No-Till Corn Response to N Fertilizer Sources and Placement Methods: A Summary of Southern Illinois Results[1]

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Experiments were conducted in southern Illinois from 1984-1986 to evaluate the placement efficiency of several N fertilizers used in no-till corn production. Such information has become of meaningful importance as producers strive to obtain the greatest possible returns from their N fertilizer investment and to obtain yields and a level of profitability equal to that of more conventionally produced corn. Also, in the near future, no-tillage will become an important tool for many farmers in southern Illinois who wish to continue to produce corn on lands that are otherwise too erosive to meet mandated soil loss criteria. Thus, an understanding of the best N management under no-till will have enhanced importance.

Nitrogen losses, mainly ammonia volatilization, denitrification, and leaching, represent the greatest deterrent to the achievement of high N use efficiency by no-till corn. Urea and urea-containing fertilizers suffer from a greater number of pathways for loss, notably ammonia volatilization, than any of the other N sources. However, their widespread availability in the fertilizer trade and competitive price make them an attractive fertilizer of choice.

Differing patterns of corn yield response were obtained all 3 years in which placement methods for three N sources were evaluated (Tables 1, 2, and 3). Complex interactions of the applied fertilizers, and their methods of placement, with rainfall events, soil moisture, soil drying, soil compactness, residue characteristics, etc., all affected the amount of loss that occurred and the ultimate amount of N available to the corn crop. Both at Belleville (Table 1) and at Carbondale (Table 2), application of urea that was either surface broadcast or sidebanded resulted in lower yields compared to UAN (urea-ammonium nitrate solution, 28% N) that was similarly applied. Likewise, higher concentrations of leaf N were also observed for broadcast and sidebanded UAN treatments compared to those of urea. Comparable results have been found by other researchers in Indiana, Kentucky, and Maryland. However, contrary to most reported research, generally, no benefit was derived from surface banding of urea compared to broadcasting the fertilizer. For UAN there was evidence that surface banding the fertilizer was more beneficial compared to broadcasting. At Belleville, where N-Serve was also applied with the surface applications of urea, no yield response or enhancement in leaf N was observed with its use (Table 1).

Injection of N (UAN by the Nutriblast 2000 and anhydrous ammonia) into the soil below the mulch layer consistently resulted in corn yields and leaf N concentrations that were among the highest obtained for any location or year (Tables 1, 2, and 3). A notable exception was 1986 at Belleville (Table 1) where injection of UAN resulted in yields that were less than those obtained by broadcasting or surface banding the fertilizer. With the Nutriblast applicator the N is injected to a depth of about 2 inches in a high pressure

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stream and some of the fertilizer is forced to the soil surface. As such, its placement may be no better than a surface band application and it may also be susceptible to higher denitrification losses near the soil surface below the mulch layer.

Employment of N-Serve as an inclusion with the injected UAN seemed to be beneficial in reducing denitrification losses that may be substantial just below the residue cover (Table 1). At both Belleville and Carbondale injection of anhydrous ammonia, which was to a depth of 4 to 6 inches below the soil surface, consistently resulted in yields and leaf N concentrations that were among the highest obtained for any experiment-year (Tables 1 and 2). Use of N-Serve did not appear to be as beneficial in reducing N losses for anhydrous ammonia as it was for UAN.

Near-row injection of UAN, compared to mid-row injection, has subtle merits even though it had no impact on yields. Nitrogen placed near the row was usually more quickly "tapped" and resulted in more rapid corn development. This also reduced the likelihood that the N would be lost before plant absorption. Delayed crop development from mid-row injection followed through to harvest such that higher grain moisture contents were observed (Tables 1 and 3). This extra grain moisture could be a potential added expense for drying to the producer.

SUMMARY

The behavior and fate of applied fertilizer N under no-tillage production systems of corn is complex. Conditions and factors contributing to loss (and reduced plant availability) vary in intensity and magnitude from soil to soil and season to season. Therefore, different N sources and placements do not necessarily produce consistent crop responses from soil to soil or season to season. The following were some general observations after 3 years of experiments in southern Illinois:

1. Injection of N in contact with soil below the mulch cover consistently resulted in higher corn yields and levels of N in the tissue than surface broadcasting or surface banding. Deep injection with anhydrous ammonia was generally superior to more shallow injection as was accomplished by Nutriblast 2000.

2. There was no affect on yield or leaf N from broadcasting compared to sidebanding urea. However, surface banding UAN tended to give higher yields and leaf N compositions than broadcasting, especially at Carbondale.

3. Comparing the two N sources, UAN that was broadcast or surface banded gave higher yields and leaf N contents than urea that was similarly applied.

