# TWENTY YEARS OF FIELD EXPERIMENTATION WITH NITROGEN SOURCE, PLACEMENT, AND TIME OF APPLICATION TO A WEBSTER LOAM NEAR LAMBERTON.

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(Annual reports of this experiment have been reported in Soil Series 74 through 105 and some of this information will not be included here).

The fertilizer treatments have now been annually applied to the same plot areas for 20 years. After ear corn removal and stalk cutting, the fall plowdown N treatments are broadcast on their respective plots and the entire area is then plowed to an approximate 12 inch depth. The fall surface N treatments are then broadcast, with no further working of the plowed area. Each plot is 20' x 77.5' and the 4 treatment replications are arranged in a randomized block.

Spring N treatments are broadcast before seedbed preparation late in April or in early May. The corn is drilled in 30" rows to produce approximately 20,000 plants/A, using a banded starter fertilizer of 8-24-12 at the rate of 180 lbs. over the entire experimental area, thus supplying an additional 14 lbs. N/acre to all plots. Herbicides and insecticides are also annually applied. Nitrogen sidedressing treatments are broadcast in June. Nitrogen concentrations present in the sixth or "index" leaf at silking were determined and are reported along with individual plot yields and nitrogen utilization in table 1.

The yields obtained in 1979 were below average when considering the long term previous average for this experiment. Treatment averages in 1979 appeared to follow the trends which had been established with the long term average yields.

## NINETEEN YEAR AVERAGE

The average grain yields for the nineteen years of this experiment are shown in table 2. When only 40 lbs. of N/A was fall applied, urea was slightly better than ammonium nitrate with very little difference due to incorporation.

Plowing down 80 lbs. of N/A in the fall was much more effective than the lower N rates and approached the yields that were obtained with the highest treatment of fall applied N. At the 40#N/A rate applied in the spring there was no difference between urea and ammonium nitrate. Urea applied in the fall produced similar yield as with spring applications although ammonium nitrate applied in the fall was inferior to spring application at the 40#N/A rate of application.

Side dressing N produced grain yields similar to those of the same rates of spring applied N. The heaviest side dressing treatments were equally effective as the rates plowed down the previous fall.

## GENERAL CONCLUSIONS

1. Urea is as effective as ammonium nitrate for the production of corn on these medium textured non-calcareous soils.

2. Late fall surface applied N is at least equal to that plowed down, but where N fertilization rates are relatively low, spring or side-dressing N treatments appear more effective.

3. Where corn is grown annually on these soils good yields can be maintained with annual applications of 100 lbs. N/A providing adequate amounts of P and K are also supplied. At this rate of application most of the N will be removed in the grain leaving relatively small amounts to be lost to the environment.

Table 1. Average N in sixth corn leaf and grain yield @ 15.5% moisture, from a Webster loam fertilized annually with $NH_4NO_3$ or urea (4 replications).

| N applied annually in lbs/A[1] | % N 6th Leaf | Bu/A @ 15.5% Moisture I | II | III | IV | Ave. | Yield Grain N Content | N Removal |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | % | #/A |
| Check | 1.66 | 37.0 | 41.6 | 42.9 | 28.9 | 37.6 | 1.04 | 18.6 |
| 40-$NH_4NO_3$-fpd[2] | 1.80 | 44.9 | 91.7 | 40.7 | 75.3 | 63.1 | 1.07 | 32.5 |
| 40-urea-fpd | 1.92 | 80.9 | 90.6 | 60.4 | 74.8 | 76.7 | 1.05 | 38.5 |
| 40-$NH_4NO_3$-fpd[3] | 1.74 | 64.1 | 76.0 | 45.1 | 73.1 | 64.6 | 1.07 | 32.8 |
| 40-urea-fps | 1.82 | 56.7 | 62.8 | 79.9 | 121.5 | 80.2 | 1.13 | 43.1 |
| 80-$NH_4NO_3$-fpd | 2.28 | 56.0 | 138.6 | 76.8 | 107.7 | 94.8 | 1.25 | 57.4 |
| 80-urea-fpd | 2.16 | 58.3 | 124.2 | 60.0 | 102.3 | 86.2 | 1.18 | 48.8 |
| 160-$NH_4NO_3$fpd | 2.65 | 110.6 | 120.1 | 81.0 | 122.9 | 108.7 | 1.34 | 68.4 |
| 160-urea-fpd | 2.69 | 120.6 | 156.5 | 91.3 | 140.9 | 127.3 | 1.36 | 82.4 |
| 40-$NH_4NO_3$-std[4] | 1.81 | 64.5 | 116.8 | 59.6 | 105.4 | 86.6 | 1.12 | 45.9 |
| 40-urea-std | 1.61 | 64.8 | 83.2 | 58.2 | 91.6 | 74.5 | 1.10 | 38.7 |
| 80-$NH_4NO_3$-std | 2.32 | 72.5 | 114.0 | 103.7 | 59.1 | 87.3 | 1.18 | 49.3 |
| 80-urea-std | 2.16 | 101.1 | 110.1 | 84.1 | 106.0 | 100.3 | 1.26 | 59.6 |
| 40-$NH_4NO_3$-sd[5] | 2.56 | 108.9 | 86.8 | 82.5 | 118.6 | 99.2 | 1.22 | 57.1 |
| 40-urea-sd | 2.07 | 87.7 | 54.1 | 97.8 | 137.1 | 94.2 | 1.17 | 52.5 |
| 80-$NH_4NO_3$-sd | 2.58 | 131.0 | 61.8 | 93.8 | 138.7 | 106.3 | 1.29 | 65.0 |
| 80-urea-sd | 2.64 | 116.8 | 128.9 | 111.3 | 115.5 | 118.1 | 1.30 | 72.9 |
| 160-$NH_4NO_3$-sd | 2.93 | 145.3 | 142.0 | 150.8 | 153.8 | 148.0 | 1.47 | 103.1 |
| Significance | ** | | | | | ** | ** | ** |
| C.V. (%) | 8.7 | | | | | 22.8 | 7.0 | 26.2 |
| BLSD(0.05) | 0.25 | | | | | 30.8 | 0.11 | 19.3 |

[1]The entire area received an additional 14 lbs N/A as starter fertilizer annually (8-24-12 @ 180#/A).

[2]fpd -- fall plow down [3]fps -- fall plow surface [4]std -- spring top dress
[5]sd -- side dress

*Any letter(s) different from another letter in a column indicates a significant difference between the means at the 5% level.

Table 2. Yields of ear corn during 19 years on a tiled Webster loam near Lamberton with annual applications of $NH_4NO_3$ or urea nitrogen at different rates, times, and placement. (Average of 4 replications)

| N applied annually in lbs/A[1] | 1960 | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Ear corn yield in bushels per acre | | | | | | | | | |
| Check | 49.5 | 88.2 | 26.1 | 132.6 | 72.9 | 33.1 | 11.1 | 53.4 | 102.4 | 92.8 |
| 40 $NH_4NO_3$-fpd[2] | 42.3 | 87.5 | 30.9 | 148.6 | 88.3 | 34.9 | 26.8 | 75.7 | 131.6 | 109.3 |
| 40 Urea - fpd[3] | 55.1 | 78.2 | 29.1 | 148.8 | 100.3 | 38.8 | 19.8 | 86.9 | 132.5 | 124.5 |
| 40 $NH_4NO_3$-fps | 49.0 | 96.7 | 29.6 | 140.1 | 101.5 | 45.6 | 24.3 | 75.1 | 135.2 | 124.6 |
| 40 Urea - fps | 62.3 | 101.3 | 37.0 | 140.7 | 84.1 | 57.4 | 30.9 | 87.2 | 134.0 | 136.1 |
| 80 $NH_4NO_3$-fpd | 67.4 | 97.9 | 43.6 | 149.6 | 100.8 | 63.4 | 47.3 | 114.3 | 131.2 | 146.8 |
| 80 Urea - fpd | 61.7 | 76.9 | 36.7 | 154.5 | 104.9 | 73.0 | 37.8 | 117.2 | 142.6 | 144.3 |
| 160 $NH_4NO_3$-fpd | 69.8 | 97.9 | 46.7 | 147.7 | 100.9 | 70.8 | 38.5 | 127.4 | 140.2 | 158.7 |
| 160 Urea - fpd[4] | 79.4 | 112.5 | 43.5 | 152.8 | 112.4 | 73.5 | 37.7 | 121.3 | 149.9 | 161.0 |
| 40 $NH_4NO_3$-std | 66.2 | 92.0 | 45.4 | 152.2 | 99.8 | 63.4 | 23.7 | 99.8 | 128.0 | 142.0 |
| 40 Urea - std | 45.4 | 91.1 | 31.4 | 147.6 | 100.6 | 59.8 | 33.8 | 95.0 | 140.5 | 143.4 |
| 80 $NH_4NO_3$-std | 59.3 | 90.0 | 32.7 | 149.2 | 112.5 | 74.2 | 49.0 | 128.3 | 144.7 | 159.5 |
| 80 Urea - std | 57.7 | 99.1 | 40.5 | 149.3 | 115.7 | 84.4 | 41.8 | 128.6 | 138.7 | 155.9 |
| 40 $NH_4NO_3$ - sd[5] | 63.6 | 92.6 | 39.5 | 148.6 | 90.4 | 54.8 | 38.6 | 96.8 | 133.4 | 142.3 |
| 40 Urea - sd | 57.7 | 95.6 | 24.9 | 142.3 | 94.1 | 48.4 | 50.4 | 86.1 | 132.2 | 143.3 |
| 80 $NH_4NO_3$ - sd | 50.4 | 98.4 | 46.7 | 140.7 | 113.0 | 68.1 | 43.8 | 101.6 | 137.7 | 140.3 |
| 80 Urea - sd | 76.9 | 86.4 | 48.2 | 143.8 | 121.4 | 64.7 | 47.3 | 117.0 | 146.9 | 166.2 |
| 160 $NH_4NO_3$ - sd | 40.7 | 97.4 | 77.7 | 151.7 | 109.5 | 77.6 | 51.4 | 120.2 | 141.5 | 148.3 |
| Ave. annual corn yield in bu/A | 58.6 | 93.3 | 39.4 | 147.5 | 101.3 | 60.3 | 37.8 | 101.8 | 135.7 | 140.9 |

[1] The entire area received an additional 14 lbs N/A as starter fertilizer annually (8--24-12 @ 180 #/A).

[2] fpd -- fall plow down [3] fps -- fall plow surface [4] std -- spring topdress [5] sd -- sidedress

Table 2. (continued). Yields of ear corn during 19 years on a tilled Webster loam near Lamberton with annual applications of $NH_4NO_3$ or urea nitrogen at different rates, times, and placement. (Average of 4 replications).

| N applied annually in lbs/A | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 19 Year Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Ear corn yield in bushels per acre | | | | | | |
| Check | 85.7 | 40.8 | 75.6 | 69.2 | 53.4 | 58.3 | No | 141.2 | 64.6 | 37.6 | 68.0 |
| 40 $NH_4NO_3$-fpd[2] | 96.3 | 88.7 | 113.6 | 92.0 | 80.5 | 88.6 | | 145.1 | 98.1 | 63.1 | 86.4 |
| 40 Urea-fpd | 120.4 | 100.7 | 113.9 | 101.5 | 96.9 | 96.6 | Yields | 165.2 | 110.2 | 76.7 | 94.5 |
| 40 $NH_4NO_3$-fps | 122.5 | 81.5 | 109.9 | 93.0 | 88.3 | 78.2 | | 149.4 | 101.3 | 64.6 | 90.0 |
| 40 Urea-fps | 121.2 | 82.4 | 106.7 | 97.8 | 85.0 | 78.9 | Taken | 156.8 | 101.4 | 80.2 | 93.7 |
| 80 $NH_4NO_3$-fpd | 134.7 | 108.0 | 143.1 | 121.7 | 103.6 | 89.2 | | 156.9 | 128.4 | 94.8 | 107.6 |
| 80 Urea-fpd | 141.4 | 107.8 | 140.1 | 117.9 | 107.2 | 96.9 | | 146.0 | 123.6 | 86.2 | 106.1 |
| 160 $NH_4$-$NO_3$-fpd | 141.7 | 120.2 | 147.6 | 121.0 | 113.1 | 90.4 | | 149.8 | 129.3 | 108.7 | 111.6 |
| 160 Urea-fpd | 140.4 | 110.6 | 151.7 | 114.9 | 105.1 | 82.4 | | 163.0 | 124.4 | 127.3 | 113.9 |
| 40 $NH_4NO_3$-std | 125.6 | 84.0 | 117.0 | 104.0 | 82.8 | 88.0 | | 160.0 | 97.4 | 86.6 | 97.8 |
| 40 Urea-std | 118.9 | 94.6 | 116.5 | 97.1 | 94.5 | 89.0 | | 165.2 | 103.9 | 74.5 | 97.0 |
| 80 $NH_4NO_3$-std | 140.4 | 122.7 | 142.7 | 118.0 | 92.9 | 97.6 | | 162.9 | 117.1 | 87.3 | 109.5 |
| 80 Urea-std | 146.2 | 116.0 | 142.1 | 117.6 | 108.5 | 93.6 | | 162.2 | 127.4 | 100.3 | 111.9 |
| 40 $NH_4NO_3$-sd[5] | 127.1 | 104.5 | 136.0 | 99.1 | 82.7 | 91.8 | | 153.8 | 106.8 | 99.2 | 99.9 |
| 40 Urea-sd | 117.7 | 100.5 | 133.9 | 103.9 | 80.4 | 92.6 | | 165.4 | 104.8 | 94.2 | 98.4 |
| 80 $NH_4NO_3$-sd | 127.7 | 97.6 | 124.7 | 109.4 | 87.6 | 95.3 | | 163.2 | 110.6 | 106.3 | 103.3 |
| 80 Urea-sd | 140.5 | 124.4 | 149.8 | 124.0 | 95.6 | 90.1 | | 162.8 | 126.7 | 118.1 | 113.2 |
| 160 $NH_4NO_3$-sd | 136.9 | 104.2 | 150.0 | 117.1 | 105.5 | 91.3 | | 160.3 | 126.0 | 148.0 | 113.4 |
| Ave. annual corn yield in bu/A | 127.0 | 99.4 | 128.6 | 106.6 | 92.4 | 88.3 | | 157.2 | 111.2 | 91.9 | 100.9 |
| Significance | | | | | | | | | | ** | ** |
| C.V. (%) | | | | | | | | | | 22.8 | 9.4 |
| BLSD(.05) | | | | | | | | | | 30.8 | 5.5 |

[1] The entire area received an additional 14 lbs N/A as starter fertilizer annually (8-24-12 @ 180 #/A)

[2] fpd -- fall plow down [3]fps -- fall plow surface [4]std -- spring topdress [5]sd -- sidedress

* Any letter(s) different from another letter in a column indicates a significant difference between the means at the 5% level.

# WEST CENTRAL EXPERIMENT STATION - MORRIS

## WEATHER SUMMARY - 1979

| Month | Period | Precipitation 1979 | Precipitation 92-yr. av. | Precipitation Dev. from av. | Air Temperature 1979 | Air Temperature 92-yr. av. | Air Temperature Dev. from av. | Soil (10 cm) Temperature 1979 | Soil (10 cm) Temperature 10-yr. av. |
|---|---|---|---|---|---|---|---|---|---|
| January | 1-31 | 1.36 | .67 | + .69 | -3.7 | 8.2 | -11.9 | 12.5 | 20.7 |
| February | 1-28 | 1.28 | .66 | + .62 | -0.8 | 12.8 | -13.6 | 15.9 | 23.9 |
| March | 1-31 | 2.10 | 1.08 | +1.02 | 20.7 | 26.7 | -6.0 | 24.7 | 29.2 |
| April | 1-10 | .04 | .57 | - .53 | 26.2 | 38.0 | -11.8 | 29.0 | |
| | 11-20 | 1.02 | .75 | + .27 | 41.2 | 44.5 | -3.3 | 34.6 | |
| | 21-30 | .47 | .99 | - .52 | 44.6 | 48.2 | -3.6 | 41.8 | |
| Total or av. | | 1.53 | 2.31 | - .78 | 37.4 | 43.6 | -6.2 | 35.1 | 41.4 |
| May | 1-10 | .87 | .78 | + .09 | 42.8 | 52.0 | -9.2 | 43.4 | |
| | 11-20 | .64 | 1.13 | - .49 | 51.2 | 55.8 | -4.6 | 50.7 | |
| | 21-31 | 1.01 | 1.08 | + .07 | 53.3 | 60.0 | -6.7 | 59.9 | |
| Total or av. | | 2.52 | 2.99 | - .47 | 50.7 | 56.1 | -5.4 | 51.6 | 57.1 |
| June | 1-10 | .50 | 1.28 | - .78 | 61.2 | 63.2 | -2.0 | 61.2 | |
| | 11-20 | 4.09 | 1.36 | +2.73 | 66.2 | 66.5 | -0.3 | 67.8 | |
| | 21-30 | 1.71 | 1.23 | + .48 | 64.0 | 68.3 | -4.3 | 68.8 | |
| Total or av. | | 6.30 | 3.87 | +2.43 | 63.8 | 66.0 | -2.2 | 67.6 | 69.3 |
| July | 1-10 | .01 | 1.50 | -1.49 | 70.7 | 70.0 | +0.7 | 76.8 | |
| | 11-20 | .35 | 1.18 | - .83 | 68.2 | 71.4 | -3.2 | 78.0 | |
| | 21-31 | 2.35 | .89 | +1.46 | 69.0 | 71.6 | -2.6 | 76.4 | |
| Total or av. | | 2.71 | 3.57 | - .86 | 69.4 | 71.0 | -1.6 | 77.2 | 76.7 |
| August | 1-10 | .57 | 1.06 | - .49 | 69.7 | 70.4 | -0.7 | 77.4 | |
| | 11-20 | .02 | 1.04 | -1.02 | 61.6 | 69.2 | -7.6 | 70.7 | |
| | 21-31 | .56 | .85 | - .29 | 63.3 | 66.9 | -3.6 | 70.0 | |
| Total or av. | | 1.15 | 2.95 | -1.80 | 64.8 | 68.8 | -4.0 | 72.6 | 73.9 |
| September | 1-30 | .22 | 2.21 | -1.99 | 59.7 | 59.1 | +0.6 | 67.4 | 61.5 |
| October | 1-31 | 4.26 | 1.61 | +2.65 | 44.1 | 47.4 | -3.3 | 47.2 | 47.8 |
| November | 1-30 | .60 | .96 | - .36 | 28.7 | 29.8 | -1.1 | 31.5 | 33.6 |
| December | 1-31 | .26 | .68 | - .42 | 22.5 | 15.5 | +7.0 | 23.8 | 23.4 |
| April-August Growing Season | | 14.21 | 15.69 | -1.48 | 57.3 | 61.2 | -3.9 | 60.9 | 63.8 |
| January-December Annual | | 24.29 | 23.56 | + .73 | 38.3 | 42.1 | -3.8 | 44.1 | 46.7 |

# CONTINUOUS CORN SILAGE

West Central Experiment Station - Morris

S. D. Evans

## I. Experimental Description

In 1965 an experiment was initiated on McIntosh silt loam to determine the effect of removal of continuous corn silage and fertilizer on corn grain and corn silage yields and on soil properties. Rates of fertilizer used were 74 + 48 + 48 ($N + P_2O_5 + K_2O$) and 148 + 96 + 96. All plots received a broadcast application of 10 lbs/acre of zinc as zinc sulfate in the fall of 1965.

