# NITROGEN MANAGEMENT FOR NO-TILL PRODUCTION SYSTEMS

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## ABSTRACT

Nitrogen management practices including rates and sources were evaluated in high residue no-till production systems involving corn and grain sorghum. A urease inhibitor, N-(n-butyl) thiophosphoric triamide (NBPT) was evaluated. This research also assessed the impact of type of previous residue on performance of surface applied N. A chlorophyll meter was evaluated as an in-field N assessment tool. Results to date indicate that NBPT is effective in improving the performance of surface broadcast urea. Urea + NBPT and ammonium nitrate have performed better than urea or UAN in most cases, even when the previous crop residue was soybeans. The largest and most consistent differences have been noted on corn with smaller, though sometimes significant, differences on grain sorghum.

## INTRODUCTION

Careful management of nitrogen (N) is critical in conservation tillage production systems where large amounts of old crop residue are left on the soil surface to help alleviate wind and water erosion. Conservation tillage acreage in Kansas will likely increase as we enter the conservation compliance phase of the current farm program. Previous work at Kansas State University has shown that knifed placement of N in high residue production systems was superior to broadcast N applications. This research was begun to evaluate N rates, sources, a urease inhibitor, and the effect of type of previous crop residue in no-till corn and grain sorghum production systems.

## METHODS

Four corn (two continuous corn and two corn after soybeans) and four grain sorghum sites (three continuous sorghum and one sorghum after soybeans) were evaluated in 1993. Several more sites were established in 1994 and data is reported from 1 grain sorghum site (Table 5). Nitrogen rates (varied depending on crop and cropping sequence) and N sources (urea, urea + NBPT, ammonium nitrate, and urea-ammonium nitrate solution (UAN)) were evaluated. NBPT is a urease inhibitor. All nitrogen was surface broadcast just prior to or shortly after planting. All sites were no-till.

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Early plant (V-6 stage) and boot or tassel leaf samples were taken and N content determined. When boot/tassel leaf samples were taken, chlorophyll meter readings were also taken. A Minolta SPAD 502 chlorophyll meter was used. Grain yields were determined at all sites by either hand or machine harvest. Individual grain samples were retained for moisture, test weight, and N determinations.

## RESULTS

Corn results are summarized in Tables 1 and 2, and grain sorghum results are in Tables 3, 4, and 5.

Although corn yields were depressed by excessive summer rainfall, yield response to N was quite dramatic. Grain yields were increased significantly right up to the highest N rate at 3 of the 4 sites. Nitrogen source comparisons indicate that the urease inhibitor, NBPT, was effective in improving performance of urea. At 3 of 4 of the corn sites, urea + NBPT produced significantly higher corn yields than urea and UAN and generally produced higher leaf N concentrations at both the 6-leaf and tassel stage. The urease inhibitor has potential to reduce both volatilization and immobilization by slowing urea breakdown allowing the urea to get into the soil. Both volatilization and immobilization can be problems with surface applied N in high residue production systems. Ammonium nitrate performed better than urea and UAN and similarly to urea with NBPT.

The impact of kind of previous crop residue was also evaluated. Soybean residue has a lower carbon:nitrogen (C:N) than corn residue and soybeans produce less residue cover than corn so volatilization and immobilization should be less of a problem with soybean residue. One of the two corn after soybean sites, however, indicated poor performance of urea and UAN relative to urea with NBPT and ammonium nitrate. The soil surface at this site (Shawnee Co.) was moist when treatments were applied and received no rain for about a week, so volatilization could have been substantial.

Grain sorghum results indicate dramatic grain yield response to N at all sites (Tables 3, 4, and 5). As on corn, urea with NBPT and ammonium nitrate tended to produce higher yields than urea and UAN though the differences were not as dramatic as those noted on corn.

The chlorophyll meter readings seemed to correlate well with leaf N concentrations (Tables 5 and 6) and this instrument seems to have potential as an "in-field" N assessment tool.

The use of urease inhibitors has potential where urea containing N fertilizers are surface broadcast in conservation tillage production systems. NBPT will be available in 1995 under the trade name of AGROTAIN®.