4. N-Serve was not effective in influencing corn yields or leaf N content when applied as a coating on the surface-applied urea or when included with anhydrous ammonia. Inclusion of N-Serve with injected UAN gave increased yields over untreated UAN. This suggested that denitrification potential was greater in the soil just below the mulch-covered soil surface compared to deeper in soil.

5. Near-row injection of N showed benefits over mid-row placement. The N was more accessible for rapid plant uptake when near-row placed and led to a more rapidly developing crop. This continued through to harvest such that mid-row N treatments were usually higher in grain moisture at harvest than near-row placement.

Table 1. Corn Grain Yield, Ear Leaf N Composition, and Grain Moisture at Harvest from No-Till Corn Experiments in 1984-1986 at the Belleville Research Center as Affected by Different N Fertilizers and Placements.[1]

Treatments[2]	Corn Grain Yield				Ear Leaf N				Grain Moisture at Harvest			
	1984	1985	1986	Mean	1984	1985	1986	Mean	1984	1985	1986	Mean
	bu/ac^{-1}				%				%			
Broadcast												
Urea	101	86	93	93	1.86	1.72	1.99	1.86	25.6	16.0	17.0	19.5
Urea + N-Serve	97	90	90	92	1.94	1.69	1.92	1.85	25.7	16.1	17.1	19.6
28% N Sol.	115	99	88	100	2.06	1.95	1.89	1.97	26.3	16.0	17.0	19.8
Sideband												
Urea	90	91	90	90	1.80	1.76	1.92	1.83	25.8	15.9	17.2	19.6
Urea+N-Serve	90	88	86	88	1.77	1.78	1.98	1.84	25.8	16.1	17.0	19.6
28% N Sol.	108	108	92	103	2.00	2.05	2.01	2.02	26.7	15.9	17.1	19.9
Injection												
28% N Sol. (6")	107	111	85	101	1.98	2.15	1.97	2.03	26.1	16.2	17.1	19.8
28% N Sol. (15")	111	110	82	101	1.99	2.32	2.15	2.15	27.2	17.1	17.2	20.5
28% N Sol.+NS (6")	119	112	85	105	2.04	2.14	2.04	2.07	26.0	16.3	17.2	19.8
Anhy NH_3 (8")	108	105	104	106	1.98	2.15	2.44	2.19	26.1	16.5	17.2	19.9
Anhy NH_3+NS (8")	98	103	101	101	1.98	2.06	2.56	2.20	26.0	16.4	17.2	19.9
$LSD_{.05}$	6	8	6		0.16	0.18	0.14		0.6	0.4	0.2	
0-N (Control)	37	33	23	31	1.34	1.31	1.37	1.34	27.0	17.8	18.3	21.0

[1]Date represent the mean values of N applied at 75 and 150 lbs N ac^{-1}. Variety planted (all years): Pioneer 3378.
[2]Treatments were applied at 2-4 leaf stage after emergence. Sideband was placement of the N fertilizer in 2-inch wide bands, approximately 4 inches from corn rows. Injection of 28% N solution was by the Nutriblast 2000 at the indicated distances from corn rows. Anhydrous ammonia was applied with a knife applicator to a depth of 6 inches and spaced approximately 8 inches from corn rows.

Table 2. The Effect of Urea and Urea-Ammonium Nitrate Solution Placement On No-Till Corn in 1984-1986 at the Carbondale Agronomy Research Center.[1]

Treatment[2]	Corn Grain Yield				Ear Leaf N				Grain Moisture at Harvest			
	1984	1985	1986	Mean	1984	1985	1986	Mean	1984	1985	1986	Mean
	----------bu/ac^{-1}----------				----------%----------				----------%----------			
Broadcast												
Urea	95	39	65	66	1.36	1.11	1.87	1.45	25.1	19.7	13.9	19.6
28% N Sol.	93	40	74	69	1.62	1.09	1.91	1.54	25.1	20.1	14.0	19.7
Sideband												
Urea	91	43	66	67	1.43	1.09	1.77	1.43	24.6	19.3	14.0	19.3
28% N Sol.	105	49	75	76	1.72	1.08	1.98	1.59	24.7	19.2	14.1	19.3
Injection												
28% N Sol (6")	104	69	79	84	1.82	1.41	2.33	1.85	24.8	19.0	14.3	19.4
28% N Sol (15")	104	65	80	83	1.88	1.45	2.29	1.87	24.5	19.5	14.2	19.4
Anhy NH_3 (8")	110	(105)[3]	90	( )[3]	1.84	(2.84)[3]	2.45	( )[3]	24.8	(21.1)[3]	14.3	( )[3]
$^{LSD}_{.05}$	NS	9	9		0.15	0.24	0.24		NS	0.9	0.4	
0-N (Control)	61	23	29	38	1.14	1.29	1.47	1.30	25.7	21.9	14.1	20.6

[1]Data represent the mean values of N applied at 75 and 150 lbs N ac^{-1}. Variety planted (all years): Pioneer 3378.
[2]Treatments were applied at the 2-4 leaf stage after emergence. Sideband was placement of the N fertilizers in 2-inch wide bands approximately 4 inches from corn rows. Injection of 28% N solution was by Nutriblast 2000 at the indicated distances from corn rows.
[3]Anhydrous ammonia mean not calculated because 1985 application of ammonia was 2 weeks later than other N fertilizers.