## II. 1979 Operations

In 1979 the variety was Trojan TXS99. Counter was applied at 1 lb/acre (active ingredient) at planting on May 21. Lasso @ 2 lbs/acre plus Bladex @ 2.2 lbs/acre were applied broadcast on May 23. Silage yields were taken on September 26 and grain yields on October 25.

## III. Silage Yields - Dry matter; tons/acre.

| Treatment | 1979 yield | 1966-79 yield |
|---|---|---|
| Silage, low fertility | 6.72 | 5.56 |
| Silage, high fertility | 7.11 | 5.97 |
| Grain, low fertility | 6.84 | 5.76 |
| Grain, high fertility | 6.98 | 5.50 |

## IV. Grain Yields - Bushels/acre @ 15.5% M.

| | 1979 yield | 1966-79 yield |
|---|---|---|
| Grain, low fertility | 98.66 | 90.22 |
| Grain, high fertility | 97.80 | 92.75 |

## V. Check Yields

Yields on an additional unfertilized, unreplicated check adjacent to the experimental area:

| | 1979 yield | 1966-79 yield |
|---|---|---|
| Grain (0 + 0 + 0) | 20.47 Bu/A | 51.37 Bu/A |
| Silage (0 + 0 + 0) | 3.04 Tons/A | 3.76 Tons/A |

## VI. Discussion

A. In 1979 there were no significant differences in silage yields but the high fertility plots yielded slightly more than the low fertility plots.

B. The 14-year average yields show very little difference between silage and grain plots, but there is still a slight advantage for the higher fertility level.

# EFFECT OF FERTILIZER ON CORN GRAIN YIELD AND N CONTENT OF THE EAR LEAVES

West Central Experiment Station - Morris

S. D. Evans, A. C. Caldwell, and Greg Buzicky

Plot areas were established in the fall of 1972 on a Doland silt loam at the West Central Experiment Station to study the effect of fertilizer treatments on corn yield and nutrient content and on chemical elements added to soils. Reported below are some of the observations during the seven years of the experiment.

A 95-day hybrid was planted each year at about 22,000 seeds/A during the first three weeks in May. Corn rootworm and weed control chemicals were used. A starter fertilizer (6-24-24) was applied along the row at 143 lbs/A at planting time. Nitrogen in addition to the starter was applied broadcast as urea, at the times indicated in Table 1. An organic source of N was applied as soybean oil meal, which supplied some P and K as well. The 80-lb rate of meal supplied 8 and 25 lbs/A of P and K, respectively; the 120-lb rate of meal, 12 and 38 lbs/A of P and K, respectively. All materials were incorporated soon after application. The treatments were replicated 4 times.

Grain yield was determined on mature corn. Sixth corn leaf samples were collected for analysis at silking.

## Corn Grain Yield

Yields for each of the seven years and the average are given in Table 1. The only significant yield differences occurred in 1974 and 1979. In no case was more than 80 lbs N/A needed for maximum yield. In fact, in some years lesser amounts of N were adequate--1976 - 40 lbs/A, 1977 - starter only, and 1978 - 40 lbs/A. The seven-year average shows maximum yield at 80 lbs N/A.

In most years there was little difference between fall and spring applications of N. In 1975 and 1978 some fall treatments yielded slightly more than corresponding spring treatments. The seven-year average shows no difference between fall and spring applications.

Treatments receiving the organic N source, soybean oil meal, were not significantly different from the corresponding urea treatments 4 and 5. However, there was some year-to-year variation. In 1973 the 80-lb organic treatment was lower yielding than the 80-lb urea treatment, possibly due to inadequate mineralization. In 1975 the 120-lb organic treatment yielded more than the 120-lb urea treatment and in 1979 the 80-lb organic treatment yielded more than the 80-lb urea treatment. The seven-year average again shows no differtnce between organic and urea N sources.

The extra 30 lbs P/A (treatment 12) did not yield significantly better than treatment 4, but in 1976 the yield difference was 11.3 bu/A. There was no significant effect on the seven-year average.

Results of the first seven years of this trial show that (1) 80 lbs N/A were needed for maximum yield, (2) there was no difference between fall and spring urea applications, (3) there was no difference between urea and soybean oil meal as N sources, and (4) the amount of P supplied in the starter was adequate.

N Content of Sixth Leaf

All the values for ear leaf N are given in Table 2. Significant differences occurred in all years except 1977. There was considerable year-to-year variation in N contents within a specific treatment. For example, the 80-lb spring applied urea (treatment 4) varied from a low of 2.53% in 1973 to a high of 3.37% in 1974. In all years there was an increase in the leaf N content as urea rates increased to the 120-lb rate, even though yields reached a maximum at the 80-lb rate. In 1973, 1975, 1976, and 1979 treatments 1 and 2 (starter only) had values in the deficient range (<2.45% N). The 40-lb urea treatment had N contents in the deficient range in 1973 and 1979, in the low range (2.46-2.75%) in 1975 and 1976, and in the sufficient range (2.76-3.50%) in 1974, 1977, and 1978. In all years except 1974 and 1976, leaf N levels were a good indicator of the adequacy of N for maximum yields. In 1974 all N levels were high even though it took 80 lbs N/A for maximum yields. In 1976 yields were very low due to the extreme drouth and maximum yield was at the 40-lb N/A rate.

Soil $NO_3$-N Content

A summary of the fall soil $NO_3$-N levels are given in Table 3. In general the $NO_3$-N levels are related to the N applied. With 80, 120, and 160 lbs N/A there was a large increase in soil $NO_3$-N in 1973 and 1974. In the fall of 1975 levels in all treatments dropped drastically. This was probably due to the high yield in 1975 (Table 1) and the high precipitation from June thru August (Table 4). Samples were taken to a depth of 8 feet in 1974 and 1975 and a comparison of these values shows that considerable $NO_3$-N moved below the 8-foot depth. With the poor crop in 1976, levels again increased and the evidence of this increase was still present in the samples taken in the fall of 1978.

Table 1. Effect of fertilizer treatments on corn grain yield.

| No. | Fertilizer Treatments | In addition to starter N[2] (lbs/A) | In addition to starter P (lbs/A) | Grain Yield 1973 (bu/A) | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 7-year average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Starter[1] | 0 | 0 | 112.5 | 77.3 | 99.4 | 19.9 | 101.8 | 117.9 | 79.6 | 86.9 |
| 2 | " | 0 | 0 | 116.3 | 70.7 | 104.5 | 20.1 | 100.6 | 117.4 | 75.0 | 86.4 |
| 3 | " | 40 | 0 | 122.1 | 81.7 | 104.7 | 24.2 | 101.4 | 128.2 | 107.9 | 95.7 |
| 4 | " | 80 | 0 | 129.8 | 94.0 | 110.9 | 24.4 | 103.3 | 129.3 | 112.2 | 100.4 |
| 5 | " | 120 | 0 | 128.2 | 91.2 | 112.5 | 21.2 | 102.5 | 126.7 | 111.0 | 99.1 |
| 6 | " | 120 (SD) | 0 | 126.5 | 90.4 | 119.8 | 19.6 | 103.1 | 126.4 | 116.3 | 100.3 |
| 7 | " | 160 (SD) | 0 | 128.9 | 91.9 | 110.7 | 25.6 | 99.3 | 125.7 | 105.8 | 98.3 |
| 8 | " | 80 (F) | 0 | 118.2 | 92.8 | 119.0 | 23.2 | 99.6 | 135.7 | 115.7 | 100.6 |
| 9 | " | 120 (F) | 0 | 128.9 | 90.2 | 125.7 | 21.2 | 103.4 | 128.6 | 115.8 | 102.0 |
| 10 | " | 80 (ORG) | 8 | 122.2 | 87.8 | 114.7 | 25.4 | 99.4 | 129.0 | 121.9 | 100.0 |
| 11 | " | 120 (ORG) | 12 | 127.7 | 96.9 | 119.2 | 22.0 | 101.0 | 130.7 | 113.1 | 101.5 |
| 12 | " | 80 | 30 | 123.6 | 91.8 | 108.9 | 24.7 | 104.2 | 127.8 | 123.5 | 100.5 |
| Significance | | | | NS | ** | NS | NS | NS | NS | ** | ** |
| BLSD(.05) | | | | - | 16.9 | - | - | - | - | 12.0 | 12.0 |

[1] Starter (6-24-24) was applied along the row at planting time at 143 lbs/A.

[2] Nitrogen sources were urea except for treatments 10 and 11 which were soybean oil meal. All treatments were spring applied except 8 and 9 which were applied in the fall. Two treatments received split applications of nitrogen: Treatment 6 received 80 lbs at planting and 40 lbs sidedressed and treatment 7 received 80 lbs at planting and 80 lbs sidedressed.

Table 2. Effect of fertilizer treatments on the nitrogen content of the sixth leaf at silking.

| Fertilizer treatments | | | | N content of sixth leaves | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | In addition to starter | | | | | | | | | |
| No. | | N[2] | P | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 7-year average |
| | | lbs/A | | % | | | | | | | |
| 1 | Starter[1] | 0 | 0 | 2.20 | 2.96 | 2.26 | 2.25 | 3.11 | 2.64 | 1.85 | 2.47 |
| 2 | " | 0 | 0 | 2.18 | 3.04 | 2.27 | 2.09 | 3.00 | 2.65 | 1.71 | 2.42 |
| 3 | " | 40 | 0 | 2.40 | 3.26 | 2.59 | 2.57 | 3.07 | 3.00 | 1.98 | 2.70 |
| 4 | " | 80 | 0 | 2.53 | 3.37 | 2.85 | 2.62 | 3.13 | 3.13 | 2.86 | 2.93 |
| 5 | " | 120 | 0 | 2.74 | 3.50 | 2.90 | 2.79 | 3.16 | 3.24 | 2.99 | 3.05 |
| 6 | " | 120 (SD) | 0 | 2.55 | 3.46 | 2.88 | 2.53 | 3.12 | 3.24 | 2.96 | 2.96 |
| 7 | " | 160 (SD) | 0 | 2.62 | 3.45 | 2.85 | 2.67 | 3.04 | 3.22 | 2.68 | 2.93 |
| 8 | " | 80 (F) | 0 | 2.50 | 3.32 | 2.82 | 2.64 | 3.14 | 3.12 | 2.86 | 2.91 |
| 9 | " | 120 (F) | 0 | 2.48 | 3.46 | 2.80 | 2.62 | 3.23 | 3.11 | 2.88 | 2.94 |
| 10 | " | 80 (ORG) | 8 | 2.52 | 3.42 | 2.84 | 2.54 | 3.23 | 3.16 | 3.00 | 2.96 |
| 11 | " | 120 (ORG) | 12 | 2.61 | 3.42 | 2.93 | 2.67 | 2.98 | 3.20 | 2.62 | 2.92 |
| 12 | " | 80 | 30 | 2.49 | 3.36 | 2.60 | 2.64 | 3.09 | 3.13 | 2.40 | 2.92 |
| Significance | | | | ** | ** | ** | ** | NS | ** | ** | |
| BLSD(.05) | | | | .22 | .19 | .23 | .16 | - | .13 | .59 | |

[1] Starter (6-24-24) was applied along the row at planting time at 143 lbs/A.

[2] Nitrogen sources were urea except for treatments 10 and 11 which were soybean oil meal. All treatments were spring applied except 8 and 9 which were applied in the fall. Two treatments received split applications of nitrogen: Treatment 6 received 80 lbs at planting and 40 lbs sidedressed and treatment 7 received 80 lbs at planting and 80 lbs sidedressed.

Table 3. Effect of fertilizer treatments on fall soil $NO_3$-N content.

| Sample Depth - ft - | Trt. No. | Annual Bcst. N Rate lbs/A | Year 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 |
|---|---|---|---|---|---|---|---|---|---|
| | | | - lbs $NO_3$-N/A - | | | | | | |
| 0-2 | 1 | 0 | 39 | 48 | 47 | 10 | 54 | 35 | 28 |
| 0-3 | 1 | 0 | 54 | 64 | 63 | 10 | 68 | 63 | 39 |
| 0-4 | 1 | 0 | 65 | 87 | 85 | 15 | 82 | 88 | 57 |
| 0-2 | 3 | 40 | 27 | - | 40 | 7 | 79 | 41 | 33 |
| 0-3 | 3 | 40 | 46 | - | 64 | 11 | 105 | 100 | 89 |
| 0-4 | 3 | 40 | 80 | - | 103 | 18 | 134 | 132 | 140 |
| 0-2 | 4 | 80 | 23 | 64 | 100 | 30 | 115 | 86 | 40 |
| 0-3 | 4 | 80 | 40 | 91 | 128 | 48 | 143 | 186 | 174 |
| 0-4 | 4 | 80 | 65 | 125 | 159 | 57 | 168 | 218 | 245 |
| 0-2 | 5 | 120 | 39 | 112 | 178 | 40 | 187 | 234 | 87 |
| 0-3 | 5 | 120 | 63 | 152 | 220 | 70 | 233 | 470 | 311 |
| 0-4 | 5 | 120 | 89 | 185 | 256 | 81 | 270 | 528 | 458 |
| 0-2 | 7 | 160 | 37 | - | 174 | 80 | 258 | 149 | 100 |
| 0-3 | 7 | 160 | 59 | - | 211 | 122 | 314 | 299 | 370 |
| 0-4 | 7 | 160 | 87 | - | 244 | 141 | 347 | 365 | 596 |

Table 4. Total monthly precipitation at the West Central Experiment Station, April-November.

| Month | Year 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 92-Year Average |
|---|---|---|---|---|---|---|---|---|---|
| | - inches - | | | | | | | | |
| April | 2.61 | 1.09 | 1.37 | 2.76 | .47 | 1.90 | 2.80 | 1.53 | 2.31 |
| May | 4.40 | 3.80 | 2.59 | 1.53 | .39 | 5.48 | 2.48 | 2.52 | 2.99 |
| June | 2.20 | .98 | 2.40 | 6.84 | 1.63 | 2.72 | 5.52 | 6.30 | 3.87 |
| July | 6.28 | 5.55 | 3.88 | 2.03 | 1.07 | 3.52 | 2.08 | 2.71 | 3.57 |
| August | 1.72 | 1.76 | 4.79 | 4.39 | 1.76 | 3.20 | 2.63 | 1.15 | 2.95 |
| September | .38 | 2.26 | .72 | 1.61 | .57 | 3.50 | 3.03 | .22 | 2.21 |
| October | 1.81 | 1.79 | .68 | 1.59 | .08 | 3.25 | .08 | 4.26 | 1.61 |
| November | 1.43 | .95 | 1.17 | 1.77 | .14 | 3.13 | 1.25 | .60 | .96 |
| Total | 20.83 | 18.18 | 17.60 | 22.43 | 6.11 | 26.70 | 19.87 | 19.29 | 20.47 |

# FOLIAR FERTILIZATION OF CORN

G.L. Malzer and S. Evans

Considerable interest was aroused several years ago with foliar fertilization of crops, when Dr. John Hanway of Iowa State University obtained large yield responses with soybeans. This has not only stimulated additional work with soybeans, but has also created interest with other crops. It was the objective of this trial to determine if foliar applications of nutrients to corn could be beneficial in increasing yields and/or nitrogen utilization (Protein content).

