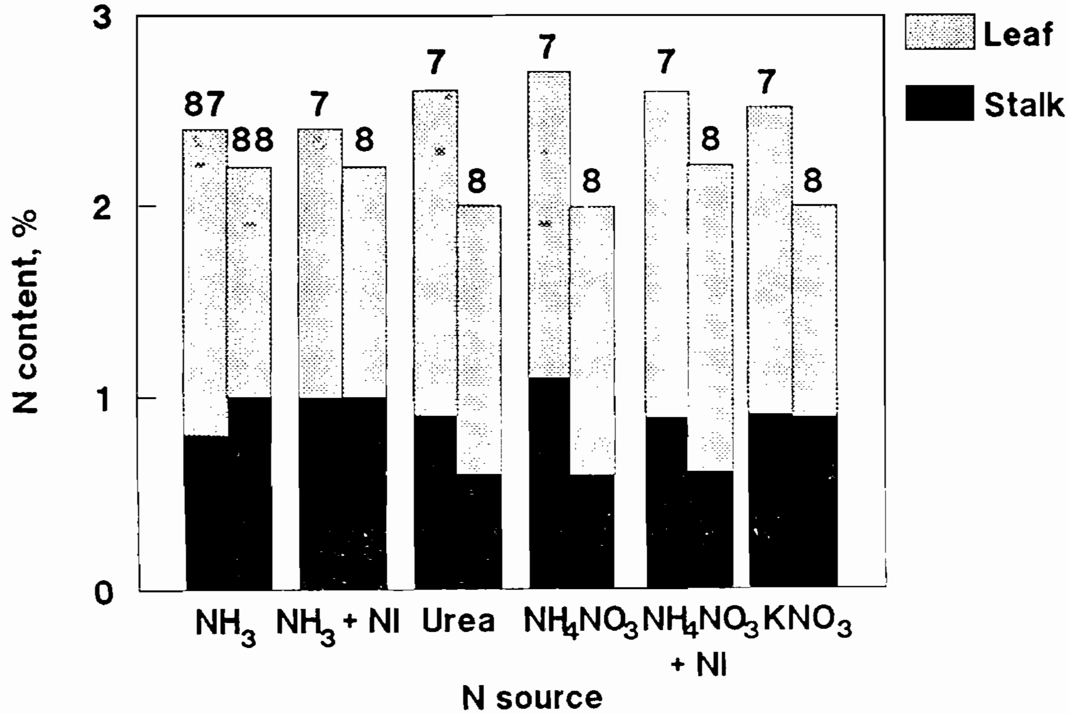


Figure 5. Corn yield as affected by timing of supply of two N sources and by nitrapyrin. Data are 1987-88 averages.

