EFFECT OF NITROGEN FERTILIZER PLACEMENT AND SOURCES ON NO-TILL CORN

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INTRODUCTION

No-tillage production of corn can lead to a number of savings for growers including costs of time, machinery, labor, and energy. However, savings of soil and water are perhaps the most important attributes of no-tillage production on the sloping, erosion-prone soils found in southern Illinois, Indiana, Missouri, and Kentucky.

Producer acceptance of no-tillage has not been overwhelming. Problems in achieving acceptable stands, difficulties in adequately controlling pests of all types, especially weeds, and an overall lack of appreciation of the higher management skills demanded of growers have all or partially contributed to slow adoption. The ultimate test of whether the practice becomes adopted is the profit obtained compared to that of conventional tillage.

One of the significant questions in no-tillage corn production is that of fertility management, especially that of nitrogen (N) fertilization. Numerous literature sources can be offered which show that N losses are considerably greater under no-tillage compared to conventional and has lead to higher N fertilizer recommendations for no-till corn. The inability to get the N in contact with soil upon application and the greater losses due to denitrification under no-till are among the more important reasons for the poor efficiency of N use by the corn.

It was the objective of these experiments to evaluate the effect of 3 N placement methods (broadcast, sideband, and injection into the soil) and 4 N sources including urea, urea-ammonium nitrate solution (UAN-28%N), anhydrous ammonia, and urea-urea phosphate (UUP) on corn grain yield and nutrient composition of leaf tissue. UUP is an experimental granular fertilizer produced by the National Fertilizer Development Center of TVA with a reported lower ammonia loss potential than that for urea. In certain studies N-Serve (a nitrification inhibitor) was also added to selected N treatments to determine its enhancement of N use efficiency by corn.

EXPERIMENTAL DETAILS

Experiments were established in 1983 and 1984 at the Belleville Research Center and Carbondale Agronomy Research Center of Southern Illinois University on soils typical for the area. Treatments involved a combination of N placement methods (broadcast, sideband in ∿2 in.

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bands approximately 4 in. from the row, injection of anhydrous ammonia to a depth of ∿6 in. and 8 in. from the row, and injection of a UAN stream at ∿2,000 psi. to a soil depth of 1-2 in. at 6 in. and 15 in. spacings from corn rows), N sources (granular urea, urea-ammonium nitrate solution, granular urea-urea phosphate, 38-13-0, and anhydrous ammonia), and N rates (0, 75, and 150 lb N/ac). Triple superphosphate (0-46-0) was applied to all treatments not receiving UUP to compensate for the phosphorus contained in the fertilizer. The experimental design used was a randomized complete block design with 6 replications at Belleville and 5 replications at Carbondale. Specific details and events including precipitation is given in Table 1. Because of the extreme heat and drought of 1983 and a subsequent windstorm which further damaged the experiment, data from the Carbondale study was omitted as no treatment effects were observed including a lack of N rate response.

DISCUSSION OF RESULTS

Corn yields were severely reduced because of moisture and heat stress at Belleville in 1983 (Table 2). A significant response to both rate of N and to N placement and source was observed, however. Anhydrous ammonia treated with N-Serve and UAN broadcast were significantly greater than all urea treatments, whether broadcast or sideband applied or treated with N-Serve. Except for UAN broadcast, the UUP treatments that were either broadcast or sidebanded were the highest yielding among all N sources placed by those methods. Statistically, UUP was higher yielding than all urea treatments except for broadcasted urea treated with N-Serve. The average yield superiority of UUP over urea was about 8 bu/ac. UAN and anhydrous ammonia yielded essentially the same as UUP in 1983. The highest ear leaf N composition was in anhydrous ammonia treatments where the DRIS index was the least negative and suggested the best balance between N and other essential elements. Although not significant, the UUP treatments, broadcast or sidebanded, were higher in N percentage than all urea treatments except broadcasted urea treated with N-Serve.