## Experimental Procedures

Six treatments were replicated six times, arranged in a randomized complete block design and established at the West Central Experiment Station at Morris. The treatments consisted of a control, two rates of "Folian" (5 and 10 gal.) at two different stages of growth (Tassel and 16 days later) along with an additional treatment of NZN applied before tasseling at the rate of 1 qt/acre. The experimental areas had been previously fertilized according to soil test recommendations.

## General Results

No significant positive yield responses were obtained to foliar applications of either "Folian" or "NZN". Slight depressions in yield were obtained with the high rate of "folian" applied near tasseling. The foliar treatment appeared to have little or no impact upon protein in the grain or nitrogen utilization.

Table 1. Yield, nitrogen content of grain, and nitrogen removal by corn grain as influenced by rate and time of foliar fertilization to corn. - Morris, 1979.

| Treatments | | Corn Grain | | |
|---|---|---|---|---|
| Solution | Time | Yield | N Content | N Removal |
| | | bu/A | % | #/A |
| Control | | 99.7 | 1.47 | 69.2 |
| Folian - 5 gal/A | Tassel | 95.5 | 1.45 | 65.4 |
| Folian - 10 gal/A | Tassel | 91.1 | 1.46 | 63.1 |
| Folian - 5 gal/A | 16 days post tassel | 93.5 | 1.49 | 65.8 |
| Folian - 10 gal/A | 16 days post tassel | 97.7 | 1.52 | 70.5 |
| NZN - 1 qt/A | Before tassel | 99.1 | 1.46 | 68.6 |
| Significance | | + | NS | NS |
| BLSD(.05) | | 7.7 | - | - |

# MANURE RATE STUDY

West Central Experiment Station - Morris

S. D. Evans, P. R. Goodrich, R. C. Munter, and R. E. Smith

Solid and liquid beef manures were applied at three rates and the effects were compared against check plots. Treatments and results from previous years are given in Soil Series 91, 95, 97, 99, 103 and 105.

## I. Manure Application and Analysis

Manure was applied for the sixth time in the fall of 1978. Samples were taken at the time of application and were analyzed by the Animal Waste Laboratory in the Department of Agricultural Engineering. The amounts are given in Table 1. The chemical analysis of each manure is given in Table 2. Using these figures, the amount of each nutrient applied to each manure treatment is given in Table 3.

## II. Planting Information

The plots were planted to Dekalb XL12 on May 17, 1979. Lorsban @ 8.8 lbs/acre (1 lb/acre active ingredient) was applied in the row to the entire area at planting. Starter fertilizer consisting of 154 lbs/acre of 10-26-26 was applied to the fertilized treatment. Nitrogen in the form of urea had been applied on October 18, 1978, prior to plowing to provide 110 lbs/acre of N. Lasso (2 lbs/acre) and Bladex (2.2 lbs/acre) were applied broadcast on May 18, 1979.

## III. Soil Sampling and Analysis

### A. 1978 Measurements

The results of some of the analyses of the soil samples collected to a depth of 10 feet are given in Table 4.

1. $NO_3$-N - In general there was a decrease of $NO_3$-N at most depths compared to one year earlier. There was again an increase in both $NO_3$-N level and depth of $NO_3$-N penetration as manure rates increased. Downward movement of $NO_3$-N was minimal, but was apparent in most manure treatments.

2. Chloride - There was some downward movement of chloride.

3. Electrical conductivity - There was some increase in the 3rd and 4th foot, but the increases did not occur in all treatments.

4. Available P - All manure treatments except LB1 had significantly higher P levels than the fertilized treatment.

5. Extractable K - All manure treatments had increased the soil K levels.

B. 1979 Measurements

$NO_3$-N was the only variable measured in 1979. The values shown in Table 5 indicate small but inconsistent changes in the manure treatments.

IV. Plant Tissue Analysis

A. 1978 Harvest Samples (Table 6)

Stover from all manure treated plots had significantly higher P and K levels and lower Mg levels than FE. The N level of the SB3 treatment was significantly higher than the FE treatment. The Ca levels were decreased slightly by the manure treatments. The N level in the grain on the manure treatments was not significantly different than on the fertilized treatment.

B. 1979 Samples

1. Corn leaves at silking (Table 7)

All manure treatments except LB1 had significantly higher levels of P and K than the fertilized treatment. Nitrogen levels were adequate and increased with higher rates of manure. The levels of Ca and Mg in general decreased with increasing manure. Zinc levels in the SB1, LB1, LB2 and LB3 treatments were significantly lower than in the fertilized treatment.

2. Samples were taken at harvest, but analyses is not complete.

V. Field and Plant Measurements - 1979 (Table 8)

A. Early plant height - All manure treatments were significantly taller than the fertilized check.

B. Early plant dry weight - All manure treatments except LB1 had larger plants than the fertilized treatment.

C. Ear moisture - All manure treatments were significantly drier than FE.

D. Grain yield - All manure treatments yielded more than the fertilized treatment, but only SB1 and LB2 were significantly higher yielding.

E. Silage yield - There were no significant differences in silage yield between the fertilized treatment and the manure treatments.

## VI. Summary

Solid beef manure or liquid beef manure have been applied annually in the fall (except 1977) at 3 rates to continuous corn. There have been significant increases and decreases in many of the essential elements in the ear leaf tissue, corn stover, and corn grain. The manure applications in general have given corn grain and silage yields equivalent to where recommended rates of fertilizer were applied annually. After 6 years (fall 1978) there was considerable movement of $NO_3^-$ and $Cl^-$ below the rooting depth of corn.

To date this research indicates that an annual application of solid beef manure at 9.0 tons/acre/year (dry weight) or liquid beef manure at 1.6 tons/acre/year (dry weight) was more than adequate to produce corn grain yields equivalent to those where recommended rates of inorganic fertilizer were applied. Application of higher rates of each manure did not result in higher yields, but did result in higher than normal P and K levels in the ear leaves and substantial $NO_3$-N buildup and leaching below the rooting depth of corn. Therefore, the maximum recommended rates of application of these two manures to continuous corn under conditions in western Minnesota would appear to be at the lowest levels used in this experiment. In fact, the solid beef manure could probably be applied at a rate somewhat less than 9.0 tons/acre/year.

Table 1. Actual amounts of manure applied in the fall of 1978.

| Treatment | Dry Weight | Wet Weight |
|---|---|---|
| | - tons/acre - | |
| SB1 | 12.737 | 33.333 |
| SB2 | 25.473 | 66.667 |
| SB3 | 38.210 | 100.000 |
| LB1 | 1.721 | 18.844 |
| LB2 | 3.441 | 37.687 |
| LB3 | 5.162 | 56.531 |

Table 2. Average* analysis of manure samples applied in the fall of 1978.

| Measurement | Unit† | Type of Manure SB | LB |
|---|---|---|---|
| pH | - | 7.1 | 5.9 |
| Total solids | % | 39.29 | 9.131 |
| Total Kjeldahl N | % | 2.894 | 5.384 |
| $NH_4^+$-N | % | 1.154 | 2.922 |
| Organic N | % | 1.740 | 2.462 |
| Emission Spectrograph | | | |
| P | % | .79 | 1.27 |
| K | % | 1.94 | 2.06 |
| Ca | % | 1.37 | 1.76 |
| Mg | % | .56 | 1.22 |
| Na | % | .12 | .29 |
| Fe | ppm | 2097 | 1032 |
| Al | ppm | 1381 | 271 |
| Mn | ppm | 249 | 356 |
| Zn | ppm | 148 | 284 |
| Cu | ppm | 10 | 15 |
| B | ppm | 15 | 25 |

* Values based on 2 samples of SB and 3 samples of LB manure.

† Dry weight basis.

Table 3. Nutrients applied in 1978 for the 1979 crop year.

| Element | Treatment SB1 | SB2 | SB3 | LB1 | LB2 | LB3 |
|---|---|---|---|---|---|---|
| | - lbs/acre - | | | | | |
| Total Kjeldahl N | 737 | 1474 | 2212 | 185 | 371 | 556 |
| $NH_4$-N | 294 | 588 | 882 | 101 | 201 | 302 |
| Org-N | 443 | 886 | 1330 | 85 | 169 | 254 |
| P | 201 | 402 | 604 | 44 | 87 | 131 |
| K | 494 | 988 | 1070 | 71 | 142 | 213 |
| Ca | 349 | 698 | 1047 | 61 | 121 | 182 |
| Mg | 143 | 285 | 428 | 42 | 84 | 126 |
| Na | 31 | 61 | 92 | 10 | 20 | 30 |
| Fe | 53 | 107 | 160 | 3.6 | 7.1 | 10.7 |
| Al | 35 | 70 | 106 | 0.9 | 1.9 | 2.8 |
| Mn | 6.3 | 12.7 | 19.0 | 1.2 | 2.5 | 3.7 |
| Zn | 3.8 | 7.5 | 11.3 | 1.0 | 2.0 | 2.9 |
| Cu | 0.2 | 0.5 | 0.8 | 0.05 | 0.10 | 0.15 |
| B | 0.4 | 0.8 | 1.1 | 0.09 | 0.17 | 0.26 |

Table 4. Effect of two types of beef manure and commercial fertilizer on the $NO_3$-N, Cl, P, and K levels and electrical conductivity of a Tara soil profile - fall 1978.

| Depth | Treatment | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CK | FE | SB1 | SB2 | SB3 | LB1 | LB2 | LB3 |
| - ft - | | | | $NO_3$-N, ppm | | | | |
| 0-1 | 5.1 | 9.3 | 15.5 | 32.9 | 58.5 | 9.2 | 13.6 | 17.5 |
| 1-2 | 2.1 | 50.1 | 57.5 | 153.4 | 121.3 | 24.9 | 116.0 | 126.8 |
| 2-3 | 3.0 | 80.3 | 102.4 | 202.5 | 208.2 | 91.6 | 104.6 | 205.8 |
| 3-4 | 6.1 | 49.9 | 33.7 | 140.4 | 166.8 | 33.8 | 64.3 | 114.2 |
| 4-5 | 6.9 | 20.4 | 13.8 | 26.9 | 101.4 | 13.6 | 45.9 | 36.1 |
| 5-6 | 6.0 | 10.6 | 7.3 | 10.1 | 63.2 | 8.4 | 23.2 | 19.4 |
| 6-7 | 5.7 | 8.2 | 6.7 | 21.5 | 37.5 | 7.5 | 11.2 | 12.8 |
| 7-8 | 5.3 | 7.7 | 6.4 | 9.0 | 22.1 | 5.5 | 6.9 | 7.3 |
| 8-9 | 4.5 | 7.1 | 6.1 | 7.7 | 13.9 | 4.5 | 5.8 | 6.7 |
| 9-10 | 4.0 | 5.9 | 4.0 | 6.4 | 8.6 | 4.0 | 5.6 | 5.1 |
| | | | | Chloride, ppm | | | | |
| 0-1 | 16.5 | 7.2 | 15.0 | 24.6 | 33.4 | 21.9 | 8.4 | 37.9 |
| 1-2 | 5.6 | 15.9 | 46.2 | 79.1 | 40.6 | 16.0 | 56.4 | 36.5 |
| 2-3 | 13.9 | 29.0 | 143.0 | 228.7 | 138.1 | 78.2 | 51.8 | 107.5 |
| 3-4 | 11.1 | 21.2 | 62.0 | 212.0 | 142.5 | 35.1 | 51.2 | 124.5 |
| 4-5 | 8.8 | 12.5 | 20.5 | 60.0 | 78.5 | 17.3 | 37.8 | 58.3 |
| 5-6 | 9.9 | 7.5 | 14.1 | 17.0 | 59.8 | 10.1 | 21.6 | 28.5 |
| 6-7 | 6.5 | 16.6 | 13.6 | 33.5 | 37.1 | 8.7 | 13.9 | 22.3 |
| 7-8 | 7.6 | 6.3 | 11.4 | 8.4 | 27.2 | 7.1 | 8.8 | 15.1 |
| 8-9 | 7.9 | 4.3 | 8.9 | 6.5 | 14.3 | 8.8 | 8.1 | 10.3 |
| 9-10 | 11.8 | 4.5 | 9.8 | 6.4 | 7.6 | 4.7 | 6.4 | 7.0 |
| | | | | E. C., mmhos/cm | | | | |
| 0-1 | .164 | .245 | .269 | .352 | .520 | .229 | .257 | .219 |
| 1-2 | .237 | .411 | .497 | .512 | .721 | .326 | .647 | .676 |
| 2-3 | .328 | .506 | .730 | 1.157 | 1.089 | .632 | .608 | .970 |
| 3-4 | .234 | .385 | .387 | .862 | .935 | .332 | .438 | .624 |
| 4-5 | .217 | .267 | .261 | .331 | .659 | .236 | .373 | .317 |
| 5-6 | .214 | .239 | .223 | .269 | .475 | .239 | .290 | .247 |
| 6-7 | .203 | .241 | .226 | .297 | .362 | .229 | .260 | .223 |
| 7-8 | .223 | .219 | .241 | .252 | .275 | .222 | .229 | .219 |
| 8-9 | .230 | .214 | .242 | .276 | .265 | .221 | .238 | .216 |
| 9-10 | .269 | .139 | .243 | .266 | .224 | .197 | .262 | .210 |
| | | | | Available P, ppm | | | | |
| 0-1 | 7.1 | 10.4 | 55.4 | 73.9 | 59.9 | 12.0 | 45.6 | 72.4 |
| | | | | Extractable K, ppm | | | | |
| 0-1 | 139 | 133 | 295 | 486 | 994 | 161 | 227 | 259 |

Table 5. Effect of two types of beef cattle manure and commercial fertilizer on the $NO_3$-N level of a Tara soil profile - fall 1979.

| Depth | Treatment | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CK | FE | SB1 | SB2 | SB3 | LB1 | LB2 | LB3 |
| - ft - | - $NO_3$-N, ppm - | | | | | | | |
| 0-1 | 4.4 | 7.0 | 15.9 | 48.6 | 82.6 | 4.9 | 9.8 | 48.2 |
| 1-2 | 1.5 | 17.9 | 62.7 | 152.0 | 164.3 | 23.9 | 72.8 | 194.0 |
| 2-3 | 1.7 | 28.4 | 72.7 | 171.7 | 138.9 | 51.5 | 78.6 | 142.7 |
| 3-4 | 5.1 | 32.7 | 54.5 | 134.0 | 136.7 | 28.0 | 50.1 | 95.9 |

Table 6. Summary of analysis of stover and grain samples - 1978.

| Treatment | Stover | | | | | | | | | | | Grain |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | P | K | Ca | Mg | Fe | Zn | Cu | Mn | B | Cl | N |
| | % | | | | | ppm | | | | | | - % - |
| CK | .64 | .06 | 1.10 | .37 | .49 | 254 | 9.6 | 3.9 | 43 | 5.8 | 2517 | 1.59 |
| FE | .94 | .06 | 1.37 | .44 | .52 | 310 | 14.9 | 4.8 | 66 | 5.5 | 3883 | 1.82 |
| SB1 | .79 | .23 | 2.04 | .35 | .32 | 352 | 11.1 | 4.4 | 59 | 5.1 | 3880 | 1.81 |
| SB2 | .94 | .36 | 2.66 | .39 | .26 | 311 | 7.0 | 2.9 | 58 | 5.4 | 3070 | 1.85 |
| SB3 | 1.16 | .44 | 2.84 | .33 | .22 | 291 | 9.6 | 3.1 | 53 | 5.0 | 2423 | 1.86 |
| LB1 | .75 | .12 | 1.59 | .41 | .39 | 312 | 8.3 | 4.6 | 61 | 5.4 | 3537 | 1.80 |
| LB2 | .80 | .19 | 1.87 | .35 | .34 | 294 | 6.8 | 4.7 | 56 | 5.8 | 2737 | 1.81 |
| LB3 | .88 | .26 | 2.36 | .40 | .30 | 363 | 6.9 | 3.5 | 68 | 5.6 | 2850 | 1.92 |
| Significance: | ** | ** | ** | * | ** | NS | + | NS | NS | NS | NS | * |
| BLSD(.05): | .19 | .07 | .37 | .07 | .09 | - | - | - | - | - | - | .18 |

Table 7. Summary of analysis of corn leaves at silking - 1979.

