IN SEARCH OF "EAN" OF SPRING WHEAT

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Abstract

Many spring wheat varieties respond reliably to enhanced ammonium nutrition (EAN) in the greenhouse. Three field studies were established in 1992 to determine if similar responses could be obtained in the field. Butte 86 spring wheat was fertilized (100 lb N/A) with calcium nitrate, urea, urea + DCD, forestry-grade (0.1 g) urea pellets and forestry-grade urea pellets + DCD. The goal was to provide wheat with a large range of ammonium:nitrate ratios and to determine the effect on wheat development and yield. Intensive plant measurements were taken at the 7 leaf stage and at harvest. Soil analyses indicated that the various fertilizer sources provided a wide range of ammonium:nitrate ratios at the onset of tillering. Some benefits to EAN were observed. At the 7 leaf stage plant dry matter and percent N were lower for calcium nitrate than for the other N sources. Average main stem development was about 1 day behind for calcium nitrate than for the other N sources. Head counts at harvest showed an 8% advantage for urea + DCD and a 5-6% advantage for the forestry-grade pellets. Overall, grain yields were surprisingly non-responsive to N fertilization, given the high yields and modest initial soil nitrate levels. There was little effect of EAN on grain yield.

Introduction

Spring wheat, in general, grows best in the greenhouse when presented with a mixture of ammonium and nitrate nutrition. This concept has been called "mixed N nutrition," "enhanced ammonium nutrition," or "EAN". The yield component most commonly increased by EAN is the number of tillers per plant. While varieties differ in their response to EAN, screening studies at TVA-NFERC have shown that most of the varieties commonly grown in North Dakota are responsive to EAN in the greenhouse or growth chamber.

By contrast, current fertilization practice in North Dakota consists of what could be termed "ZAN" or "zero ammonium nutrition". In our drier climate, most farmers typically fall apply anhydrous ammonia in October. By the time the wheat crop is up and growing the following year, the fall ammonia application is usually totally nitrified. Unless a starter fertilizer is used, the wheat plant receives "ZAN". Given the indications of EAN response in greenhouse trials, we were interested in testing EAN under field conditions in North Dakota.

Methods

Three field studies were conducted in 1992. Two sites were located on Fargo silty clay (lacusterine) and the third on a Hammerly loam (glacial till). The sites had 32-64 lb nitrate-N/A in the top 2 feet of soil late the previous fall. The sites were separated by at least 15-20 miles. Previous crop was barley at two sites and soybean at the third site.

Fertilization treatments consisted of a control vs 100 lb N/A as various N sources. The N sources tested were: granular calcium nitrate, granular urea, granular urea containing 5% of N as DCD-N, forestry-grade (0.1 g) urea granules, and forestry-grade urea containing 5% of N as DCD-N. Previous field research in North Dakota had shown that these N sources would give different nitrification rates. The test fertilizers, plus basal KCl fertilization, were broadcast. The plots were then rototilled and imediately seeded to Butte 86 spring wheat. Phosphate was drilled with the seed. Normal plot techniques with five replicates were used.

Four weeks after planting the plots were sampled to a 15 cm depth (4 cores per plot), sieved, mixed, subsampled, extracted wet with KCl, and analyzed for ammonium and nitrate. Wet samples were utilized as drying can artificially inflate the ammonium level in soils. At the 7 leaf stage, plants were dug up and analyzed for main stem Haun stage, tiller initiation, above-ground dry matter and N uptake. Head counts and grain yield were determined at maturity.

Results

Climatic conditions for the 1992 spring wheat growing season were very unusual. The first part of the season was hotter and drier than normal. The second part was wetter and cooler than normal, and the end of the season was cooler than normal. The hottest day of the "summer" at Fargo occurred on 30 April.