In 1984 corn yields at Belleville were much improved over those measured in 1983 even though rainfall was again appreciably below normal for the growing season (Table 2). The highest yielding treatment was UAN injected (near-row) with N-Serve. Other top yielding treatments included UAN broadcast, UAN sidebanded, and UAN injected 15 in. from the row. Lowest yields were from sidebanded N except with UAN. The generally poor yields from sidebanding may have been the result of a brief, intense shower within a few hours after application that moved the broadcast and surface banded N treatments in the soil but yet caused greater volatilization of the N as NH_3 from the concentrated bands once the soil quickly dried. Again UUP yielded slightly higher than urea treatments whether broadcast or sidebanded but the effect was not significant. UUP yields were not as great as those of UAN whether sidebanded or broadcast. The best yielding treatments were generally those which were injected although no clear cut pattern was observed. The leaf N data closely followed the yield responses observed but there was a trend for lower DRIS index values for all N treatments compared to 1983. This result suggests that N was more limiting to the plant with respect to the availability of other nutrients at that stage of crop development.

At Carbondale in 1984 no significant responses to N placement and sources were measured, but a significant response to N rate was observed (Table 2). Much higher leaf N concentrations were observed where the fertilizers were injected into the soil as opposed to surface banding or broadcast placement. The greater amount of N taken up by the corn did not translate into significantly increased yields for the injected treatments, however. As observed at Belleville, UUP treatments tended to give higher yields than urea treatments but the effect was not significant.

At Belleville in 1984 a separate experiment involving only placement methods for UAN was undertaken and the results are given in Table 3. A dramatic response to N was observed but no significant response to placement method was noted. The difference between the highest and lowest yield as affected by UAN placement was but 4 bu/ac. Leaf N composition did not follow the same ordering as yield but injected UAN treatments were significantly higher than UAN sidebanded. Failure to obtain significantly higher yields from those treatments showing superior leaf N composition levels was probably the result of limited rainfall that was received during the 1984 season. Of special note was the fact that corn grain from UAN treatments injected 6 in. from the row was significantly lower in moisture content at harvest than corn grown on UAN treatments where the fertilizer was injected "mid row" or 15 in. from the row.

CONCLUSIONS

1. Generally, injection of N sources was superior to broadcasting or sidebanding near the row for no-till corn production. Yield benefits for injection ranged from 5-10%, especially over broadcasting.

2. UAN appeared to be a slightly better N source than UUP for no-till corn and both usually gave higher yields than urea.

3. In the majority of comparisons, including N-Serve with anhydrous ammonia or injected UAN gave yields that were among the highest measured. However, adding N-Serve with urea that remained on the surface was not of any value in improving yields.

4. Near-row injection of UAN gave a more rapidly developing corn crop than did mid-row placement of UAN and resulted in a lower grain moisture content at harvest.

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Table 1

Selected Details and Experimental Conditions for 1983 and 1984 Studies at Belleville and Carbondale Involving N Fertilizer Placement and Sources on No-Till Corn.

Condition/Detail	Belleville 1983	Belleville 1984	Carbondale(1984)
Soil Type	Iva silt loam (fine-silty, mixed, mesic Aeric Ochraqualf)	Herrick silt loam (fine, montmorillonitic, mesic Aquic Argiudoll)	Weir silt loam (fine, montmorillonitic, mesic, Typic Ochraqualf)
Soil Tests			
pHw	6.6	6.6	6.7
Bray P_1 (lb/ac)	45	65	68
Avail K (lb/ac)	208	224	311
Organic Matter(%)	1.4	1.4	1.3
Previous Crop:	Corn	Corn	Wheat
Residue Remaining at Planting (lb/ac)	not measured	6,000	3,800
Variety Planted	Pioneer 3184	Pioneer 3184	Pioneer 3184
Planting Date	May 26, 1983	May 17, 1984	May 18, 1984
N Application	May 28, 1983[1]	June 5, 1984[2]	June 2, 1984[3]
Ear Leaf Sampling Date	Aug. 10, 1983	Aug. 1, 1984	July 27, 1984
Corn Harvest Date	Oct. 25, 1983	Oct. 23, 1984	Oct. 22, 1984

Rainfall Received and Deviation from Normal(Inches)

	Belleville			Carbondale	
		Deviation			
Month	Normal	1983	1984	Normal	Deviation
April	3.9	+1.5	+0.9	4.3	-1.2
May	4.1	-0.3	-0.5	4.7	-0.3
June	3.8	-0.3	-1.1	4.1	-0.8
July	3.1	-2.1	-1.5	3.4	-1.0
August	3.9	-1.9	-0.4	4.0	-0.4
September	3.5	-1.3	+3.8	3.5	+4.0

[1]No rain received for 5 days after application.
[2]0.15 inch of rain received ~8 hours after application.
[3]No rain received for 11 days after application.