| Treatment | N | P | K | Ca | Mg | Fe | Zn | Cu | Mn | B |
|---|---|---|---|---|---|---|---|---|---|---|
| | % | | | | | ppm | | | | |
| CK | 1.60 | .21 | 1.65 | .51 | .43 | 69 | 11.1 | 2.4 | 35 | 5.3 |
| FE | 3.14 | .30 | 2.04 | .52 | .48 | 107 | 23.4 | 5.5 | 82 | 4.9 |
| SB1 | 3.11 | .45 | 2.69 | .48 | .31 | 98 | 14.4 | 5.0 | 85 | 5.6 |
| SB2 | 3.12 | .50 | 2.79 | .50 | .27 | 114 | 23.3 | 4.9 | 95 | 5.9 |
| SB3 | 3.21 | .50 | 2.78 | .43 | .22 | 109 | 27.6 | 4.4 | 83 | 5.7 |
| LB1 | 2.79 | .34 | 2.18 | .50 | .37 | 95 | 15.3 | 4.8 | 66 | 4.6 |
| LB2 | 3.18 | .51 | 2.46 | .56 | .41 | 109 | 13.5 | 4.8 | 102 | 5.4 |
| LB3 | 3.25 | .54 | 2.75 | .53 | .34 | 114 | 17.6 | 3.9 | 102 | 6.0 |
| Significance: | ** | ** | ** | * | ** | ** | ** | ** | ** | NS |
| BLSD(.05): | .21 | .06 | .21 | .07 | .05 | 9 | 3.9 | 1.4 | 22 | - |

Table 8. Summary of plant measurements - 1979.

| Treatment | Early plant height inches | Early plant (10) dry wt. grams | Grain: Ear moisture at harvest % | Grain: Yield @ 15.5% M. bu/A | Silage: Dry matter at harvest % | Silage: Silage yield (D.M.) lb/A | Silage: Ear wt. ÷ silage wt. % |
|---|---|---|---|---|---|---|---|
| CK | 16.0 | 26.9 | 33.6 | 41.1 | 35.2 | 9043 | 47.1 |
| FE | 21.6 | 48.3 | 27.5 | 89.5 | 36.7 | 13772 | 44.3 |
| SB1 | 28.4 | 67.8 | 20.2 | 108.9 | 38.0 | 14199 | 46.5 |
| SB2 | 28.3 | 72.8 | 18.5 | 95.5 | 39.1 | 13966 | 49.3 |
| SB3 | 27.8 | 74.2 | 21.4 | 106.7 | 29.2 | 12155 | 34.0 |
| LB1 | 24.1 | 49.9 | 24.5 | 102.6 | 38.0 | 13125 | 48.6 |
| LB2 | 27.5 | 61.8 | 23.1 | 114.3 | 37.0 | 15472 | 50.5 |
| LB3 | 27.2 | 67.4 | 21.2 | 100.4 | 38.9 | 13859 | 46.1 |
| Significance: | ** | ** | ** | ** | + | * | NS |
| BLSD(.05): | 1.8 | 12.7 | 2.9 | 18.2 | - | 3083 | - |

# RESIDUAL EFFECT OF HEAVY APPLICATIONS OF ANIMAL MANURES ON CORN GROWTH AND YIELD AND ON SOIL PROPERTIES

West Central Experiment Station - Morris

S. D. Evans, P. R. Goodrich, R. C. Munter, and R. E. Smith

The experiment initiated in 1970 was continued. Treatments and results in previous years are given in Soil Series 88, 89, 91, 95, 97, 99, 103, and 105. Manure was applied in 1970 and 1971 only. Fertilizer has been applied to the fertilized checks each year.

## I. Planting Information

Twenty-four rows of corn (var. Dekalb XL12) were planted in each plot on May 17, 1979. Lorsban @ 8.8 lbs/acre (1 lb/acre active ingredient) was applied to the entire area. Starter fertilizer consisting of 154 lbs/acre of 10-26-26 was applied to the fertilized treatment only. Nitrogen in the form of urea was applied to the fertilized plots to provide 110 lbs/acre of N on October 18, 1978. Lasso (2 lbs/acre) and Bladex (2.2 lbs/acre) were applied broadcast on May 18, 1979.

## II. Soil Sampling and Analysis

### A. 1978 Measurements

The results of some of the analyses of the soil samples collected to a depth of 16 feet are given in Table 1.

1. $NO_3$-N - Levels in the top foot were similar to one year before, but levels from 1 to 4 feet changed. The maximum level in the SB and LH treatments was in the 3- to 4-foot zone, while that in the LB treatment remained in the 2- to 3-foot zone. Levels in the 4- to 6-foot zone for all treatments except CK had increased since the last measurements in 1975. Below this depth there were no large increases or decreases.

2. Chloride - Levels in the top 3 feet of the manure treatments decreased, while the level in the 4th foot increased. Below 4 feet chloride levels had not changed greatly since 1975, but there appeared to be some downward movement.

3. Electrical conductivity - The conductivity of the 2- to 3-foot zone decreased and the 3- to 4-foot zone increased compared to one year earlier.

4. Available P - Levels in all the manure treatments were almost identical and 3 times those in the fertilized treatment.

5. Extractable K - Levels in all the manure treatments were much higher than FE and very similar to one year earlier.

B. 1979 Measurements

$NO_3$-N was the only soil variable measured in 1979. The values shown in Table 2 indicate that levels in the beef manure treated plots were still higher than in the fertilized plot. The total $NO_3$-N in the top 4 feet of soil decreased for all treatments.

## III. Plant Tissue Analysis

A. 1978 Harvest Samples (Table 3)

Stover from the manure treated plots had significantly higher P and K levels and lower Mg and Cl levels than stover from the fertilized plots.

B. 1979 Samples

1. Corn leaves at silking (Table 4)

All manure treatments had higher K and lower Mg and Zn levels than the fertilized treatment. The SB and LB treatments had higher P levels than FE.

2. Samples were taken at harvest but analysis is not complete.

## IV. Field and Plant Measurements - 1979 (Table 5)

A. Early plant height and dry matter - All manure treatments had values equal to or larger than the fertilized check.

B. Grain yield - The solid beef treatment yielded significantly more than all other treatments. Yields of FE, LB, and LH were not significantly different.

C. Silage yield - Yields of FE, SB, and LB were not significantly different but were all higher than LH and CK. The LH treatment was significantly higher yielding than CK.

## V. Summary

The effects of the manure treatments applied in 1970 and 1971 are still quite evident in most soil and plant measurements. The $NO_3$-N in the soil has moved down slightly in the soil profile. Plant analysis in the fall of 1978 and summer of 1979 show large effects of the manure treatments.

In 1979 grain yields on the manure treatments were equal to or higher than the fertilized treatment. The silage yield on the LH treatment had decreased to a point where it was significantly lower than the beef manure and fertilized treatments.

Table 1. Effect of high rates of manure and commercial fertilizer eight years (fall 1978) after application on the $NO_3$-N, Cl, P, and K levels and electrical conductivity of a Tara soil profile.

| Depth - ft - | Treatment* CK | FE | SB | LB | LH |
|---|---|---|---|---|---|
| | - $NO_3$-N, ppm - | | | | |
| 0-1 | 4.1 | 7.4 | 13.9 | 17.2 | 8.2 |
| 1-2 | 1.0 | 20.7 | 25.3 | 76.9 | 15.0 |
| 2-3 | 2.7 | 72.9 | 96.9 | 164.3 | 74.1 |
| 3-4 | 4.4 | 36.2 | 116.4 | 145.6 | 61.8 |
| 4-6 | 6.5 | 10.9 | 65.4 | 93.3 | 34.3 |
| 6-8 | 6.3 | 3.6 | 28.9 | 45.4 | 21.2 |
| 8-10 | 3.5 | 2.8 | 15.8 | 32.8 | 12.7 |
| 10-12 | 2.7 | 2.3 | 7.4 | 21.6 | 7.8 |
| 12-14 | 2.8 | 2.8 | 7.1 | 10.5 | 4.8 |
| 14-16 | 2.3 | 3.0 | 5.5 | 10.6 | 3.9 |
| | - Chloride, ppm - | | | | |
| 0-1 | 5.0 | 12.4 | 15.3 | 5.5 | 12.3 |
| 1-2 | 0.1 | 8.5 | 20.9 | 27.7 | 13.2 |
| 2-3 | 2.5 | 44.9 | 86.8 | 112.7 | 46.1 |
| 3-4 | 1.1 | 27.2 | 152.7 | 119.4 | 44.7 |
| 4-6 | 3.5 | 8.1 | 110.0 | 86.2 | 24.4 |
| 6-8 | 1.7 | 1.0 | 71.8 | 45.8 | 14.2 |
| 8-10 | 0.4 | 0.1 | 38.0 | 36.8 | 7.0 |
| 10-12 | 0.8 | 0.3 | 13.8 | 20.9 | 17.8 |
| 12-14 | 0.2 | 0.1 | 12.5 | 10.2 | 2.0 |
| 14-16 | 2.7 | 0.2 | 7.3 | 10.6 | 14.5 |
| | - E.C., mmhos/cm - | | | | |
| 0-1 | .175 | .132 | .254 | .243 | .143 |
| 1-2 | .177 | .290 | .336 | .544 | .222 |
| 2-3 | .202 | .537 | .624 | .906 | .484 |
| 3-4 | .182 | .338 | .710 | .791 | .420 |
| 4-6 | .190 | .217 | .500 | .580 | .296 |
| 6-8 | .178 | .181 | .335 | .365 | .246 |
| 8-10 | .180 | .175 | .262 | .326 | .208 |
| 10-12 | .179 | .184 | .197 | .296 | .198 |
| 12-14 | .191 | .230 | .207 | .292 | .191 |
| 14-16 | .225 | .296 | .220 | .287 | .205 |
| | - Available P, ppm - | | | | |
| 0-1 | 2.8 | 24.0 | 74.8 | 73.7 | 71.9 |
| | - Extractable K, ppm - | | | | |
| 0-1 | 118 | 134 | 462 | 353 | 225 |

* CK = CHECK, FE = FERTILIZED, SB = SOLID BEEF MANURE, LB = LIQUID BEEF MANURE, LH = LIQUID HOG MANURE.

Table 2. Effect of high rates of manure and commercial fertilizer nine years (fall 1979) after application on the $NO_3$-N level of a Tara soil profile.

| Depth - ft - | Treatment CK | FE | SB | LB | LH |
|---|---|---|---|---|---|
| | - $NO_3$-N, ppm | | | | |
| 0-1 | 2.7 | 6.0 | 6.4 | 12.0 | 5.5 |
| 1-2 | 0.6 | 22.4 | 27.2 | 72.0 | 15.5 |
| 2-3 | 0.6 | 50.2 | 88.9 | 139.6 | 56.6 |
| 3-4 | 2.3 | 32.1 | 54.2 | 104.9 | 38.0 |

Table 3. Summary of analysis of stover and grain samples - 1978.

| Treatment | Stover N | P | K | Ca | Mg | Fe | Zn | Cu | Mn | B | Cl | Grain N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | | | | | ppm | | | | | | % |
| CH | .49 | .04 | .80 | .46 | .59 | 515 | 12.8 | 2.9 | 62 | 5.0 | 1890 | 1.43 |
| FE | .78 | .06 | 1.39 | .45 | .52 | 597 | 13.4 | 4.6 | 67 | 5.6 | 4213 | 1.79 |
| SB | .81 | .22 | 2.15 | .40 | .30 | 582 | 8.4 | 4.8 | 78 | 5.8 | 2707 | 1.77 |
| LB | .86 | .25 | 2.40 | .41 | .26 | 486 | 8.0 | 3.8 | 73 | 6.1 | 1403 | 1.79 |
| LH | .67 | .12 | 1.97 | .40 | .33 | 461 | 8.8 | 4.3 | 67 | 5.5 | 2947 | 1.73 |
| Signif.: | ** | ** | ** | NS | ** | NS | NS | * | NS | NS | ** | ** |
| BLSD(.05): | .15 | .05 | .33 | - | .12 | - | - | 1.0 | - | - | 1174 | .13 |

Table 4. Summary of analysis of corn leaves at silking - 1979.

| Treatment | N | P | K | Ca | Mg | Fe | Zn | Cu | Mn | B |
|---|---|---|---|---|---|---|---|---|---|---|
| | % | | | | | ppm | | | | |
| CK | 1.20 | .15 | 1.26 | .38 | .31 | 52 | 7.8 | 1.6 | 24 | 4.8 |
| FE | 3.00 | .29 | 1.68 | .50 | .47 | 98 | 20.8 | 3.1 | 64 | 4.5 |
| SB | 2.81 | .40 | 2.10 | .48 | .28 | 89 | 12.8 | 3.0 | 64 | 3.3 |
| LB | 2.89 | .47 | 2.32 | .51 | .27 | 102 | 13.1 | 3.0 | 67 | 3.8 |
| LH | 2.45 | .30 | 2.07 | .50 | .31 | 83 | 16.3 | 2.9 | 54 | 4.4 |
| Significance: | ** | ** | ** | * | ** | ** | ** | ** | ** | NS |
| BLSD(.05): | .35 | .08 | .24 | .11 | .09 | 11 | 1.7 | .5 | 15 | - |

Table 5. Summary of plant measurements - 1979.

| Treatment | Early plant height inches | Early plants (10) dry wt. grams | Grain: Ear moisture at harvest % | Grain: Yield @ 15.5% M. bu/A | Silage: Dry matter at harvest % | Silage: Silage yield (D.M.) lb/A | Silage: Ear wt. ÷ silage wt. % |
|---|---|---|---|---|---|---|---|
| CK | 14.9 | 25.5 | 34.0 | 21.8 | 31.4 | 4991 | 22.7 |
| FE | 23.3 | 51.8 | 24.9 | 100.6 | 36.2 | 12675 | 45.9 |
| SB | 25.3 | 57.4 | 20.4 | 129.1 | 39.8 | 13899 | 49.5 |
| LB | 27.3 | 63.7 | 21.3 | 92.1 | 38.3 | 13803 | 50.7 |
| LH | 23.8 | 54.0 | 26.8 | 94.2 | 33.6 | 10884 | 48.1 |
| Significance: | ** | ** | ** | ** | ** | ** | ** |
| BLSD(.05) | 2.3 | 7.7 | 2.6 | 8.8 | 3.1 | 1085 | 8.0 |

# INFLUENCE OF NITROGEN FERTILIZATION ON FORAGE PRODUCTION AND NITROGEN UTILIZATION BY THREE SMALL GRAIN VARIETIES*

G.L. Malzer and S. Evans

The semi-dwarf varieties of hard red spring wheat account for the major portion of acreage in Minnesota planted to hard red wheat. The advent of these short stemmed wheat varieties not only provided improved physical characteristics and a high yield potential, but also provided a plant system which was capable of responding to higher application rates of nitrogen without lodging. The reasons why some semi-dwarf wheat varieties appear to be more responsive to nitrogen application is not well understood, but it has been suggested that it may be an inter-relationship of a highly efficient rooting system along with it's above ground physical characteristics. An experiment was established to investigate the root growth characteristics of different hard red spring wheat varieties as influenced by nitrogen application and to assess if below ground parameters could be used in the selection of small grain varieties for efficient nitrogen utilization.

## EXPERIMENTAL PROCEDURES

Six treatments including three hard red spring wheat varieties were combined with two nitrogen treatments into a randomized complete block design with three replications and the plots established at the West Central Experiment Station at Morris. The three wheat varieties included Chris (medium height), Era (Semi-dwarf), and Mn 7125 (Experimental Semi-dwarf). The nitrogen treatments included either zero or 120 =N/A as ammonium nitrate applied as a spring preplant incorporated treatment.

Dry matter production was determined at three different times during plant growth and analyzed for nutrient composition. Grain was harvested on August 17 by hand harvesting known areas from each plot. Soil samples were obtained at the four samplings above (July 2, July 11, July 30, and August 17) for determination of rooting density, soil moisture and soil nitrate nitrogen. Root samples were obtained utilizing a coring technique. For root analysis, samples were collected over the row and between the row to a depth of four feet. Each core (2 5/8" diameter) was divided into eight 6" increments and each sample consisted of a composite of two cores. The root samples at this time are in the process of being analyzed. Soil samples for moisture and nitrate analysis were taken in a similar manner by obtaining one core in the immediate area from which the root samples were obtained.

## GENERAL RESULTS

Preliminary nitrate soil tests indicated a very low nitrate nitrogen content in the 0-2' depth. Appreciable quantities of nitrate nitrogen were present in the 2-4' depth in 1979. Significant dry matter production increases were obtained due to nitrogen application with both Chris and MN 7125 through all three forage harvests. Era wheat showed no dry matter increase to the application of fertilizer nitrogen at any sampling date. There was no difference between varieties when no fertilizer nitrogen had been applied. Era, however, produced significantly less forage than Chris or MN 7125 when nitrogen was applied. Nitrogen content (%) in the

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*This project was financed through support in part by Minnesota Wheat Council.

forage was increased in all three varieties due to nitrogen fertilization with differences being the most evident with early plant growth. Again, variety differences were more apparent at the high nitrogen level than on the control. Era had the highest nitrogen content under high fertility, but this carried through only to the second sampling. Nitrogen removal with the forage reflected mainly the nitrogen fertilization, although some differences were found between varieties with nitrogen treatments. Only MN 7125 produced a significant improvement in grain yield with nitrogen application. Protein (N content) of the grain increased with nitrogen fertilization on Chris and Era, but not MN 7125. Chris, as expected, had the highest protein content, although under low fertility all three varieties were similar. Nitrogen application depressed grain test weight for all three varieties tested.