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Table 1. Nitrogen management for irrigated corn production, Shawnee Co.

| N Rate* | | | Continuous Corn | | | | Corn after Soybeans | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | N | Leaf N | | Grain | | Leaf N | | Grain | |
| C/C | C/S | Source | 6-leaf | Tassel | Yield | N | 6-leaf | Tassel | Yield | N |
| - lb/a - | | | - - % - - | | bu/a | % | - - % - - | | bu/a | % |
| 0 | 0 | -- | 3.01 | 2.41 | 81 | 1.45 | 2.44 | 1.49 | 43 | 1.35 |
| 60 | 30 | Urea | 2.91 | 2.00 | 86 | 1.42 | 3.10 | 1.67 | 49 | 1.28 |
| 120 | 60 | Urea | 3.53 | 2.85 | 120 | 1.49 | 3.33 | 2.15 | 80 | 1.33 |
| 180 | 120 | Urea | 3.39 | 2.83 | 128 | 1.46 | 3.47 | 2.31 | 90 | 1.28 |
| 60 | 30 | Urea + NBPT | 3.44 | 2.67 | 111 | 1.44 | 3.08 | 1.98 | 69 | 1.27 |
| 120 | 60 | Urea + NBPT | 3.49 | 2.88 | 138 | 1.49 | 3.51 | 2.62 | 100 | 1.30 |
| 180 | 120 | Urea + NBPT | 3.56 | 2.99 | 142 | 1.55 | 3.53 | 2.81 | 128 | 1.43 |
| 60 | 30 | Am. Nit. | 3.47 | 2.92 | 123 | 1.47 | 2.90 | 1.99 | 69 | 1.31 |
| 120 | 60 | Am. Nit. | 3.56 | 2.91 | 141 | 1.52 | 3.51 | 2.18 | 99 | 1.26 |
| 180 | 120 | Am. Nit. | 3.67 | 2.81 | 129 | 1.60 | 3.74 | 2.81 | 127 | 1.43 |
| 60 | 30 | UAN | 3.54 | 2.43 | 121 | 1.47 | 2.76 | 1.73 | 42 | 1.31 |
| 120 | 60 | UAN | 3.40 | 2.75 | 130 | 1.41 | 3.14 | 1.86 | 67 | 1.24 |
| 180 | 120 | UAN | 3.70 | 2.93 | 138 | 1.52 | 3.54 | 2.39 | 105 | 1.33 |
| LSD (.05) | | | 0.26 | 0.28 | 24 | 0.10 | 0.35 | 0.36 | 30 | 0.16 |
| Mean Values: | | | | | | | | | | |
| N Rate lb/a | | | | | | | | | | |
| C/C | C/S | | | | | | | | | |
| 60 | 30 | | 3.34 | 2.51 | 112 | 1.45 | 2.95 | 1.84 | 57 | 1.29 |
| 120 | 60 | | 3.49 | 2.85 | 132 | 1.48 | 3.34 | 2.20 | 86 | 1.29 |
| 180 | 120 | | 3.58 | 2.89 | 133 | 1.53 | 3.57 | 2.61 | 112 | 1.36 |
| LSD (.05) | | | 0.12 | 0.12 | 9 | 0.05 | 0.18 | 0.18 | 15 | NS |
| N Source | | | | | | | | | | |
| | | Urea | 3.28 | 2.56 | 111 | 1.45 | 3.30 | 2.05 | 73 | 1.30 |
| | | Urea + NBPT | 3.50 | 2.85 | 131 | 1.49 | 3.33 | 2.51 | 99 | 1.33 |
| | | Am. Nit. | 3.57 | 2.90 | 131 | 1.53 | 3.38 | 2.33 | 98 | 1.33 |
| | | UAN | 3.55 | 2.70 | 129 | 1.47 | 3.15 | 2.00 | 71 | 1.29 |
| LSD (.05) | | | 0.14 | 0.14 | 11 | 0.05 | 0.21 | 0.21 | 17 | NS |

* C/C = Continuous corn, C/S = Corn after soybeans

Table 2. Nitrogen management for dryland no-till corn production, Osage Co.

