NITROGEN MANAGEMENT SYSTEMS FOR RIDGE-TILLED CORN PRODUCTION

Barney Gordon, David Whitney, and Robert Raney

Assistant Professor, Professor, and Associate Professor (retired), Dept. of Agronomy, Kansas State University, Manhattan, Ks. 66506.

ABSTRACT

The use of conservation tillage methods, including ridge-tillage, increases crop residue cover which can lead to loss of urea-based fertilizers applied broadcast. Field tests were conducted during 1987-1991 at the Irrigation Experiment Field, located near Scandia, Kansas, on a Crete silt loam soil (fine, montmorillionitic, mesic, Panchic, Arguistoll). Treatments included anhydrous ammonia (AA) applied preplant knife-injected; 28% urea-ammonium nitrate solution (UAN) applied preplant knife-injected, surface broadcast, or surface banded (dribbled); and split applications of knife-injected and dribbled UAN. Nitrogen rates were 50, 100 and 200 lb/acre and a 0 N check. When averaged over a five-year period, grain yields were less with UAN broadcast and dribbled treatments than with the other 4 application treatments. Preplant surface banding (dribble) was no more effective than surface broadcasting. Split applications of dribbled UAN gave greater yields than a single preplant application. Grain yields were unaffected by splitting knife-injected applications of UAN. No differences occurred in grain yield or grain N concentration between the anhydrous ammonia and the UAN knife-injected treatments. Yield was unaffected by application method x N rate interactions. Higher N rates did not compensate for inefficient application systems. Corn grain N concentration and grain N removed followed the same trends as grain yields. Maximal grain yield, regardless of application treatment, was achieved with 158 lb/acre N. In April of 1991 total amount of residual soil nitrate N (NO_3-N) was greater in plots receiving 200 lb/acre N than in plots receiving 50 or 100 lb/acre N.

INTRODUCTION

Use of conservation tillage practices has increased greatly in the past 10 years because of their effectiveness in conserving soil and water. Interest in ridge-tillage is also growing nationally. Ridge-tillage involves planting on a raised bed that was formed by cultivation during the preceding growing season. Ridges, 6-8 inches in height, are built by cultivation when the corn is approxomatly 15-20 inches tall. Tillage at planting time is confined to a narrow strip on the top of the ridge. The large amount of residue left on the soil surface in the ridge-tillage system can affect loss of N fertilizers through immobilization, denitrification, and volatilization.

Much work has been done with N management in no-tillage situations but little information is available concerning N application methods and timing in a ridge-tillage system. This study was initiated to assess the effects on N rates and preplant broadcast, knife-injected, and dribbled UAN applications; preplant knife injected AA applications; and split UAN applications on grain yield, grain N concentration, and grain N removal of ridge-tilled furrow irrigated corn.

MATERIALS AND METHODS

A furrow-irrigated experiment was conducted at the Irrigation Experiment Field, located near Scandia, Kansas, on a Crete silt loam soil. Ridges were established in the experimental area in 1986. The experimental design was a two factor randomized complete block, replicated 4 times. Plots consisted of four rows (30 inch inter-row spacing) 60 feet long. Treatments included four preplant N application methods (knife-injected AA, knife injected 28% UAN, surface broadcsat UAN, and surface-dribbled UAN) and two split applications systems (dribbled and knife-injected UAN). Knife injected AA and UAN were applied 6 inches below the soil surface, midway between the old corn rows on 30-inch centers. Broadcast UAN was applied using flat fan spray nozzles at 15-inch centers on a boom set 24 inches above the soil surface. Dribble treatments were applied to the soil surface at the base of the ridge using sprayer mounted metering orifices and drop tubes. In the split application systems, 1/2 of the N was applied preplant and 1/2 was applied when the corn was 12-15 inches in height. Sidedress dribble applications were incorporated by cultivation. All application methods were evaluated at N rates of 50, 100, and 200 lb/acre. A no N check treatment was also included.