Table 1. Forage yield, forage N content, total forage nitrogen removal, and yield grain characteristics of three small grain varieties as influenced by nitrogen treatment.

| Treatment | | Forage Yield | | | Forage N Content | | |
|---|---|---|---|---|---|---|---|
| | | Harvest No. | | | Harvest No. | | |
| Variety | N Rate | 1 | 2 | 3 | 1 | 2 | 3 |
| | #/A | --------T/A--------- | | | ----------%---------- | | |
| Chris | 0 | 0.92 | 1.50 | 2.24 | 2.62 | 1.77 | 1.39 |
| Chris | 120 | 1.22 | 1.91 | 2.86 | 2.99 | 2.23 | 1.33 |
| MN 7125 | 0 | 0.83 | 1.42 | 2.16 | 2.44 | 1.92 | 1.28 |
| MN 7125 | 120 | 1.12 | 1.76 | 2.65 | 3.13 | 2.35 | 1.49 |
| Era | 0 | 0.84 | 1.45 | 1.93 | 2.67 | 2.10 | 1.53 |
| Era | 120 | 0.86 | 1.57 | 2.15 | 3.58 | 2.62 | 1.55 |
| Signif. | | ** | ** | ** | ** | ** | ** |
| BLSD(.05) | | 0.14 | 0.17 | 0.34 | 0.21 | 0.15 | 0.13 |

| | | Forage N Removal | | | | | Harvest | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Grain Yield | Straw Yield | N Content Grain | N Content Straw | N Removal Grain | N Removal Straw | Test Wt. |
| | | ---------#/A-------- | | | bu/A | T/A | -----%----- | | ----#/A---- | | #/bu |
| Chris | 0 | 48.3 | 53.0 | 62.4 | 33.4 | 1.73 | 2.39 | 0.43 | 44.3 | 14.7 | 57.2 |
| Chris | 120 | 72.5 | 84.8 | 75.8 | 33.8 | 2.34 | 2.88 | 0.71 | 54.3 | 33.2 | 54.9 |
| MN 7125 | 0 | 40.3 | 54.7 | 55.4 | 34.1 | 1.48 | 2.52 | 0.57 | 47.9 | 16.8 | 57.1 |
| MN 7125 | 120 | 69.6 | 82.8 | 78.9 | 45.0 | 1.97 | 2.51 | 0.75 | 63.1 | 29.7 | 55.0 |
| Era | 0 | 44.5 | 61.2 | 59.3 | 31.0 | 1.49 | 2.43 | 0.69 | 42.1 | 20.4 | 56.3 |
| Era | 120 | 62.0 | 82.0 | 66.9 | 34.9 | 1.85 | 2.62 | 0.80 | 51.0 | 29.7 | 54.3 |
| Signif. | | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| BLSD(.05) | | 8.6 | 8.5 | 10.9 | 5.5 | 0.20 | 0.22 | 0.07 | 10.4 | 3.1 | 1.2 |

# NITROGEN FERTILIZATION AND NITROGEN UTILIZATION BY SEVEN SMALL GRAIN VARIETIES - Morris, MN. - 1979*

G.L. Malzer, S. Evans, and R. Busch

The Semi-dwarf varieties of hard red spring wheat account for a major portion of the acreage planted to hard red spring wheat in Minnesota. These short statured varieties not only provided improved physical characteristics, but also provided the potential for a system which might be capable of responding to higher rates of nitrogen application without lodging. The difference that exist between wheat varieties in their ability to utilize soil and fertilizer nitrogen is not well understood. A portion of the differences which exist may be due to the genetic ability of the plant because of some favorable plant characteristic either above or below the soil surface. If selection of plant genotypes can be made for more effective nitrogen uptake and utilization, advancements may be made in increasing present yield levels as well as improving the overall protein content of the grain. Trials were established in 1979 to examine some of the differences which exist between wheat varieties in their response to fertilizer nitrogen and their ability to utilize existing soil nitrogen. Existing popular varieties as well as older varieties and experimental varieties were included for comparison. Similar trails were conducted at Crookston as well as Morris, MN.

## EXPERIMENTAL PROCEDURES

Seven varieties of hard red spring wheat were compared at nitrogen application rates of 0, 60, and 120# N/A at the West Central Experiment Station at Morris. Nitrogen was applied as spring applications of ammonium nitrate broadcast and incorporated. The treatments were arranged in a split plot design with nitrogen as the main effect and the seven varieties planted within a uniformly fertilized area. All treatments were replicated three times. Experimental plots were planted into areas 4' x 20' on May 14th.

Total plant dry matter was measured at approximately the "soft dough" stage of growth (July 30th) and samples collected for nitrogen content and calculation of nitrogen uptake. Yield grain was harvested on August 17th by harvesting 16 ft.$^2$ of the plot area. The above ground growth (straw + grain) was removed from the experimental plot area, allowed to air dry in a forced air dryer. The samples were then weighed, thrashed and the grain reweighed for yield determination. Straw weights were determined by difference. Samples of straw and grain were collected and analyzed for nitrogen content and determination of nitrogen removal. Lodging scores were obtained from the experimental treatments at harvest time. Lodging rankings were made on a 1-5 scale with a ranking of one having excellent standing characteristics and a rating of five being flat on the soil surface.

## GENERAL RESULTS

Grain yields ranged from 25-40 bu/A with no significant yield response attributed to nitrogen fertilization. Nitrogen fertilization did increase protein content in the grain and there was a trend toward increased total nitrogen uptake (forage). Major differences were obtained between varities not only in yield but also in most of the nitrogen utilization characteristics. James was the highest yielding variety with Coteau somewhat lower but still better than the remaining varities. Similar yields were obtained with WS 1809, Era, MN 70170, Chris and Waldron. James, the highest yielding variety was intermediate in protein content when compared to the

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*This project was financed through support in part by Minnesota Wheat Council.

other varieties. The lowest protein contents were obtained with Era and MN 70170, while the highest protein contents were obtained with Coteau, WS 1809 and Chris. Differences were also obtained between varieties in total nitrogen uptake, nitrogen removal in the grain, and nitrogen remaining in the straw. Similar to the results obtained at Crookston, nitrogen had no influence on the lodging score and variations that were encountered could be accounted for because of the varieties.

Data thus far would suggest that the variety and the genetic potential of our plant system must be considered when evaluating nitrogen utilization. Evidence would suggest that selection of varieties on the basis of nitrogen utilization characteristics may be possible. More information in this area is needed.

Table 1. Influence of nitrogen fertilization and variety on yield, N content, test weight, and lodging of seven hard red spring wheat varieties.

| Nitrogen Rate | Variety | Grain Yield | Grain N content | Grain Test wt. | Forage Total Dry Matter | Forage N content | Forage Lodging Score |
|---|---|---|---|---|---|---|---|
| #/A | | bu/A | % | #/bu | T/A | % | |
| 0 | - | 29.8 | 2.62 | 54.0 | 2.25 | 1.36 | 2.0 |
| 60 | - | 30.8 | 2.70 | 52.3 | 2.37 | 1.46 | 2.4 |
| 120 | - | 32.6 | 2.77 | 51.9 | 2.56 | 1.51 | 2.2 |
| Significance | | NS | + | * | NS | * | NS |
| BLSD(.05) | | - | .11 | 1.3 | - | 0.11 | - |
| - | Coteau | 36.4 | 2.89 | 56.8 | 2.77 | 1.37 | 2.1 |
| - | WS 1809 | 29.5 | 2.79 | 52.7 | 2.12 | 1.45 | 2.4 |
| - | Era | 29.7 | 2.55 | 52.0 | 2.33 | 1.58 | 2.1 |
| - | MN 70170 | 26.0 | 2.55 | 50.1 | 2.11 | 1.56 | 2.0 |
| - | Chris | 28.7 | 2.79 | 54.2 | 2.47 | 1.36 | 2.8 |
| - | James | 40.1 | 2.68 | 52.4 | 2.60 | 1.41 | 2.1 |
| - | Waldron | 27.0 | 2.68 | 51.0 | 2.33 | 1.40 | 2.0 |
| Significance | | ** | ** | ** | ** | ** | ** |
| BLSD(.05) | | 3.1 | .09 | 1.1 | 0.14 | 0.07 | 0.4 |
| 0 | Coteau | 34.8 | 2.95 | 57.4 | 2.71 | 1.35 | 2.0 |
| 0 | WS 1809 | 26.9 | 2.52 | 53.6 | 1.99 | 1.34 | 2.0 |
| 0 | Era | 28.3 | 2.55 | 54.2 | 2.27 | 1.48 | 2.0 |
| 0 | MN 70170 | 25.1 | 2.48 | 51.7 | 1.93 | 1.34 | 2.0 |
| 0 | Chris | 28.8 | 2.82 | 55.6 | 2.34 | 1.27 | 2.7 |
| 0 | James | 37.7 | 2.62 | 53.7 | 2.30 | 1.45 | 1.7 |
| 0 | Waldron | 26.7 | 2.41 | 52.0 | 2.18 | 1.33 | 2.0 |
| 60 | Coteau | 35.2 | 2.89 | 56.4 | 2.71 | 1.33 | 2.3 |
| 60 | WS 1809 | 29.9 | 2.80 | 53.4 | 2.08 | 1.46 | 2.7 |
| 60 | Era | 30.0 | 2.36 | 51.7 | 2.29 | 1.61 | 2.3 |
| 60 | MN 70170 | 25.8 | 2.52 | 49.3 | 2.11 | 1.60 | 2.0 |
| 60 | Chris | 30.0 | 2.79 | 52.8 | 2.39 | 1.37 | 2.7 |
| 60 | James | 39.6 | 2.69 | 52.0 | 2.61 | 1.34 | 2.7 |
| 60 | Waldron | 25.2 | 2.89 | 50.5 | 2.40 | 1.50 | 2.0 |
| 120 | Coteau | 39.1 | 2.85 | 56.8 | 2.89 | 1.43 | 2.0 |
| 120 | WS 1809 | 31.8 | 2.88 | 51.1 | 2.31 | 1.57 | 2.7 |
| 120 | Era | 30.7 | 2.75 | 50.2 | 2.42 | 1.64 | 2.0 |
| 120 | MN 70170 | 27.2 | 2.66 | 49.4 | 2.29 | 1.73 | 2.0 |
| 120 | Chris | 27.1 | 2.77 | 54.3 | 2.67 | 1.44 | 3.0 |
| 120 | James | 42.9 | 2.73 | 51.4 | 2.90 | 1.43 | 2.0 |
| 120 | Waldron | 29.1 | 2.75 | 50.5 | 2.40 | 1.36 | 2.0 |
| Significance | | NS | ** | NS | NS | ** | NS |
| BLSD(.05) | | - | 0.17 | - | - | 0.15 | - |

Table 2. Influence of nitrogen fertilization and variety on straw production and nitrogen uptake of forage, straw and grain of seven hard red spring wheat varieties.

| Nitrogen Rate | Variety | Harvest Straw | | Nitrogen Removal | | | |
|---|---|---|---|---|---|---|---|
| | | Dry Matter | N content | Forage | Straw | Grain | Grain + Straw |
| #/A | | T/A | % | #/A | | | |
| 0 | - | 1.46 | 0.56 | 61.3 | 16.1 | 43.7 | 59.8 |
| 60 | - | 1.59 | 0.70 | 68.9 | 22.4 | 46.5 | 68.9 |
| 120 | - | 1.81 | 0.77 | 77.1 | 27.3 | 50.4 | 77.8 |
| Significance | | NS | * | + | + | NS | NS |
| BLSD(.05) | | - | 0.13 | 12.3 | 6.9 | - | - |
| - | Coteau | 1.95 | 0.55 | 76.2 | 21.5 | 58.6 | 80.1 |
| - | WS 1809 | 1.34 | 0.75 | 62.0 | 20.6 | 45.2 | 65.8 |
| - | Era | 1.51 | 0.84 | 73.7 | 25.9 | 42.3 | 68.2 |
| - | MN 70170 | 1.46 | 0.83 | 66.1 | 24.8 | 37.0 | 61.8 |
| - | Chris | 1.77 | 0.60 | 67.3 | 21.7 | 44.6 | 66.3 |
| - | James | 1.74 | 0.59 | 73.2 | 20.7 | 60.0 | 80.7 |
| - | Waldron | 1.57 | 0.58 | 65.2 | 18.5 | 40.3 | 58.8 |
| Significance | | ** | ** | ** | ** | ** | ** |
| BLSD(.05) | | 0.07 | 0.06 | 5.6 | 2.0 | 5.3 | 5.2 |
| 0 | Coteau | 1.76 | 0.49 | 73.2 | 17.2 | 57.1 | 74.2 |
| 0 | WS 1809 | 1.19 | 0.63 | 53.0 | 15.0 | 37.9 | 52.9 |
| 0 | Era | 1.37 | 0.64 | 67.4 | 17.5 | 40.2 | 57.7 |
| 0 | MN 70170 | 1.29 | 0.69 | 51.7 | 18.1 | 34.6 | 52.7 |
| 0 | Chris | 1.55 | 0.49 | 59.0 | 15.1 | 45.2 | 60.3 |
| 0 | James | 1.57 | 0.49 | 66.6 | 15.4 | 55.1 | 70.5 |
| 0 | Waldron | 1.45 | 0.50 | 58.1 | 14.5 | 35.8 | 50.4 |
| 60 | Coteau | 1.93 | 0.53 | 72.4 | 20.8 | 56.7 | 77.5 |
| 60 | WS 1809 | 1.35 | 0.80 | 60.8 | 22.3 | 46.6 | 68.9 |
| 60 | Era | 1.54 | 0.89 | 74.2 | 28.0 | 39.4 | 67.4 |
| 60 | MN 70170 | 1.43 | 0.85 | 67.2 | 24.6 | 36.2 | 60.8 |
| 60 | Chris | 1.66 | 0.63 | 65.8 | 21.6 | 46.6 | 62.2 |
| 60 | James | 1.70 | 0.60 | 69.8 | 20.8 | 59.5 | 80.2 |
| 60 | Waldron | 1.56 | 0.60 | 72.1 | 19.0 | 40.5 | 59.5 |
| 120 | Coteau | 2.13 | 0.62 | 83.0 | 26.4 | 62.1 | 88.5 |
| 120 | WS 1809 | 1.47 | 0.82 | 72.4 | 24.4 | 51.2 | 75.5 |
| 120 | Era | 1.63 | 0.98 | 79.4 | 32.1 | 47.3 | 79.4 |
| 120 | MN 70170 | 1.67 | 0.95 | 79.3 | 31.8 | 40.4 | 72.2 |
| 120 | Chris | 2.11 | 0.68 | 77.1 | 28.5 | 42.1 | 70.6 |
| 120 | James | 1.93 | 0.67 | 83.2 | 25.9 | 65.4 | 91.3 |
| 120 | Waldron | 1.71 | 0.64 | 65.4 | 22.1 | 44.7 | 66.7 |
| Significance | | + | NS | + | NS | NS | NS |
| BLSD(.05) | | 0.15 | - | 11.3 | - | - | - |

# PESTICIDE INTERACTION PLOTS AT ROSEMOUNT

Russell S. Adams, Jr.

Carbofuran has been found to fail in several areas in the midwest. Currently intense controversy exists as to whether this failure is due to the development of resistance in the target pest or to the development of a soil microflora that more rapidly degrades it. The problem is associated with high lime or calcareous soils.

Our lab belongs to the group that believes that degrading soil microflora have developed. We have isolated three cultures that can utilize carbofuran as a sole carbon source. These organisms degrade carbofuran much more rapidly at a pH above 7.

An added bit of information that seems to implicate the soil microflora are data obtained at Rosemount this summer. Our continuous corn plots were discontinued after 7 years of identical treatments on each plot. The plot area was planted to oats and stand evaluated as soon as stabilized. The crop was then tandem disced and replanted to oats. Again the stand was evaluated when stabilized. Then the crop was moldboard plowed and planted to soybeans. Since we have found that the stand of soybeans does not predict the yield these were grown to maturity and harvested.

Serious injury to oats and soybeans occurred only after the 8 lb/A treatment of atrazine the previous year. As was found with an earlier study greater injury occurred to the second crop of oats than the first. This was attributed to greater rainfall (4.95 inches) on the second crop than the first (2.95 inches). Clearly less atrazine residue injury occurred where carbofuran was used than where it was not. This suggested that the same microflora favored by carbofuran also degraded atrazine. Data follow in the table below.

Table 1. Stand of oats and yield of soybeans in atrazine x carbofuran residue plots.

| | No atrazine | | | 8 lb/A atrazine | | |
|---|---|---|---|---|---|---|
| Soil pH | Oats I Stand % Control | Oats II Stand % Control | Soybeans bu/A | Oats I Stand % Control | Oats II Stand % Control | Soybeans bu/A |
| | | | No carbofuran | | | |
| 5.4 | 100 | 100 | 27.8 | 133 | 58 | 24.3 |
| 6.3 | 100 | 100 | 25.8 | 77 | 36 | 13.6 |
| 6.8 | 100 | 100 | 26.3 | 73 | 23 | 11.7 |
| 7.2 | 100 | 100 | 28.9 | 56 | 4 | 2.8 |
| | | | With 2 lb/A carbofuran | | | |
| 5.4 | 105 | 96 | 21.9 | 104 | 40 | 27.2 |
| 6.3 | 110 | 97 | 24.7 | 98 | 48 | 20.5 |
| 6.8 | 108 | 84 | 28.6 | 85 | 24 | 22.0 |
| 7.2 | 125 | 112 | 25.4 | 84 | 30 | 8.5 |

# ALFALFA AND RED CLOVER POTASSIUM TRIALS

Staples, Minnesota 1979

C.J. Overdahl, Melvin Wiens and J. Lensing

Alfalfa and red clover trials at Staples were first established in July, 1970. At that time experiments were established using varying amounts of phosphorus, sulfur, lime and potassium. Soil tests were high for sulfur and phosphorus, and after 1974 these trials were discontinued; no responses had been obtained. The lime trial was also discontinued at that time because lime in the irrigation water had raised the pH of all plots above 7. In the last 4 years, pH in the trial area is 7.5 or higher.