Table 3. The Effect of Placement of Urea-Ammonium Nitrate Solution on No-Till Corn in a Separate Study at the Belleville Research Center in 1984-1986.

Treatment[1]	Corn Grain Yields				Ear Leaf N				Grain Moisture at Harvest			
	1984	1985	1986	Mean	1984	1985	1986	Mean	1984	1985	1986	Mean
	----------bu/ac^{-1}----------				----------%				----------%			
0-N	26	31	19	25	1.14	1.30	1.28	1.24	26.9	18.0	18.9	21.3
Broadcast	97	95	64	85	1.77	1.78	1.67	1.74	25.3	15.5	17.6	19.5
Sideband	98	102	81	86	1.64	1.93	1.85	1.81	24.9	15.7	17.2	19.3
Injection (6")	101	104	77	94	1.82	2.19	1.92	1.98	25.0	15.9	17.4	19.4
Injection (15")	100	92	72	88	1.84	1.93	1.95	1.92	26.2	15.7	17.4	20.1
$LSD_{.05}$	8	9	10		0.17	0.24	0.19		0.7	0.8	0.7	

[1]Data represent the application of 28% N solution at 100 lbs N ac^{-1}. Corn variety planted (all years): Pioneer 3378. Treatments were applied at the 2-4 leaf stage after emergence. Sideband placement of the fertilizer was in 2-inch wide bands approximately 4 inches from corn rows. Injection was made by Nutriblast 2000 high pressure injection apparatus at the indicated distances from corn rows.

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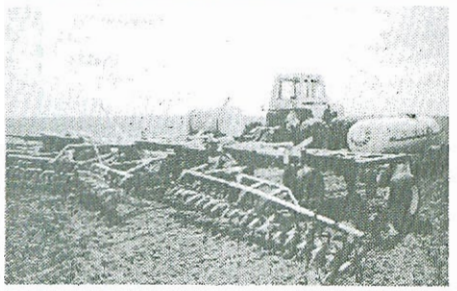

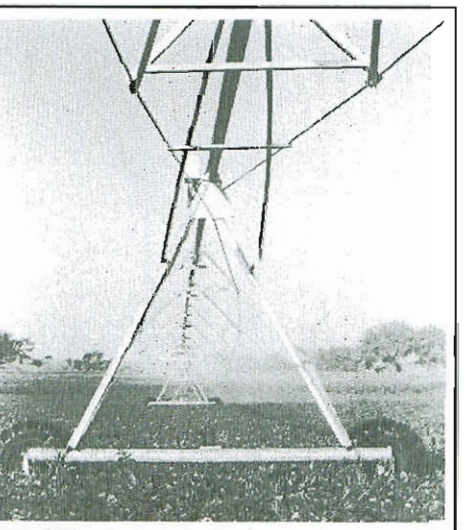
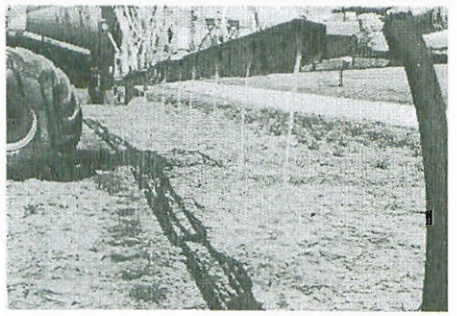
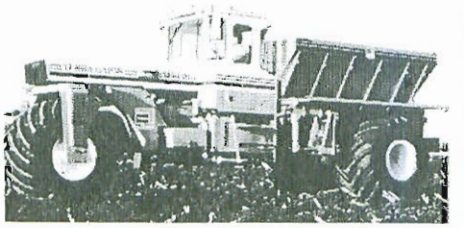
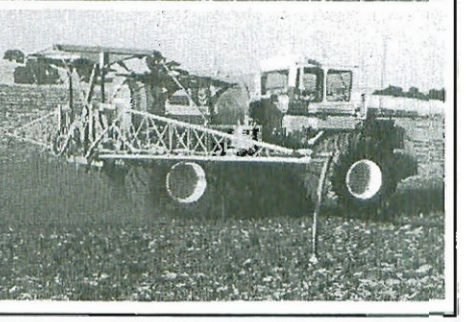

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