Corn (Garst 8344) was seeded in late April or early May each year at the rate of 26,500 seed/acre using a Buffalo all-flex till planter equipped with 10-inch sweeps for ridge clearing. Nitrogen application dates and date of first rainfall event after N application are given in Table 1. Irrigation amounts averaged 12 acre/inches per year. Soil samples were taken in 6 inch increments to a depth of 24 inches on April 5, 1991. The amounts of NH_4-N and NO_3-N were calculated for a 24 inch profile using the assumption that 1 acre of soil 6 inches deep weighs 1,800,000 pounds.

RESULTS AND DISSCUSSION

No interaction ($p < 0.05$) occurred between application method and N rate in any year of the experiment for grain yield; therefore, only main effects are discussed.

When averaged over the 5-year period, grain yields were lower in the UAN broadcast and dribble treatments than in the other 4 application systems (Table 2). Surface applying UAN in a band (dribble) failed to improve yields over broadcasting. Applying 1/2 of the N as a sidedress application rather than all preplant did improve yields in the dribble system. Split application of knife-injected UAN was no better than applying all of the N preplant on this medium textured soil. Only in 1990 was the preplant, broadcast treatment as effective as the knife-injected treatments. Volitilization and/or immobilization losses may have been minimized by a 0.51 inch rainfall received within 12 hours after application. Grain yields in the AA knife and UAN knife systems were similiar in all 5 years of the test.

The lack of an interaction between application method and N rate indicates that corn responded to N in the same manner within the different application systems. When quadradic equations were fit to N response data in each application system, the amount of N needed for maximal yield was found to be very similiar for all application systems. When averaged over all systems and years, maximal grain yield was achieved with 158 lb/acre (Fig. 1).

Grain N concentration in 1990 and 1991 followed the same trends as grain yield, with no application method by N rate interactions. When averaged over N rates, grain N concentration was less in the UAN broadcast and preplant dribble systems than in the other four application systems (Table 3). Grain N concentration in the UAN preplant dribble treatment was similiar to that in the broadcast treatment in both 1990 and 1991. Split dribble applications resulted in greater grain N concentrations than a single preplant dribble application. Split applications of knife-injected UAN were no more effective in increasing grain N concentration than the all preplant knifed UAN and AA in both years. Grain N concentrations in the preplant AA and UAN knife treatments were equal.

Less N was removed in the broadcast and dribble application systems than in the knife-injected systems (Table 4). These data also indicate that surface banding failed to result in greater N removal than broadcast applications.

Total amount of inorganic N (NH_4-N + NO_3-N) in the top 24 inches of the soil profile in April 1991 is shown in Fig. 2. Total amounts of both NH_4-N and NO_3-N showed interactions ($p < 0.05$) between application method and N rate. Inorganic N at the 200 lb/acre N rate was much greater in all three knife injected systems than in the surface applied systems, whereas little difference occurred among application systems at the 50 and 100 lb/acre N rates. Single degree of freedom contrasts revealed there were no differences between NO_3-N amount in the preplant knife and split knife UAN treatments ($p > 0.228$). Applying part of the N closer to the time of use by the corn plant did not reduce nitrate carryover when N was applied at the 200 lb/acre rate. When N is applied at rates greater than needed for optimal yield, inorganic N can accumulate in the soil profile and may be subject to subsequent leaching.

Table 1. Nitrogen application date and amount (inches) of first rainfall event after preplant N application.

Variable	1987	1988	1989	1990	1991
N applied					
preplant	20 April	30 April	30 April	25 April	1 May
sidedress	5 June	5 June	6 June	6 June	4 June
First rain after					
N application	3 May	2 May	7 May	25 April	16 May
Amount (inches)	1.69	0.31	0.71	0.51	1.02

Table 2. Effect of application method and N rate on corn grain yield for 1987-1991.

	1987	1988	1989	1990	1991	Avg.
	--------------bu/acre--------------					
0 N Check	112	70	79	116	91	94
Application Method						
AA; Preplant, Knife	154	151	165	169	144	157
UAN; Preplant, Knife	158	146	168	168	142	156
UAN; Preplant, Broadcast	130	137	152	168	130	143
UAN; Preplant, Dribble	135	143	159	157	128	145
UAN; Split, Knife	157	146	167	165	140	155
UAN; Split, Dribble	151	140	156	163	141	150
LSD (0.05)	7	8	13	12	11	4
N-Rate, lb/acre						
50	139	127	137	148	122	135
100	149	149	171	169	143	156
200	155	156	176	178	148	163
LSD (0.05)	5	6	9	7	8	3

Table 3. Mean corn grain N concentration as affected by application method and N rate for 1990 and 1991.