After 1974 only the potassium trials on alfalfa and red clover are continued. The red clover had to be reseeded in 1974 and no red clover yields were obtained that year. In 1977 both alfalfa and red clover areas were plowed and reseeded. The main purpose was to have the higher yielding anchor alfalfa and Arlington red clover in the comparisons.

## Yield and soil test results

The objective of the alfalfa-red clover comparisons is to measure the approximate economic differences of these crops on soils where considerable potash is needed.

Potassium soil tests were below expectations through 1976, even with annual treatments of 240 pounds of $K_2O$ per acre. Table 1 shows a K test as low as 128 pounds of exchangeable K in 1976 where 2 treatments of 120 pounds of $K_2O$ had been added annually since 1970. The 120 pounds treatment was increased to 180, and the 240 pound treatment was increased to 360 for 1978. This increase in potassium rates has been reflected in increases of K test up to 287 pounds of K from one of the 360 pound treatments. The upward trend does not appear to continue from the 360 pounds of $K_2O$ treatments in 1979. Table 1b shows 0 to 3 inch tests over the 300 level only from one 360 pound treatment, and averages for the 0 to 6 inch depth do not go above 300 pounds. The higher soil test K of nearly 300 pounds from the annual 360 pounds of $K_2O$ treatment yield about .3 ton of alfalfa more than the 180 pounds annual treatment, with a soil test ranging between 100 and 138 pounds of K.

Alfalfa responded significantly to potash with the 360 pound treatment resulting in yields only slightly higher than the 180 pound treatment, in spite of the much greater difference in soil test K.

Red clover did not significantly respond to potash, even with a K soil test as low as 58. Red clover yielded nearly as well as alfalfa in 1978 and produced approximately a ton more per acre on the no-potash plot than did the alfalfa.

There has been no real difference in yield between October or June application, nor has there been an advantage to split applications.

Yields of over 5 tons of alfalfa have been measured on the no-potash treated plots (1974 & 1975), while the 0 to 6 inch soil sample is very low, i.e.,

between 40 and 60 pounds of exchangeable K. Subsoil samples taken in 1974 show K tests of 50 at 1 to 2 feet and 20 at 2 to 3 feet deep, indicating that subsoil K source cannot explain the good alfalfa yields on the check plots. In 1978, however, the no-potash plots yielded approximately 2 tons per acre and shows K deficiency symptons.

Plant analysis

Generally, October treated plots show more K in leaves at the first cut since the June application goes on just after the first cutting. On the other hand, K levels are higher for the third cut from June application than from the October treatment (Table 2).

The critical level of 2.5% K described in some research reports would indicate that many of the samples before 1978 were below this level. In 1978 and 1979, only a few of the 180 pound treated plots were below this level and none from the plots receiving 360 pounds of $K_2O$. The check plots for both alfalfa and red clover were considerably below this level in most samples for all the years of the trial. The third cutting in 1979 was taken late in September.

Table 1a. Potassium treatments effect on red clover and alfalfa yields and soil tests.

| | Annual treatments of $K_2O$ in lbs/A and time of application | | | | | | |
|---|---|---|---|---|---|---|---|
| | None | June 240 | Oct. 240 | June 120 | Oct. 120 | June 120 Oct. 120 | Significance |
| | Yields Tons/Acre at 15% Moisture | | | | | | |
| Alfalfa | | | | | | | |
| 1972 | 3.4 | 3.6 | 3.8 | 3.5 | 3.4 | 3.6 | ns |
| 1973 | 4.0a | 4.8bc | 4.6bc | 4.6bc | 4.3ab | 4.8c | 5% |
| 1974 | 5.1a | 6.5b | 6.4b | 6.4b | 6.3b | 6.5b | 5% |
| 1975 | 5.1a | 6.4bc | 6.6c | 6.1b | 6.2b | 6.4bc | 1% |
| 1976 | 4.5a | 6.2c | 6.1c | 5.8b | 5.6b | 5.7b | 1% |
| Red Clover | | | | | | | |
| 1972 | 4.2 | 5.0 | 4.5 | 4.7 | 4.7 | 4.7 | ns |
| 1973 | 3.3 | 3.6 | 3.3 | 3.4 | 3.6 | 3.7 | ns |
| 1974* | - | - | - | - | - | - | |
| 1975 | 5.0a | 6.0b | 5.8b | 5.8b | 5.6b | 6.0b | 5% |
| 1976* | 2.8a | 3.2b | 3.3b | 3.2b | 3.1b | 3.2b | 5% |

| | Soil Test K lbs/A | | | | | | |
|---|---|---|---|---|---|---|---|
| | None | June 240 | Oct. 240 | June 120 | Oct. 120 | June 120+ Oct. 120 | |
| Alfalfa | | | | | | | |
| 1972 | 92 | 258 | 322 | 160 | 165 | 185 | Avg. pH-7.6 (1978) |
| 1973 | 85 | 290 | 210 | 150 | 140 | 195 | |
| 1974 | 60 | 175 | 240 | 95 | 75 | 200 | Avg. P Alf=47 R.C.=72 (1978) |
| 1975 | 48 | 178 | 160 | 75 | 63 | 135 | |
| 1976 | 40 | 210 | 145 | 68 | 68 | 128 | |
| 1977** | | | | | | | |
| Red Clover | | | | | | | |
| 1972 | 107 | 262 | 230 | 182 | 167 | 162 | |
| 1973 | 90 | 290 | 240 | 160 | 190 | 310 | |
| 1974* | 135 | 180 | 200 | 150 | 155 | 180 | |
| 1975 | 60 | 180 | 83 | 108 | 60 | 115 | |
| 1977** | | | | | | | |

*Red clover failed in 1974, was reseeded August 1, 1974
**Crops reseeded in 1977 to Anchor alfalfa and Arlington Red Clover. No yields or soil samples taken in 1977. Treatments of $K_2O$ in 1978 were increased to from 120 to 180 pouncs of $K_2O$ per acre and the 240 pound treatment was increased to 360 (data in Table 1b).

Table 1b. Potassium treatment effect on red clover and alfalfa yields in 1978 and 1979 after $K_2O$ increase.

| | $K_2O$ in lb/A annual and time of application | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1978 Cutting | None | June 360 | Oct. 360 | June 180 | Oct. 180 | June 180+ Oct. 180 | Significance | BLSD(.05) |
| Alfalfa | | | | | | | | |
| 1 | .38 | 1.31 | 1.22 | 1.05 | 1.05 | 1.22 | ** | .20 |
| 2 | .71 | 1.19 | 1.20 | 1.08 | 1.12 | 1.14 | ** | .14 |
| 3 | .88 | 1.31 | 1.39 | 1.28 | 1.25 | 1.37 | ** | .12 |
| Total | 1.97 | 3.81 | 3.81 | 3.41 | 3.42 | 3.73 | ** | .32 |
| Red Clover | | | | | | | | |
| 1 | .96 | 1.40 | .95 | .87 | 1.12 | 1.06 | ns | - |
| 2 | .97 | 1.19 | 1.21 | 1.20 | 1.20 | 1.19 | ** | .12 |
| 3 | 1.02 | 1.27 | 1.20 | 1.26 | 1.17 | 1.21 | ns | - |
| Total | 2.95 | 2.86 | 3.36 | 3.33 | 3.49 | 3.46 | ns | - |
| 1979 | | | | | | | | |
| Alfalfa | | | | | | | | |
| 1 | .58 | 1.58 | 1.64 | 1.41 | 1.45 | 1.50 | ** | .20 |
| 2 | 1.17 | 1.62 | 1.59 | 1.56 | 1.53 | 1.70 | ** | .14 |
| 3 | .51 | .93 | .95 | .88 | .88 | .84 | ** | .21 |
| Total | 2.26 | 4.13 | 4.18 | 3.85 | 3.86 | 4.04 | ** | .32 |
| | Soil test K lbs/A (Sept.) | | | | | | | |
| Alfalfa | | | | | | | | |
| 1978 | 54 | 287 | 216 | 123 | 91 | 212 | | |
| 1979 | | | | | | | | |
| 0-3" | 55 | 317 | 249 | 180 | 116 | 261 | ** | 38 |
| 3-6" | 44 | 275 | 303 | 96 | 84 | 206 | ** | 40 |
| Avg(0-6") | 50 | 296 | 276 | 138 | 100 | 233 | | |

Table 1b. (cont)

| | None | June 360 | Oct. 360 | June 180 | Oct. 180 | June 180+ Oct. 180 |
|---|---|---|---|---|---|---|
| | Soil test K lbs/acre (Sept.) | | | | | |
| Red Clover | | | | | | |
| 1978 | 58 | 300 | 170 | 138 | 86 | 210 |
| 1979 | No Crop | | | | | |

Phosphorus & pH averages for all plots

1979 P 0-3" = 37
3-6" = 33
pH - 7.5

Table 2. Potassium (%) in alfalfa and red clover tops.

| | Plant Analysis %K | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | $K_2O$ treatments | | | |
| | None | June 240 | Oct. 240 | June 120 | Oct. 120 | June 120 Oct. 120 | Significance |
| Alfalfa | | | | | | | |
| 1972-1st cut | 2.05 | 2.76 | 2.98 | 2.20 | 2.74 | 2.65 | |
| 2nd cut | 2.00 | 2.50 | 2.46 | 2.27 | 1.92 | 2.34 | |
| 3rd cut | 2.52 | 3.44 | 3.08 | 2.94 | 2.85 | 3.18 | |
| 1973-1st cut | 1.74a | 2.74b | 2.88b | 2.40b | 2.45b | 2.47b | 5% |
| 2nd cut | 1.58 | 2.76b | 2.76b | 2.48b | 2.39b | 2.65b | 1% |
| 3rd cut | 1.64a | 2.60b | 2.57b | 2.45b | 2.17b | 2.56b | 5% |
| 1974-1st cut | 1.37 | 3.08 | 3.59 | 2.17 | 2.32 | 3.21 | |
| 2nd cut | 1.29 | 2.40 | 2.85 | 2.25 | 1.89 | 2.60 | |
| 3rd cut | 1.11 | 2.18 | 2.48 | 2.08 | 1.62 | 2.46 | |
| 1975-1st cut | 1.24a | 2.19c | 2.67d | 1.67b | 2.15c | 2.31c | 1% |
| 2nd cut | 1.39a | 2.74c | 2.49bc | 2.27b | 1.93a | 2.67c | 1% |
| 3rd cut | 1.23a | 2.60c | 2.85c | 2.15b | 1.72a | 2.56bc | 1% |
| 1976-1st cut | 1.24a | 3.66f | 3.26de | 1.55b | 2.38c | 2.99d | 5% |
| 2nd cut | 1.45a | 2.98d | 2.83d | 2.68c | 2.02b | 2.90d | 5% |
| 3rd cut | 1.49a | 2.78cd | 2.86d | 2.26b | 2.03b | 2.68c | 5% |
| 1977-None | | | | | | | |
| Red Clover | | | | | | | |
| 1972-1st cut | 2.14 | 3.05 | 2.83 | 3.02 | 2.61 | 3.04 | |
| 2nd cut | 2.20 | 2.86 | 2.60 | 2.51 | 2.21 | 2.44 | |
| 3rd cut | 2.65 | 3.54 | 2.98 | 3.32 | 2.87 | 2.98 | |
| 1973-1st cut | 1.76a | 2.63b | 2.65b | 2.56b | 2.42b | 2.66b | 5% |
| 2nd cut | 2.03a | 2.84c | 2.97c | 2.65bc | 2.48b | 2.92c | 1% |
| 3rd cut | 1.81a | 3.00d | 2.53c | 2.40c | 2.10b | 2.66c | 1% |
| 1974-None | | | | | | | |
| 1975-1st cut | 1.55a | 2.59d | 2.33cd | 2.01bc | 1.87ab | 2.45d | 1% |
| 2nd cut | 1.69a | 3.00c | 2.18b | 2.80c | 2.05b | 2.89c | 1% |
| 3rd cut | 1.78a | 3.12d | 2.37b | 2.68c | 2.25b | 2.87c | 1% |
| 1976-1st cut | 1.43 | 2.96 | 3.18 | 2.08 | 2.47 | 2.80 | 5% |
| 2nd cut | 1.70a | 3.09c | 2.67b | 2.66b | 2.47b | 3.05c | 5% |
| 1977-None | | | | | | | |

Where letters differ, the values are significantly different. (5%)

Table 2. (cont.) Plant analysis %K (1978 & 1979)

| | $K_2O$ treatments and dates of application | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | None | June 360 | Oct. 360 | June 180 | Oct. 180 | June 180 Oct. 180 | Significance | |
| **1978** | | | | | | | | BLSD 5% |
| Alfalfa | | | | | | | | |
| 1st cut | 1.51 | 2.66 | 2.83 | 2.33 | 2.48 | 2.71 | ** | .15 |
| 2nd cut | 1.52 | 2.74 | 2.77 | 2.37 | 2.30 | 2.81 | ** | .14 |
| 3rd cut | 1.58 | 2.96 | 2.86 | 2.56 | 2.33 | 2.81 | ** | .12 |
| Red Clover | | | | | | | | |
| 1st cut | 1.64 | 3.11 | 2.74 | 2.40 | 2.49 | 2.86 | ** | .44 |
| 2nd cut | 1.63 | 3.12 | 2.72 | 2.77 | 2.50 | 3.02 | ** | .15 |
| 3rd cut | 1.60 | 3.21 | 2.74 | 2.82 | 2.39 | 2.94 | ** | .26 |

Sufficiency levels for alfalfa 2.5%

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **1979** | | | | | | | | |
| Alfalfa | | | | | | | | |
| 1st cut | 1.34 | 3.14 | 3.04 | 2.42 | 2.54 | 3.08 | ** | .19 |
| 2nd cut | 1.49 | 3.17 | 3.20 | 2.68 | 2.51 | 3.24 | ** | .21 |
| 3rd cut | 0.86 | 2.09 | 2.03 | 1.87 | 1.60 | 2.06 | ** | .12 |
| Red Clover | | | | | | | | |
| No crop | | | | | | | | |

# BARLEY FERTILIZATION TRIALS AT STAPLES

Jerome N. Lensing, A.C. Caldwell, Mike O'Leary, Mel Wiens

Agricultural production on the sandy soils of central Minnesota has expanded in recent years due largely to the development of irrigation. Although corn, potatoes, alfalfa, and some vegetable crops are grown under irrigation, there is wide interest in the production of small grains. Considerable work has been done on the production of wheat under irrigation, but there is an increased interest in producing barley if satisfactory yields and acceptable quality can be obtained for malting. Three separate experiments were continued to determine the importance of nitrogen fertilization on the production of malting barley under irrigation at Staples, Minnesota on a sandy loam soil in 1979.

All experimental areas received 60 #$K_2O$/A applied broadcast and plowed down. Preplant nitrogen treatments were broadcast over the plot area (12' x 20') and incorporated immediately with a harrow. Plot areas were packed prior to planting at a seeding rate of 90#/A on April 23. Starter fertilizer was applied as 20#$P_2O_5$/A with the seed. Weeds were controlled with an application of Brominal + (¼ #a.i./A) at the 4 leaf stage. A total of 12.2 inches of water was applied as irrigation with an addition 14 inches received as rainfall.

## A. Variety x Nitrogen Rate Trial

This trial was designed to evaluate the performance of a semi-dwarf and two tall varieties of malting barley with various nitrogen rates applied as split applications under irrigation. A split plot design replicated four times with varieties as main plots and nitrogen rates as subplots were used. Varieties included were Manker, Morex and an experimental semi-dwarf, M-32. The nitrogen rates used were 0, 45, 90, and 135 lbs nitrogen per acre applied as ammonium nitrate with 2/3 of nitrogen applied as preplant incorporated and 1/3 applied at tillering stage prior to an irrigation.

There was a significant varietal difference in test weight and percent plump kernals. (Table 1) Nitrogen increased yields significantly up to 90 #N/A with a significant increase in protein and grain nitrogen removal to 135 #N/A. Nitrogen significantly decreased test weight and % plump kernals. Malting grade barley (% protein less than 13.5% and % plump kernals greater than 65%) was produced with nitrogen rates up to 90 #N/A with all varieties.

The nitrogen content of M-32 forage (whole plant samples-soft dough stage) was significantly higher with signficantly lower yield potential. (Table 2) Nitrogen rates signficantly increased forage yields, % N content and nitrogen removal. The interaction of nitrogen with variety showed that Manker and M-32 forage yields were signficantly increased with rates of nitrogen to 135 # N/A compared to Morex with a significant yield increase to 90 # N/A.