| N Rate* | | | Duane Lamond Farm | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Continuous Corn | | | | Corn after Soybeans | | | |
| | | N | Leaf N | | Grain | | Leaf N | | Grain | |
| C/C | C/S | Source | 6-leaf | Tassel | Yield | N | 6-leaf | Tassel | Yield | N |
| - lb/a - | | | - - % - - | | bu/a | % | - - % - - | | bu/a | % |
| 0 | 0 | -- | 3.17 | 1.63 | 20 | 0.94 | 2.17 | 1.43 | 18 | 1.13 |
| 50 | 25 | Urea | 3.50 | 2.24 | 44 | 0.95 | 2.40 | 1.64 | 30 | 1.02 |
| 100 | 50 | Urea | 3.69 | 2.39 | 44 | 1.07 | 2.55 | 2.12 | 44 | 1.09 |
| 150 | 100 | Urea | 3.84 | 2.81 | 62 | 1.27 | 2.69 | 2.65 | 70 | 1.14 |
| 50 | 25 | Urea + NBPT | 3.63 | 2.39 | 64 | 0.96 | 2.40 | 1.56 | 31 | 1.11 |
| 100 | 50 | Urea + NBPT | 3.77 | 2.45 | 69 | 1.14 | 2.52 | 2.10 | 46 | 1.05 |
| 150 | 100 | Urea + NBPT | 3.74 | 3.05 | 71 | 1.27 | 2.82 | 2.63 | 65 | 1.19 |
| 50 | 25 | Am. Nit. | 3.52 | 2.36 | 60 | 1.09 | 2.54 | 1.76 | 32 | 1.04 |
| 100 | 40 | Am. Nit. | 3.74 | 2.53 | 58 | 1.07 | 2.63 | 1.91 | 42 | 1.07 |
| 150 | 100 | Am. Nit. | 3.65 | 2.60 | 65 | 1.21 | 2.62 | 2.57 | 62 | 1.13 |
| 50 | 25 | UAN | 3.47 | 2.15 | 35 | 0.95 | -- | -- | -- | -- |
| 100 | 50 | UAN | 3.60 | 2.12 | 47 | 0.95 | -- | -- | -- | -- |
| 150 | 100 | UAN | 3.56 | 2.60 | 53 | 1.14 | -- | -- | -- | -- |
| LSD (.05) | | | 0.29 | 0.34 | 15 | 0.16 | 0.27 | 0.35 | 12 | 0.13 |
| Mean Values: | | | | | | | | | | |
| N Rate lb/a | | | | | | | | | | |
| C/C | C/S | | | | | | | | | |
| 50 | 25 | | 3.53 | 2.28 | 51 | 0.98 | 2.45 | 1.65 | 31 | 1.06 |
| 100 | 50 | | 3.70 | 2.37 | 55 | 1.06 | 2.57 | 2.05 | 44 | 1.07 |
| 150 | 100 | | 3.70 | 2.77 | 63 | 1.22 | 2.68 | 2.61 | 65 | 1.15 |
| LSD (.05) | | | 0.14 | 0.17 | 8 | 0.08 | 0.15 | 0.21 | 7 | 0.07 |
| N Source | | | | | | | | | | |
| | | Urea | 3.68 | 2.48 | 50 | 1.09 | 2.55 | 2.13 | 48 | 1.08 |
| | | Urea + NBPT | 3.71 | 2.63 | 68 | 1.13 | 2.58 | 2.10 | 47 | 1.12 |
| | | Am. Nit. | 3.64 | 2.50 | 61 | 1.13 | 2.56 | 2.08 | 45 | 1.08 |
| | | UAN | 3.54 | 2.29 | 45 | 1.01 | -- | -- | -- | -- |
| LSD (.05) | | | NS | 0.19 | 9 | 0.09 | NS | NS | NS | NS |

* C/C = Continuous corn, C/S = Corn after soybeans

Table 3. Nitrogen management for no-till grain sorghum production, Nemaha Co.