	1990	1991	Avg.
	---------%N-----------		
0 N Check	1.24	1.27	1.25
Application Method			
AA; Preplant, Knife	1.36	1.43	1.39
UAN; Preplant, Knife	1.36	1.42	1.39
UAN; Preplant, Broadcast	1.30	1.35	1.33
UAN; Preplant, Dribble	1.31	1.35	1.33
UAN; Split, Knife	1.34	1.43	1.39
UAN; Split, Dribble	1.34	1.39	1.37
LSD (0.05)	0.04	0.06	0.04
N-Rate, lb/acre			
50	1.30	1.34	1.31
100	1.33	1.40	1.37
200	1.38	1.45	1.42
LSD (0.05)	0.02	0.04	0.04

Table 4. Total grain N removal as affected by application method and N rate for 1990 and 1991.

	N removed in grain		
	1990	1991	Avg.
	--------lb/acre--------		
0 N check	81	65	75
Application Method			
AA; Preplant, Knife	128	115	122
UAN; Preplant, Knife	127	133	120
UAN; Preplant, Broadcast	122	99	111
UAN; Preplant, Dribble	114	97	106
UAN; Split, Knife	123	112	118
UAN; Split, Dribble	121	110	116
LSD (.05)	5	9	6
N-Rate, lb/acre			
50	108	90	99
100	124	113	119
200	136	120	128
LSD (.05)	5	7	6

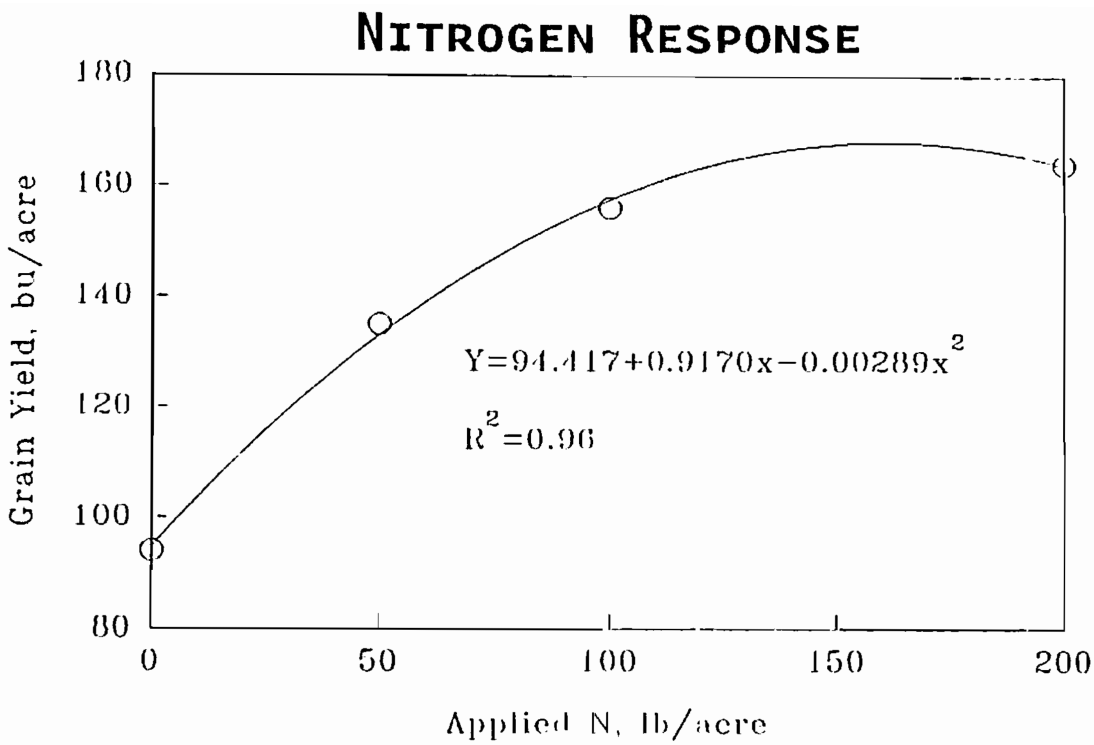

Fig. 1. Relationship between applied N and corn grain yield.