Table 2

The Effect of N Fertilizer Placement and Source on No-Till Corn Yields and Leaf Tissue N Status When Applied at 2 Locations and N Rates in 1983 and 1984

	Belleville				Carbondale	
	1983		1984		1984	
Treatment	Yield	Leaf N & (DRIS)	Yield	Leaf N & (DRIS)	Yield	Leaf N & (DRIS)
Placement & N Source	bu/ac	%	bu/ac	%	bu/ac	%
Broadcast						
Urea	62	1.89(-5)	101	1.86(-8)	95	1.36(-14)
UUP[1]	72	1.90(-5)	104	1.87(-8)	100	1.39(-15)
UAN (28%N)	77	1.99(-1)	115	2.06(-7)	93	1.62(-11)
Urea +1 lb/ac NS[2]	67	1.91(-2)	97	1.94(-9)	---	----
Sideband[3]						
Urea	64	1.88(-2)	90	1.80(-10)	91	1.43(-11)
UUP	72	1.94(-3)	92	1.78(-9)	97	1.65(-10)
UAN (28%N)	71	2.00(-1)	108	2.00(-8)	105	1.72(-7)
Urea +1 lb/ac NS	60	1.84(-4)	90	1.77(-8)	---	----
Inject[4]						
Anhy NH_3	71	2.27(-1)	108	1.98(-11)	110	1.84(-6)
Anhy NH_3 +½ lb/ac NS	80	2.34(-1)	98	1.98(-10)	---	----
UAN (near-row)	--	----	107	1.98(-11)	104	1.82(-9)
UAN (mid-row)	--	----	111	1.99(-7)	104	1.88(-6)
UAN (near-row) +½ lb/ac NS	--	----	119	2.04(-7)	---	----
$LSD_{.05}$	7	0.12	6	0.16	NS	0.15
N Rate (lb/ac)						
0	33	1.60(-8)	37	1.34(-13)	61	1.14(-16)
75	62	1.90(-3)	89	1.76(-11)	95	1.46(-11)
150	78	2.09(-2)	117	2.06(-7)	105	1.80(-7)
$LSD_{.05}$	3	0.05	2	0.06	8	0.07

[1]UUP = Urea-urea phosphate, 38-13-0, experimental granular fertilizer from TVA.
[2]NS = N-Serve, 2-chloro-6-(trichloromethyl) pyridine.
[3]Sidebanding = N placed in 2-4 in. bands approximately 4 in. from corn rows.
[4]Inject = Anhydrous ammonia injected to a depth of 6 in. approximately 8 in. from corn rows. UAN applied via 2,000 psi high pressure injection to a depth of 1-2 in. "Near-Row" implies application approximately 6 in. from corn rows; whereas, "Mid-Row" placement was approximately 15 in. from corn rows.

Table 3

Grain Yield, Moisture and Leaf Nutrient Composition of No-Till Corn as Affected by Placement Methods of Urea-Ammonium Nitrate(28%N) Solution. (Belleville Research Center, 1984, Ave. of 6 Replications)

N	Grain		Leaf Nutrient Composition											
Treatment[1]	Yield	Moisture	N	P	K	Ca	Mg	S	Zn	Fe	Mn	Cu	B	Al
	bu/ac	%	%						ppm					
0-N	26	26.9	1.14	0.36	1.46	0.46	0.39	0.25	24	76	17	15	7	53
Broadcast	97	25.3	1.77	0.29	1.38	0.63	0.51	0.25	31	100	30	16	8	57
Sideband	98	24.8	1.64	0.29	1.31	0.67	0.57	0.22	29	101	34	14	7	62
High Pressure Injection (6 in. from corn row)	101	25.0	1.82	0.30	1.26	0.67	0.59	0.24	30	100	45	14	9	62
High Pressure Injection (15 in. from corn row)	100	26.2	1.84	0.31	1.38	0.64	0.53	0.26	30	112	37	15	8	60
$LSD_{.05}$	8	0.7	0.17	0.04	NS	0.07	0.10	NS	3	11	5	NS	NS	NS

[1]N applied at 100 lb/ac.
Sideband = UAN placement in 2 in. wide bands~4 in. from corn rows.
High Pressure Injection = UAN application via 2000 psi stream into the soil to a depth of 1-2 in.

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