Table 1. Effect of variety and N rate on yield, test weight, % plumpness, and % protein of barley grain at Staples, MN in 1979.

| Treatment | Yield | Test Weight | Plumpness | Protein |
|---|---|---|---|---|
| Variety | Bu/A | lbs/bu | % | % |
| Manker | 55.2 | 49.8 | 66.6 | 11.0 |
| Morex | 56.6 | 47.9 | 72.8 | 11.3 |
| M-32 | 51.3 | 46.1 | 67.5 | 11.0 |
| Signif. | NS | ** | ** | NS |
| BLSD(.05) | - | 1.2 | 2.7 | - |
| N-Rate | | | | |
| 0 #N/A | 30.8 | 48.2 | 73.7 | 10.9 |
| 45 #N/A | 51.4 | 48.4 | 74.8 | 10.0 |
| 90 #N/A | 66.2 | 48.0 | 67.0 | 11.2 |
| 135 #N/A | 69.1 | 47.2 | 60.3 | 12.4 |
| Signif. | ** | + | ** | ** |
| BLSD(.05) | 4.8 | 1.0 | 2.5 | .4 |
| Interaction | | | | |
| Manker x 0#N/A | 30.1 | 49.7 | 73.0 | 10.7 |
| Manker x 45#N/A | 52.9 | 49.6 | 70.2 | 9.8 |
| Manker x 90#N/A | 66.3 | 49.9 | 64.6 | 11.2 |
| Manker x 135#N/A | 71.3 | 49.8 | 58.5 | 12.4 |
| Morex x 0 " | 33.0 | 47.7 | 74.5 | 11.1 |
| Morex x 45 " | 56.1 | 49.2 | 79.8 | 9.9 |
| Morex x 90 " | 66.8 | 48.1 | 71.8 | 11.2 |
| Morex x 135 " | 70.6 | 46.8 | 65.1 | 13.0 |
| M-32 x 0 " | 29.2 | 47.0 | 73.6 | 10.9 |
| M-32 x 45 " | 45.2 | 46.4 | 74.4 | 10.4 |
| M-32 x 90 " | 65.4 | 46.0 | 64.6 | 11.0 |
| M-32 x 135 " | 65.5 | 45.0 | 57.2 | 11.8 |
| Signif. | NS | NS | NS | NS |
| C.V. | 13.2 | 2.0 | 4.8 | 4.7 |

Table 2. Effect of variety and N rate on barley dry matter yield, percent N, and total N removal of forage at soft dough stage at Staples, MN in 1979.

| Treatment | Yield | N Content | N Removal |
|---|---|---|---|
| Variety | T/A | % | lbs/A |
| Manker | 2.47 | 1.06 | 54.0 |
| Morex | 2.31 | 1.11 | 51.9 |
| M-32 | 2.11 | 1.22 | 52.8 |
| Signif. | ** | ** | NS |
| BLSD(.05) | .17 | .08 | - |
| **N Rate** | | | |
| 0 #N/A | 1.35 | 1.05 | 28.3 |
| 45 #N/A | 2.20 | .98 | 43.3 |
| 90 #N/A | 2.68 | 1.14 | 61.1 |
| 135 #N/A | 2.95 | 1.34 | 78.9 |
| Signif. | ** | ** | ** |
| BLSD(.05) | .13 | .08 | 6.6 |
| **Interaction** | | | |
| Manker x 0 #N/A | 1.35 | .93 | 25.3 |
| Manker x 45 #N/A | 2.35 | 1.00 | 47.3 |
| Manker x 90 " | 2.90 | 1.07 | 62.2 |
| Manker x 135 " | 3.29 | 1.23 | 81.0 |
| Morex x 0 " | 1.48 | 1.10 | 32.4 |
| Morex x 45 " | 2.19 | .90 | 39.3 |
| Morex x 90 " | 2.77 | 1.10 | 61.1 |
| Morex x 135 " | 2.78 | 1.34 | 75.9 |
| M-32 x 0 " | 1.21 | 1.12 | 27.3 |
| M-32 x 45 " | 2.06 | 1.05 | 43.3 |
| M-32 x 90 " | 2.38 | 1.25 | 60.0 |
| M-32 x 135 " | 2.79 | 1.44 | 80.7 |
| Signif. | + | NS | NS |
| BLSD(.05) | .24 | - | - |
| C.V. | 7.4 | 9.6 | 15.0 |

## B. Time of Application Trial

This trial was designed to evaluate various application schemes of nitrogen on the production of malting barley under irrigation. A randomized complete block design with four replications of five treatments was used. Nitrogen was applied at various times at a rate of 90 lbs nitrogen per acre as ammonium nitrate.

| Treatment Code | Treatments | |
|---|---|---|
| A | 0 Nitrogen | |
| B | 90 #N/A - preplant | |
| C | 60 #N/A - preplant; | 30 #N/A - tillering stage |
| D | 60 #N/A - preplant; | 30 #N/A - early boot stage |
| E | 40 #N/A - preplant; | 30 #N/A - tillering stage<br>20 #N/A - early boot stage |

The application of nitrogen significantly increased grain yield and nitrogen removal. (Table 3) 90 #N/A applied as 2/3 preplant and 1/3 early boot significantly decreased yields compared to the other split application schemes. The three time application scheme and the 2/3 preplant, 1/3 boot scheme produced significantly higher protein content and grain N removal. Forage yield and nitrogen removal were signifantly increased with nitrogen (Table 4).

## C. Seeding Rate x Nitrogen Rate x Potassium Rate Trial

This trial was designed to evaluate the affects of seeding rate, nitrogen rate, and potassium rate on yield and quality of malting barley under irrigation. Treatments were set out in a factorial arrangement (2 x 2 x 2) replicated four times in a randomized complete block design. Seeding rates of 96 and 144 #/A, nitrogen rates of 45 and 90 #/A, and $K_2O$ rates of 60 and 260 #/A were used. Nitrogen was applied as ammonium nitrate with 2/3 applied preplant incorporated and 1/3 applied at tillering stage. Potassium was applied preplant incorporated.

The high seeding rate significantly decreased percent plump kernals. Yield and percent protein of grain were significantly increased with the 90 #/A N rate. Interactions of the variables were non-significant (Table 5).

Table 3. Effect of time of nitrogen application on Manker barley yield, test weight, percent plumpness and percent protein at Staples, MN in 1978.

| Treatment Code | Yield Bu/A | Test Wt. #/bu | Plumpness % | Protein % |
|---|---|---|---|---|
| A | 29.6 | 48.4 | 70.1 | 9.7 |
| B | 56.7 | 50.6 | 71.2 | 9.9 |
| C | 52.5 | 50.5 | 69.6 | 9.9 |
| D | 61.6 | 51.9 | 79.2 | 11.2 |
| E | 65.2 | 51.2 | 71.4 | 11.2 |
| Signif. | ** | NS | ** | ** |
| BLSD(.05) | 8.2 | - | 2.1 | .9 |
| C.V. | 10.8 | 3.4 | 2.9 | 5.6 |

Table 4. Effect of time of nitrogen application on Manker barley dry matter yield, percent N, and total N removal of forage at soft dough stage at Staples, MN in 1978.

| Treatment Code | Yield T/A | N Content % | N Removal #/A |
|---|---|---|---|
| A | 1.20 | .97 | 23.2 |
| B | 2.72 | .92 | 49.9 |
| C | 2.63 | 1.08 | 56.8 |
| D | 2.77 | 1.19 | 66.1 |
| E | 2.79 | 1.12 | 62.4 |
| Signif. | ** | * | ** |
| BLSD(.05) | .28 | .16 | 9.1 |
| C.V. | 8.1 | 9.5 | 12.1 |

Table 5. Effect of seeding rate, nitrogen rate and potassium rate on yield, grain protein, test weight and percent plump kernals of Manker barley at Staples, MN, 1979.

| Treatment | | | Yield | Grain Protein | Test Weight | Plump Kernals |
|---|---|---|---|---|---|---|
| Seeding Rate | | | Bu/A | % | lbs/Bu | % |
| 96 lbs/A | | | 60.6 | 10.9 | 48.2 | 64.8 |
| 144 lbs/A | | | 63.6 | 10.6 | 47.7 | 56.8 |
| Significance | | | NS | NS | NS | ** |
| BLSD(.05) | | | - | - | - | 3.6 |
| N-Rate | | | | | | |
| 45 lbs/A | | | 56.6 | 10.1 | 47.7 | 60.9 |
| 90 lbs/A | | | 67.5 | 11.5 | 48.2 | 60.7 |
| Significance | | | ** | ** | NS | NS |
| BLSD(.05) | | | 4.6 | .5 | - | - |
| $K_2O$ Rate | | | | | | |
| 60 lbs/A | | | 61.2 | 10.8 | 47.9 | 61.2 |
| 260 lbs/A | | | 63.0 | 10.7 | 47.9 | 60.4 |
| Significance | | | NS | NS | - | - |
| Interaction | | | | | | |
| | lbs/A | | | | | |
| Seeding Rate | N | $K_2O$ | | | | |
| 96 | 45 | 60 | 53.2 | 10.4 | 48.4 | 67.2 |
| 96 | 45 | 260 | 58.4 | 10.2 | 48.0 | 64.9 |
| 96 | 90 | 60 | 62.8 | 11.7 | 48.0 | 62.6 |
| 96 | 90 | 260 | 67.8 | 11.2 | 48.4 | 64.3 |
| 144 | 45 | 60 | 60.2 | 9.7 | 47.6 | 56.2 |
| 144 | 45 | 260 | 54.8 | 10.0 | 46.7 | 55.2 |
| 144 | 90 | 60 | 68.6 | 11.4 | 47.8 | 58.7 |
| 144 | 90 | 260 | 70.8 | 11.5 | 48.6 | 57.1 |
| Significance | | | NS | NS | NS | NS |
| C.V., % | | | 10.0 | 6.4 | 2.4 | 8.0 |

# NITROGEN FERTILIZER DISTRIBUTION BETWEEN CORN PLANTS, SOIL AND AQUIFER UNDER IRRIGATED CONDITION

A.C. Caldwell, G. Buzicky, M. Wiens

## Introduction

In 1978, a field experiment was established at the Staples Irrigation Center as part of a two year study to investigate nutrient movement under a well fertilized, irrigated corn crop. Objectives in this study were to record the distribution of fertilizer nitrogen, the affects of nitrogen fertilizer application timing and to monitor the movement of nitrogen into the aquifer. A report of the first year's work can be found in Soil Series 103.

## Procedures

Fertilizer rates in 1978 were 100 lbs/A phosphate, 500 lbs/A potash, and 50 lbs/A sulfur. Three nitrogen treatments were used; a check plot receiving no nitrogen fertilizer, 160 lbs N/A, applied at planting, and 160 lbs N/A applied in four split applications. The split applications were applied as follows; 20 lbs N/A, at planting, 40 lbs N/A on June 27, 60 lbs N/A on July 7 and 40 lbs N/A on July 25. Those plots receiving fertilizer nitrogen contained subplots on which 15-N labeled fertilizer was applied. In addition, each split nitrogen application was individually labeled. All nitrogen treatments were replicated four times. Urea was used as the nitrogen source.

Soil samples were taken to a depth of ten feet before fertilizer application and after crop harvest. Subplots were sampled to eighteen inches in the fall.

Soil solution samplers were installed in each of the twelve plots to monitor nutrient movement in the rooting zone (2.5 ft.) and just below the rooting zone (5 ft.).

Each plot also contained a well so that the aquifer, at a depth of approximately 14 feet, could be sampled. Water samples were taken twice each week throughout the growing season.

## Experimental Results

### I. Plant Yields and Analysis

Treatments of 0, 160 lb N/A, at planting and 160 lb N/A in split application resulted in grain yields of 44.1 bu/A, 86.4 bu/A, and 123.8 bu/A, and silage yields of 5183 lb/A, 9564 lbs/A and 13,742 lbs/A respectively. This resulted in total nitrogen removal of 38.4, 73.4, and 149.5 lbs N/A for zero, 160 lbs N/A once and 160 lb N/A split applications respectively.

Recovery of fertilizer N in the split application as indicated by 15-N tracing was 55.9% (with 37.4% in the grain, 17.4% in the stover and 1.1% in the cob). The single nitrogen treatment resulted in a total recovery of 17.2%, with 11.6% in the grain, 5.2% in the stover and 0.4% in the cob. Fertilizer N recovery of individual split applications was; 26.4% of the starter application, 57.2% of the second application, 61.8% recovery of the third split, and 60.4% recovery of the final application.

## II. Soil Analysis

Soil samples, taken to a depth of ten feet, were analyzed for chloride, nitrate and sulfate. No significant differences were observed between spring and fall samples or between treatments. Samples taken from 15-N subplots showed 32.6% fertilizer nitrogen recovery in the upper 18 inches of soil for split N treatments. The single N application resulted in 25.6% recovery in the upper 18 inches. In both treatments, the majority of the fertilizer N was recovered in the 0-9 inch soil increment.

## III. Soil Solution Samples

The highest concentrations of chloride and nitrate in the soil solution samplers occurred in the first week of July at 2.5 feet and one month later at five feet. Nitrate concentrations were considerably higher under the single N application than under the split method of application which, in turn, were slightly higher than the check plots. Analysis of the nitrates during peak concentrations at the 5 ft. depth showed that less than 1% of the nitrate was from fertilizer nitrogen under the split N treatments; 50.9% of the nitrate under the single N application was attributable to fertilizer nitrogen.

Peak concentrations of sulfates did not occur at the 2.5 foot depth until mid-August and did not reach the 5 foot level until early October.

## IV. Well Water Analysis

Wells located in each plot were sampled twice each week. Well water samples were analyzed for orthophosphate, nitrate, sulfate and chloride. Orthophosphate remained below detectable levels in all wells throughout the year. Fluctuations in the nitrate and chloride levels could not be correlated with the 1978 fertilizer applications. Sulfate levels remained constant throughout the year as sulfates from the 1978 application did not reach the aquifer.

## Summary

In 1978 a yield response to nitrogen fertilization was observed. At crop harvest, 88.7% of the nitrogen applied in split applications could be accounted for in the soil and plant material. In contrast, when a single application at planting was used, only 42.8% of the fertilizer N was recovered. With single N application, higher concentrations of nitrate at a depth of five feet were observed and over 50% of these nitrates were due to fertilizer nitrogen. At the five foot depth, nitrate concentrations beneath the split application plots were only slightly higher than those beneath check plots.

Peak concentrations of chloride and sulfate were also noted in the soil solution samplers, but as with nitrate, these peaks could not be correlated with fluctuations in the aquifer. Soil samples, taken to a depth of ten feet, did not indicate differences between treatments or increases after fertilization.

# INFLUENCE OF NITROGEN RATE, FORM AND USE OF EXTEND ON THE YIELDS AND NITROGEN UTILIZATION OF CORN UNDER IRRIGATION - Staples, MN - 1979

G.L. Malzer, T. Graff, J. Lensing and M. Wiens

Nitrogen management on the coarse textured irrigated soils of Minnesota continues to be a concern that corn producers must consider in their management operation. Nitrogen management includes many aspects of nitrogen fertilization, including nitrogen rates, forms, times, methods of applications and in the relatively recent past additives which might be applied with nitrogen fertilizer. One such product, "Extend" (a product of Kalo Laboratory) has been commercially available for the last several years. Primarily recommended by the company for use with 28% nitrogen solutions, "Extend" is promoted as a chemical which would improve the lasting power of the nitrogen fertilizer by possibly encapsulating some of the fertilizer. Trials were established in 1979 to investigate the potential use of Extend in the nitrogen management programs for irrigated corn production.

## EXPERIMENTAL PROCEDURES

Twenty treatments were replicated four times and arranged in a randomized complete block design. The treatments were established on a Sverdrup sandy loam at the CMDIR station at Staples, MN. Potassium (225# $K_2O$/A) and Phosphorus (30# $P_2O_5$/A) were broadcast and incorporated prior to planting. The treatments included a control, three rates of nitrogen (60, 120, and 180# N/A), three forms of nitrogen (urea, ammonium nitrate, and 28% nitrogen solution) with all combinations applied with or without Extend at its recommended rate of application. All nitrogen applications were made prior to planting. One additional treatment was included as 180# N/A as urea applied in split applications in order to get some idea of nitrogen loss. Extend treatments were applied with the fertilizer either as a mixture with 28% nitrogen solutions, or as coatings onto the dry fertilizer material. Nitrogen treatments were not incorporated.

Corn (Pioneer 3978-85 day R.M.) was hand planted in 30" rows at a population of 28,000 ppa on May 10th. Weed control was accomplished with a combination of chemical (atrazine - 2# ai/A, Lasso 3# ai/A) and conventional (cultivation) methods. Irrigation started on June 14th and was carried through until September 25th with a total of 17.6 inches (13.2 Net) of irrigation water being applied. An additional 15.24 inches of rainfall was obtained during the growing season.

Leaf samples from opposite and below the ear at silking were obtained on August 10, dried and analyzed for Kjeldahl nitrogen. Dry matter production and yields were obtained on October 17th by hand harvesting two rows 20 feet long. Ears were separated from the stalks, field weights of each obtained and subsamples collected for moisture determination and nitrogen analysis for calculation of nitrogen removal. Grain yields were adjusted back to 15.5% moisture.