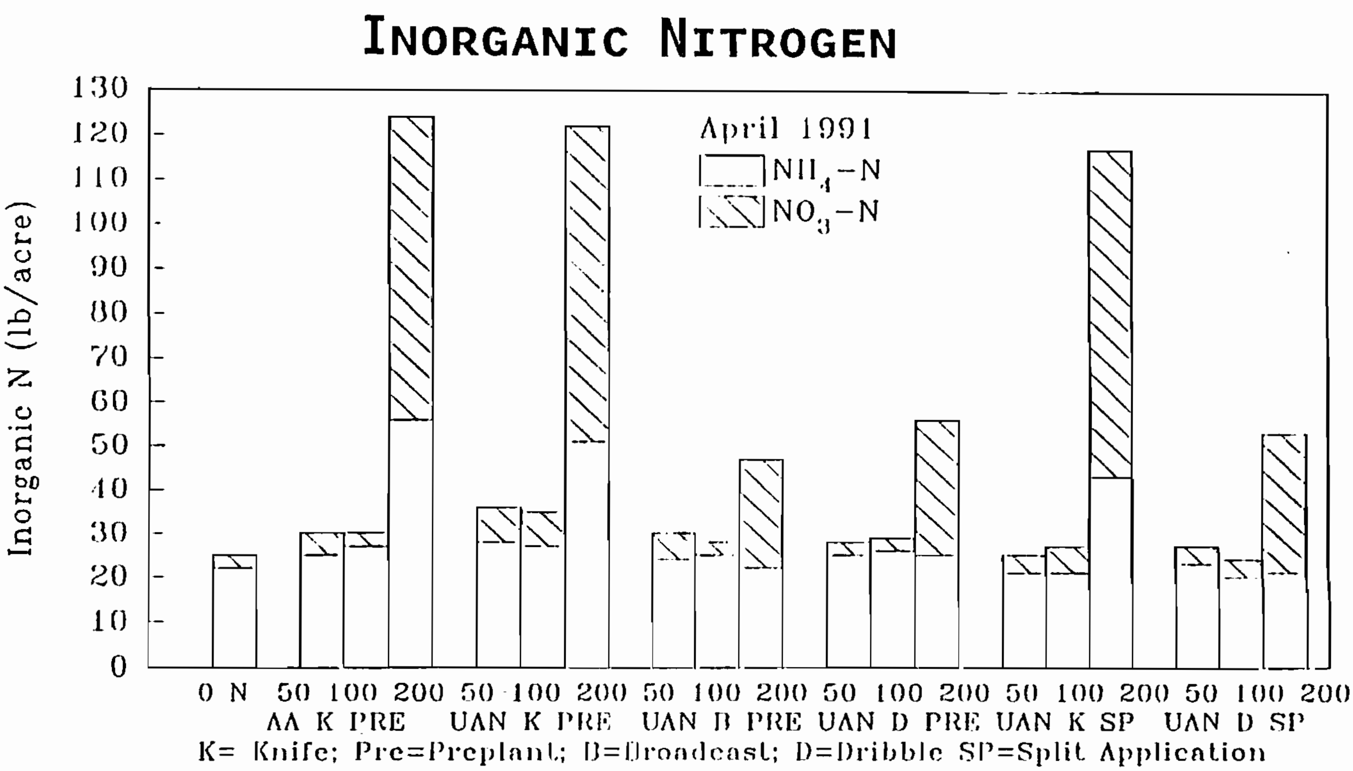

Fig. 2. Inorganic N (NH_4-N+NO_3-N) amounts in a 24 inch soil profile.

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Program Chairman and Editor:

Ray Lamond
Department of Agronomy
Throckmorton Hall
Kansas State University
Manhattan, KS 66506