Given the large amount of data generated, only selected averages can be presented here. Soil analyses four weeks after planting suggested that we were successful in presenting the plants with a wide range of ammonium during the tillering period (Table 1). Only 4-8% of the mineral N supply in the top 15 cm of soil was present as ammonium in the control or calcium nitrate plots. Some ammonium remained with the granular urea treatment (20%). A considerable amount of N (49-65%) remained as ammonium in plots fertilized with urea + DCD or with the 0.1 g pellets. The amount of total mineral N in the topsoil was somewhat higher for the 0.1 g pellets.

Plant measurements taken at the 7 leaf stage show, in general, a poorer performance of calcium nitrate compared to the other N sources. Main stem maturity was about a day (0.2 unit) behind with calcium nitrate than with the other N sources. Plant dry matter, percent N and N uptake was also lower for calcium nitrate than for the other N sources. Total tillering was about 1.1 tiller/plant higher with N fertilization over the control, but there was no discernible difference in tiller initiation between the N sources. Examination of tiller initiation by tiller location (T1, T2, etc.) also revealed no significant EAN effect.

Head counts at harvest suggested a consistent EAN effect at all three locations (Table 3). Head counts were lowest for the control, about the same for calcium nitrate and urea, and highest for the EAN treatments (urea + DCD, forestry-grade urea, forestry-grade urea +DCD). It is not known why this EAN response was not measured at the 7-leaf stage, unless the EAN treatments influenced tiller survival more than tiller initiation. At one location the increase in head count from EAN was expressed as an increase in green, immature heads at harvest. For example, it was easy to visually distinguish the granular urea + DCD plots vs the calcium nitrate plots as the urea + DCD plots had about 100 more green heads/m^2. The presence of green, immature heads at harvest was not observed at the other two sites.

Grain yields were good (greater than 60 bu/A in general). However, there was surprisingly little effect of N fertilization on grain yield. Much greater N response was anticipated, given the high yield potential, modest initial levels of nitrate, and good visual response earlier in the season. Yields were, in general, not influenced by N source. Wheat yields tended to be the highest when fertilized with calcium nitrate and forestry-grade pellets containing DCD, the two N sources giving the lowest and highest ammonium supply (Table 1).

Conclusions

Some EAN effects were observed in spring wheat in 1992. The most consistent response was a 5-8% increase in heads/m^2. However, there was no observed increase in grain yield due to EAN in 1992. This research will be continued in 1993, when hopefully a more normal weather pattern will prevail.

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Table 1. KCl extractable ammonium and nitrate in 0-6 inch soil samples four weeks after fertilization. Three site average, North Dakota, 1992.

Treatment	NH_4^+	NO_3^-	% as NH_4^+
	------------ppm N	------------	%
Control	1	11	8
Ca Nitrate	2	48	4
Urea	12	54	20
Urea+DCD[#]	36	29	55
FGU[##]	44	46	49
FGU + DCD	51	27	65

[#]5% of N as DCD-N
[##]Forestry-grade (0.1g) urea pellets

Table 2. Effect of nitrogen source on main stem development, tiller initiation, dry matter, and N uptake at the 7 leaf stage. Three site average, North Dakota, 1992

Treatment	Haun stage	Total tillers	Dry matter	Total N	N Uptake
		/plant	mg/plant	%	mg/plant
Control	7.5	2.5	599	2.9	17
Ca Nitrate	7.4	3.6	661	3.6	24
Urea	7.6	3.5	705	4.0	28
Urea + DCD[#]	7.6	3.7	709	4.0	28
FGU[##]	7.6	3.5	728	4.0	29
FGU + DCD	7.6	3.6	706	4.1	29

[#]5% of N as DCD-N
[##]Forestry-grade (0.1g) urea pellets

Table 3. Effect of nitrogen source on head count at harvest and grain yield. Three site average, North Dakota, 1992.

Treatment	Head Count	Grain Yield
	heads/m^2	g/m^2
Control	653	406
Ca Nitrate	794	447
Urea	786	426
Urea+DCD[#]	855	430
FGU[##]	833	439
FGU + DCD	839	457

[#]5% of N as DCD-N
[##]Forestry-grade (0.1g) urea pellets

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