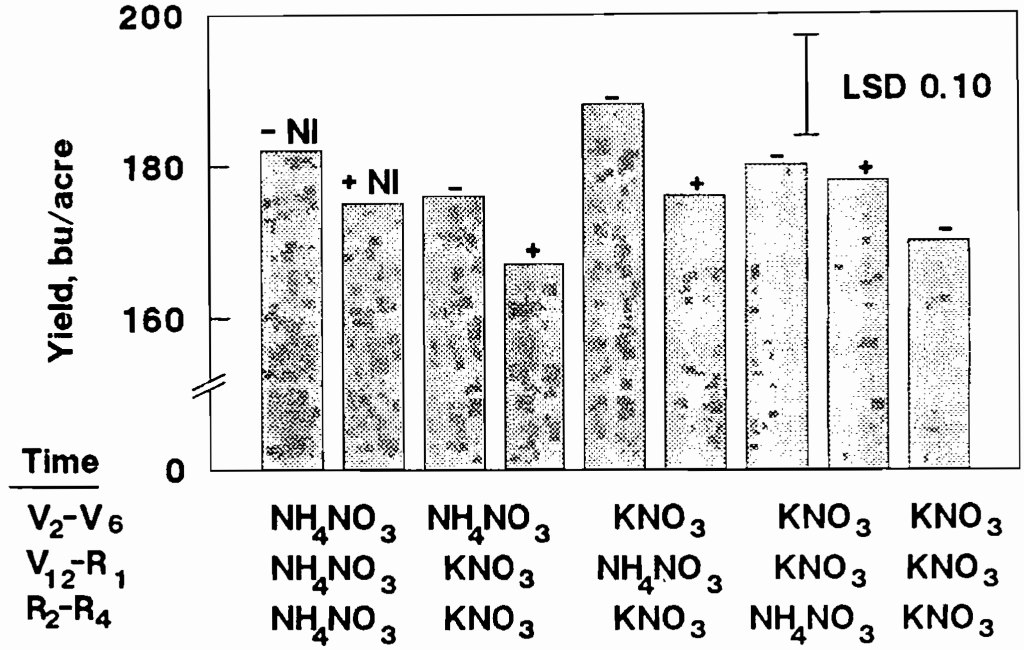
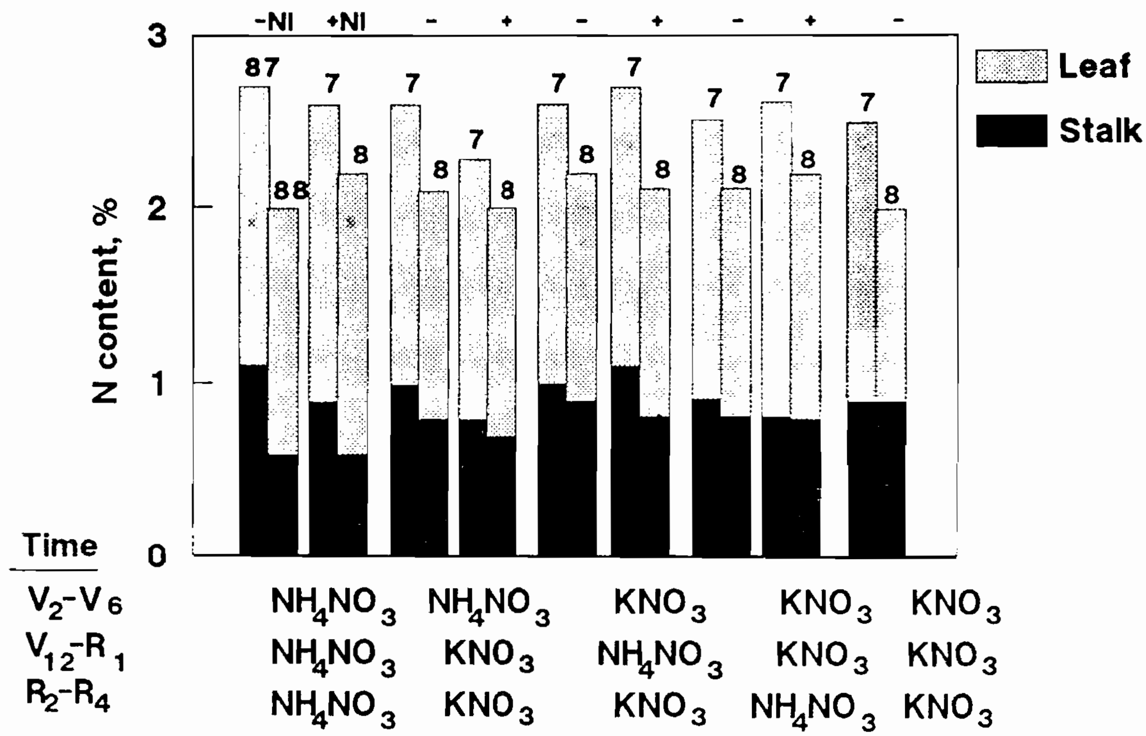


Figure 6. Effect of timing of supply of two N sources & nitrapyrin on corn ear leaf & lower stalk N content measured at growth stage R2.



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<u>CREDITS</u>

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