| N Rate* | | | Continuous Sorghum | | | Sorghum after Soybeans | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | Leaf N | Grain | | Leaf N | | Grain | |
| M/M | M/S | Source | Boot | Yield | N | 6-leaf | Boot | Yield | N |
| - lb/a - | | | % | bu/a | % | ----% | ---- | bu/a | % |
| 0 | 0 | -- | 1.76 | 60 | 1.32 | 2.15 | 2.05 | 27 | 1.43 |
| 50 | 25 | Urea | 2.00 | 78 | 1.19 | 2.39 | 2.13 | 54 | 1.47 |
| 100 | 50 | Urea | 2.28 | 106 | 1.22 | 2.84 | 2.30 | 70 | 1.49 |
| 150 | 100 | Urea | 2.48 | 110 | 1.32 | 2.47 | 2.56 | 74 | 1.43 |
| 50 | 25 | Urea + NBPT | 2.07 | 99 | 1.18 | 2.51 | 2.09 | 71 | 1.41 |
| 100 | 50 | Urea + NBPT | 2.44 | 97 | 1.24 | 2.41 | 2.22 | 78 | 1.49 |
| 150 | 100 | Urea + NBPT | 2.50 | 116 | 1.34 | 2.60 | 2.48 | 80 | 1.51 |
| 50 | 25 | Am. Nit. | 2.12 | 86 | 1.30 | 2.12 | 1.99 | 70 | 1.47 |
| 100 | 40 | Am. Nit. | 2.44 | 104 | 1.20 | 2.47 | 2.38 | 72 | 1.42 |
| 150 | 100 | Am. Nit. | 2.62 | 110 | 1.33 | 2.67 | 2.69 | 74 | 1.56 |
| 50 | 25 | UAN | 1.91 | 70 | 1.35 | 2.23 | 2.09 | 52 | 1.47 |
| 100 | 50 | UAN | 2.27 | 89 | 1.24 | 2.06 | 2.31 | 64 | 1.52 |
| 150 | 100 | UAN | 2.30 | 93 | 1.25 | 2.23 | 2.39 | 72 | 1.50 |
| LSD (.05) | | | 0.27 | 16 | 0.12 | NS | NS | 20 | NS |
| Mean Values: | | | | | | | | | |
| N Rate lb/a | | | | | | | | | |
| M/M | M/S | | | | | | | | |
| 50 | 25 | | 2.02 | 83 | 1.25 | 2.31 | 2.07 | 61 | 1.46 |
| 100 | 50 | | 2.36 | 99 | 1.23 | 2.42 | 2.30 | 71 | 1.48 |
| 150 | 100 | | 2.47 | 107 | 1.31 | 2.49 | 2.53 | 75 | 1.50 |
| LSD (.05) | | | 0.14 | 8 | 0.05 | NS | NS | 10 | NS |
| N Source | | | | | | | | | |
| | | Urea | 2.25 | 98 | 1.24 | 2.57 | 2.33 | 66 | 1.46 |
| | | Urea + NBPT | 2.34 | 104 | 1.25 | 2.47 | 2.26 | 76 | 1.47 |
| | | Am. Nit. | 2.39 | 100 | 1.28 | 2.42 | 2.35 | 72 | 1.48 |
| | | UAN | 2.16 | 84 | 1.28 | 2.17 | 2.26 | 62 | 1.49 |
| LSD (.05) | | | 0.16 | 9 | NS | NS | NS | 12 | NS |

* M/M = Milo after milo, M/S = Milo after soybeans

Table 4. Nitrogen management for continuous no-till grain sorghum production, Kansas, 1993.

| | | N. Agronomy Farm | | | N. Central Expt. Field | | |
|---|---|---|---|---|---|---|---|
| N | N | Leaf N | Grain | | Leaf N | Grain | |
| Rate | Source | Boot | Yield | N | Boot | Yield | N |
| lb/a | | % | bu/a | % | % | bu/a | % |
| 0 | -- | 1.63 | 41 | 1.35 | 1.77 | 76 | 1.18 |
| 50 | Urea | 2.37 | 66 | 1.25 | 2.45 | 102 | 1.22 |
| 100 | Urea | 2.32 | 86 | 1.16 | 2.67 | 116 | 1.26 |
| 150 | Urea | 2.52 | 99 | 1.27 | 3.03 | 127 | 1.40 |
| 50 | Urea + NBPT | 2.18 | 69 | 1.13 | 2.51 | 100 | 1.20 |
| 100 | Urea + NBPT | 2.65 | 94 | 1.39 | 2.74 | 118 | 1.30 |
| 150 | Urea + NBPT | 2.69 | 105 | 1.42 | 2.83 | 129 | 1.33 |
| 50 | Am. Nit. | 2.11 | 72 | 1.19 | 2.43 | 107 | 1.25 |
| 100 | Am. Nit. | 2.22 | 90 | 1.19 | 2.71 | 123 | 1.28 |
| 150 | Am. Nit. | 2.61 | 106 | 1.31 | 2.92 | 128 | 1.40 |
| | LSD (.05) | 0.27 | 15 | 0.17 | 0.36 | 11 | 0.14 |
| Mean Values: | | | | | | | |
| N Rate lb/a | | | | | | | |
| 50 | | 2.22 | 69 | 1.19 | 2.46 | 103 | 1.22 |
| 100 | | 2.36 | 90 | 1.25 | 2.70 | 119 | 1.28 |
| 150 | | 2.61 | 103 | 1.33 | 2.93 | 128 | 1.37 |
| | LSD (.05) | 0.17 | 9 | 0.10 | 0.22 | 5 | 0.08 |
| N Source | | | | | | | |
| | Urea | 2.37 | 84 | 1.23 | 2.71 | 115 | 1.29 |
| | Urea + NBPT | 2.51 | 89 | 1.31 | 2.69 | 115 | 1.28 |
| | Am. Nit. | 2.34 | 90 | 1.23 | 2.69 | 119 | 1.31 |
| | LSD (.05) | NS | NS | NS | NS | NS | NS |

Table 5. Nitrogen management for continuous no-till grain sorghum production, Kansas, 1994.

| | | Nemaha Co. | | |
|---|---|---|---|---|
| N | N | Leaf N | Chlorophyll | Grain |
| Rate | Source | Boot | Meter | Yield |
| lb/ac | | % | SPAD | bu/a |
| 0 | ---- | 2.31 | 34 | 107 |
| 50 | Urea | 2.90 | 50 | 134 |
| 100 | Urea | 2.98 | 54 | 141 |
| 150 | Urea | 3.25 | 57 | 139 |
| 50 | Urea + NBPT | 2.88 | 55 | 140 |
| 100 | Urea + NBPT | 3.20 | 55 | 144 |
| 150 | Urea + NBPT | 3.35 | 57 | 144 |
| 50 | UAN | 2.78 | 46 | 127 |
| 100 | UAN | 2.92 | 52 | 140 |
| 150 | UAN | 3.07 | 56 | 144 |
| 50 | Am. Nitrate | 2.78 | 51 | 128 |
| 100 | Am. Nitrate | 2.96 | 56 | 138 |
| 150 | Am. Nitrate | 3.20 | 57 | 131 |
| LSD (0.05) | | 0.22 | 5 | 18 |
| Mean Values: | | | | |
| N | 50 | 2.83 | 51 | 133 |
| Rate | 100 | 2.99 | 54 | 139 |
| | 150 | 3.22 | 56 | 142 |
| | LSD (0.05) | 0.09 | 2 | NS |
| N | Urea | 3.04 | 53 | 139 |
| Source | Urea + NBPT | 3.15 | 56 | 143 |
| | UAN | 2.92 | 51 | 137 |
| | Am. Nit. | 2.98 | 54 | 132 |
| | LSD (0.05) | 0.11 | 2 | NS |

Table 6. Chlorophyll meter as a nitrogen assessment tool.

| Treatment | | | Corn[1] Yield | Corn[1] Tassel N | Corn[1] Chlorophyll Meter | Grain Sorghum[2] Yield | Grain Sorghum[2] Boot N | Grain Sorghum[2] Chlorophyll Meter |
|---|---|---|---|---|---|---|---|---|
| | | | bu/a | % | SPAD | bu/a | % | SPAD |
| Check, 0 N | | | 50 | 2.02 | 34 | 59 | 1.72 | 32 |
| | Irr. Corn | Dryland Corn and Sorghum | | | | | | |
| N Rate | 60 | 50 | 82 | 2.40 | 51 | 85 | 2.23 | 42 |
| lb/a | 120 | 100 | 94 | 2.61 | 55 | 103 | 2.47 | 47 |
| | 180 | 150 | 98 | 2.83 | 59 | 113 | 2.67 | 50 |
| N Source | Urea | | 80 | 2.52 | 52 | 99 | 2.44 | 46 |
| | Urea + NBPT | | 100 | 2.74 | 58 | 103 | 2.51 | 47 |
| | Am. Nit | | 96 | 2.70 | 58 | 103 | 2.47 | 47 |
| | UAN | | 87 | 2.50 | 53 | --- | --- | --- |

[1]Corn is average of 1 irrigated and 1 dryland site.

[2]Grain sorghum is average of 3 sites.

# PROCEEDINGS OF THE TWENTY-FOURTH NORTH CENTRAL EXTENSION-INDUSTRY SOIL FERTILITY CONFERENCE

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