## GENERAL RESULTS

The 1979 growing season was characterized by being relatively wet with below average growing degree days. Fertilizer nitrogen losses due to early spring nitrogen fertilization were excessive in 1979. The magnitude of the nitrogen loss is reflected in Table 1, where the control produced yields of 57 bu/A while 180# N/A produced 64 bu/A and the split applications of 180# N/A produced 118 bu/A. Regardless of the amount of

of nitrogen applied, relatively large quantities of the early spring nitrogen applications were lost prior to plant demand. In the evaluation of any product such as Extend which advertise longer nitrogen availability or reduced nitrogen losses, a situation must be established where nitrogen losses first occur.

In general even when large nitrogen losses occured significant yield responses were obtained up through the highest rate of nitrogen (180# N/A). Ammonium nitrate and 28% nitrogen solutions appeared to be comparable while urea was significantly lower. It may be possible that leaching losses of nitrogen as the soluble urea form may have occured prior to hydrolysis and ammonium formation. Utilization of Extend with the nitrogen fertilizers had no positive influence on yield, and overall actually significantly reduced yields.

Other aspects of nitrogen utilization (Table 2 and 3) tend to reflect the same trends that were established with yield. Increased dry matter production and nitrogen utilization were obtained with increasing nitrogen rates. Urea was inferior to either ammonium nitrate or 28% nitrogen solution under the conditions tested. The use of Extend either had no influence or a significant negative influence on nitrogen utilizations, yield, or other crop growth parameters.

Table 1. Influence of nitrogen rate, nitrogen form and Extend on leaf N content, grain yield, grain N and grain N removal - Staples, MN - 1979.

| Treatments | | | Leaf | Corn Grain | | |
|---|---|---|---|---|---|---|
| N Rate | N Form | Extend | N | Yield 15.5%M | N conc. | N removal |
| #/A | | Yes/No | % | bu/A | % | #/A |
| 0 | - | - | 1.39 | 56.6 | 1.07 | 28.6 |
| 60 | Urea | No | 1.37 | 50.3 | 1.07 | 25.5 |
| 60 | Urea | Yes | 1.41 | 48.4 | 1.06 | 24.2 |
| 60 | AN | No | 1.32 | 57.2 | 1.14 | 30.8 |
| 60 | AN | Yes | 1.19 | 48.7 | 1.10 | 25.3 |
| 60 | 28% | No | 1.61 | 52.7 | 1.07 | 26.7 |
| 60 | 28% | Yes | 1.39 | 48.9 | 1.09 | 25.1 |
| 120 | Urea | No | 1.29 | 51.0 | 1.08 | 26.2 |
| 120 | Urea | Yes | 1.40 | 49.3 | 1.08 | 25.1 |
| 120 | AN | No | 1.43 | 57.4 | 1.14 | 30.8 |
| 120 | AN | Yes | 1.47 | 61.1 | 1.10 | 31.9 |
| 120 | 28% | No | 1.53 | 60.7 | 1.18 | 33.9 |
| 120 | 28% | Yes | 1.44 | 54.5 | 1.10 | 28.3 |
| 180 | Urea | No | 1.44 | 54.6 | 1.08 | 28.0 |
| 180 | Urea | Yes | 1.39 | 50.3 | 1.13 | 26.9 |
| 180 | AN | No | 1.78 | 70.0 | 1.18 | 39.2 |
| 180 | AN | Yes | 1.68 | 65.6 | 1.07 | 33.3 |
| 180 | 28% | No | 1.66 | 71.0 | 1.11 | 37.4 |
| 180 | 28% | Yes | 1.64 | 69.3 | 1.14 | 37.7 |
| 180(split) | Urea | No | 2.94 | 118.5 | 1.30 | 73.2 |
| Significance | | | ** | ** | ** | ** |
| BLSD(.05) | | | 0.17 | 8.9 | 0.09 | 6.3 |

Factorial arrangement (Excludes control and split N application)

| | | | | |
|---|---|---|---|---|
| **N Rate - #/A** | | | | |
| 60 | 1.38 | 51.1 | 1.09 | 26.3 |
| 120 | 1.43 | 55.6 | 1.11 | 29.4 |
| 180 | 1.60 | 63.5 | 1.12 | 33.7 |
| Significance | ** | ** | * | ** |
| BLSD(.05) | 0.07 | 3.4 | 0.03 | 2.0 |
| **N Form** | | | | |
| Urea | 1.38 | 50.6 | 1.08 | 26.0 |
| Ammonium Nitrate | 1.48 | 60.0 | 1.12 | 31.9 |
| 28% N Soln. | 1.55 | 59.5 | 1.12 | 31.5 |
| Significance | ** | ** | * | ** |
| BLSD(.05) | 0.07 | 3.4 | 0.03 | 2.0 |
| **Extend** | | | | |
| Without | 1.49 | 58.3 | 1.12 | 30.9 |
| With | 1.45 | 55.1 | 1.10 | 28.6 |
| Significance | NS | * | + | * |
| BLSD(.05) | | 3.1 | 0.02 | 1.8 |

Table 2. Influence of nitrogen rate, nitrogen form and Extend on corn forage production and dry matter content.

| Treatment | | | Corn Forage Production | | | | |
|---|---|---|---|---|---|---|---|
| | | | Dry Matter Production | | | Dry Matter at Harvest | |
| N Rate | N Form | Extend | Stover | Grain | Total | Stover | Grain |
| #/A | | Yes/No | T/A | | | % | |
| 0 | - | - | 1.29 | 1.34 | 2.63 | 43.0 | 56.2 |
| 60 | Urea | No | 1.28 | 1.19 | 2.47 | 43.4 | 56.8 |
| 60 | Urea | Yes | 1.23 | 1.14 | 2.38 | 44.3 | 57.2 |
| 60 | AN | No | 1.31 | 1.35 | 2.66 | 45.2 | 57.9 |
| 60 | AN | Yes | 1.34 | 1.15 | 2.49 | 45.5 | 58.3 |
| 60 | 28% | No | 1.36 | 1.25 | 2.61 | 42.4 | 57.7 |
| 60 | 28% | Yes | 1.20 | 1.16 | 2.35 | 41.5 | 56.8 |
| 120 | Urea | No | 1.28 | 1.21 | 2.48 | 41.4 | 57.0 |
| 120 | Urea | Yes | 1.24 | 1.16 | 2.40 | 40.0 | 55.6 |
| 120 | AN | No | 1.37 | 1.36 | 2.73 | 41.5 | 58.6 |
| 120 | AN | Yes | 1.47 | 1.44 | 2.92 | 42.2 | 59.4 |
| 120 | 28% | No | 1.51 | 1.44 | 2.95 | 37.2 | 58.7 |
| 120 | 28% | Yes | 1.49 | 1.29 | 2.78 | 39.0 | 57.9 |
| 180 | Urea | No | 1.32 | 1.29 | 2.61 | 41.8 | 57.9 |
| 180 | Urea | Yes | 1.27 | 1.19 | 2.46 | 40.1 | 57.6 |
| 180 | AN | No | 1.66 | 1.66 | 3.31 | 40.6 | 60.6 |
| 180 | AN | Yes | 1.61 | 1.55 | 3.16 | 35.8 | 60.3 |
| 180 | 28% | No | 1.88 | 1.68 | 3.56 | 41.5 | 59.4 |
| 180 | 28% | Yes | 1.72 | 1.64 | 3.36 | 42.0 | 60.1 |
| 180(split) | Urea | No | 2.23 | 2.80 | 5.04 | 39.4 | 56.0 |
| Significance | | | ** | ** | ** | * | ** |
| BLSD(.05) | | | 0.28 | 0.21 | 0.41 | 5.8 | 3.0 |
| Factorial Arrangement (Excludes control and split N application) | | | | | | | |
| N Rate #/A | | | | | | | |
| 60 | | | 1.29 | 1.21 | 2.49 | 43.7 | 57.5 |
| 120 | | | 1.39 | 1.32 | 2.71 | 40.2 | 57.9 |
| 180 | | | 1.58 | 1.50 | 3.08 | 40.3 | 59.3 |
| Significance | | | ** | ** | ** | ** | ** |
| BLSD(.05) | | | .09 | .08 | 0.14 | 1.7 | 0.9 |
| N Form | | | | | | | |
| Urea | | | 1.27 | 1.20 | 2.47 | 41.8 | 57.0 |
| Ammonium Nitrate | | | 1.46 | 1.42 | 2.88 | 41.8 | 59.2 |
| 28% N Soln. | | | 1.53 | 1.41 | 2.93 | 40.6 | 58.4 |
| Significance | | | ** | ** | ** | NS | ** |
| BLSD(.05) | | | .09 | 0.28 | 0.14 | - | 0.9 |
| Extend | | | | | | | |
| Without | | | 1.44 | 1.38 | 2.82 | 41.7 | 58.3 |
| With | | | 1.40 | 1.30 | 2.70 | 41.1 | 58.1 |
| Significance | | | NS | * | + | NS | NS |
| BLSD(.05) | | | - | 0.07 | 0.11 | - | - |

Table 3. Influence of nitrogen rate, nitrogen form, and Extend, on the nitrogen content of and nitrogen removal by corn forage.

| Treatments | | | Corn Forage | | | | |
|---|---|---|---|---|---|---|---|
| | | | N Content | | N Removal | | |
| N Rate | N Form | Extend | Stover | Grain | Stover | Grain | Total |
| #/A | | Yes/No | --------%--------- | | ----------#/A---------- | | |
| 0 | - | - | 0.44 | 1.07 | 11.0 | 28.6 | 39.6 |
| 60 | Urea | No | 0.50 | 1.07 | 12.9 | 25.5 | 38.4 |
| 60 | Urea | Yes | 0.50 | 1.06 | 12.4 | 24.2 | 36.5 |
| 60 | AN | No | 0.42 | 1.14 | 10.9 | 30.8 | 41.6 |
| 60 | AN | Yes | 0.42 | 1.10 | 11.3 | 25.3 | 36.6 |
| 60 | 28% | No | 0.44 | 1.07 | 12.1 | 26.7 | 38.9 |
| 60 | 28% | Yes | 0.38 | 1.09 | 9.1 | 25.1 | 34.2 |
| 120 | Urea | No | 0.48 | 1.08 | 12.3 | 26.2 | 38.5 |
| 120 | Urea | Yes | 0.44 | 1.08 | 10.6 | 25.1 | 35.8 |
| 120 | AN | No | 0.38 | 1.14 | 10.4 | 30.8 | 41.3 |
| 120 | AN | Yes | 0.40 | 1.10 | 11.6 | 31.9 | 43.6 |
| 120 | 28% | No | 0.56 | 1.18 | 16.6 | 33.9 | 50.5 |
| 120 | 28% | Yes | 0.40 | 1.10 | 11.9 | 28.3 | 40.2 |
| 180 | Urea | No | 0.44 | 1.08 | 11.6 | 28.0 | 39.6 |
| 180 | Urea | Yes | 0.52 | 1.13 | 13.3 | 26.9 | 40.2 |
| 180 | AN | No | 0.42 | 1.18 | 14.1 | 39.2 | 53.3 |
| 180 | AN | Yes | 0.52 | 1.07 | 16.3 | 33.3 | 49.6 |
| 180 | 28% | No | 0.39 | 1.11 | 14.6 | 37.4 | 52.0 |
| 180 | 28% | Yes | 0.44 | 1.14 | 15.1 | 37.7 | 52.7 |
| 180(split) | Urea | No | 0.91 | 1.30 | 41.3 | 73.2 | 114.5 |
| Significance | | | ** | ** | ** | ** | ** |
| BLSD(.05) | | | 0.10 | 0.09 | 4.8 | 6.3 | 9.6 |
| Factorial Arrangement (Excludes control and split N application) | | | | | | | |
| N Rate #/A | | | | | | | |
| 60 | | | 0.44 | 1.09 | 11.4 | 26.3 | 37.7 |
| 120 | | | 0.44 | 1.11 | 12.3 | 29.4 | 41.6 |
| 180 | | | 0.46 | 1.12 | 14.2 | 33.7 | 47.9 |
| Significance | | | NS | * | ** | ** | ** |
| BLSD(.05) | | | - | 0.03 | 1.2 | 2.0 | 2.6 |
| N Form | | | | | | | |
| Urea | | | 0.48 | 1.08 | 12.2 | 26.0 | 38.2 |
| Ammonium nitrate | | | 0.43 | 1.12 | 12.4 | 31.9 | 44.3 |
| 28% N Soln. | | | 0.43 | 1.12 | 13.2 | 31.5 | 44.7 |
| Significance | | | * | * | NS | ** | ** |
| BLSD(.05) | | | 0.04 | 0.03 | - | 2.0 | 2.7 |
| Extend | | | | | | | |
| Without | | | .45 | 1.12 | 12.8 | 30.9 | 43.8 |
| With | | | .45 | 1.10 | 12.4 | 28.6 | 41.0 |
| Significance | | | NS | + | NS | * | * |
| BLSD(.05) | | | - | 0.02 | - | 1.8 | 2.4 |

# INFLUENCE OF NITROGEN RATE, TIMING OF APPLICATION AND USE OF NITRIFICATION INHIBITORS ON IRRIGATED CORN - Staples - 1979

G.L. Malzer, T. Graff, J. Lensing and M. Wiens

Nitrogen management on the coarse textured irrigated soils of Minnesota is a major decision that corn producers must consider. Nitrogen fertilizer application is essential for top yields on these soils. Likewise, large amounts of fertilizer nitrogen may be lost due to leaching if the nitrogen fertilizer is applied too early. To minimize these losses, nitrogen applications are often made in split applications through the irrigation system or as late sidedressing treatments. These often add to the cost of production and require a reasonable amount of timeliness to avoid yield reductions. Commercial availability of chemical additives known as nitrification inhibitors also offer some potential in minimizing nitrogen losses and may add flexibility into the overall nitrogen management program. A trial was established in 1978 to evaluate the significance of nitrogen rates, timing of nitrogen applications and use of nitrification inhibitors.

## EXPERIMENTAL PROCEDURES

Nine treatments were replicated four times and arranged in a randomized complete block design. The treatments were established on a Sverdrup sandy loam at the CMDIR station at Staples, MN. Potassium (225 # $K_2O$/A) and Phosphorus (30 # $P_2O_5$/A) were broadcast and incorporated prior to planting. The treatments included a check, two nitrogen rates, (80 and 160 # N/A as urea), to methods of application (single vs. split) and two nitrification inhibitors (N-Serve-Dow Chemical Co. and Dwell (Terrazole -Olin Corporation). Nitrogen treatments were applied in either one single preplant application or in multiple applications during the growing season. Split applications of nitrogen were applied on May 3 (preplant), July 3 (8 leaf stage), July 16 (12 leaf stage) and on July 26 (tasseling) in a ratio of 1/6, 1/6, 3/6, and 1/6 respectively.

Nitrification inhibitor treatments were applied with the single nitrogen application treatments as coatings onto urea (0.5 # ai/A) for both N-Serve and Dwell. The preplant nitrogen applications were broadcast over the plot area and immediately incorporated by discing. Corn(Pioneer 3978) was hand planted on May 9 in 30 inch rows at a population of 28,000 seeds/A. Weed control was obtained using a combination of chemical (Atrazine-2#ai/A and Lasso 3#ai/A) and conventional (cultivation) management. Irrigation of the plot area was started on June 14 and concluded on October 1 with a total of 17.2 inches of water being applied through irrigation. An additional 15.24 inches were obtained through precipitation during the growing season.

Leaf samples from opposite and below the ear at silking were collected on August 10, dried and analyzed for Kjeldahl nitrogen. Dry matter production and grain yields were obtained on October 17 by hand harvesting two rows 20 ft. long. Ears were separated from the stalks, field weights obtained, and samples removed for moisture determination and nitrogen analysis. Corn grain yields were adjusted to 15.5% moisture.

## GENERAL RESULTS

The 1979 growing season was characterized by being unusually cold and wet. Nitrogen losses due to early spring applications on these coarse textured soils were very severe. Overall yields ranged from 74 to 129 bu/A with nitrogen management being critical, (Table 1). Control areas receiving

no nitrogen produced 74 bu/A while areas receiving 160 #N/A in a single preplant application yielded only 77 bu/A. This would suggest that nearly all of the fertilizer nitrogen was lost from the soil system prior to plant demand. Management of nitrogen fertilization by splitting the applications resulted in appreciable yield increases. Use of nitrification inhibitors with the single nitrogen application treatments appeared to slow nitrogen losses and gave some yield increases, but these were only evident at the higher rate of nitrogen application. The use of nitrification hinhibitors did not stop nitrogen losses and should not be considered as techniques to substitute for good nitrogen management practices. The other parameters measured tend to support the yield results and reflect the differences in nitrogen utilization and nitrogen losses that were encountered with the various management treatments.

Table 1. Influence of nitrogen rate, timing of nitrogen application, and nitrification inhibitors on leaf nitrogen concentration, grain yield and dry matter production of corn under irrigation.

| Treatments | | | Leaf | Grain | Dry Matter Production | | |
|---|---|---|---|---|---|---|---|
| N Rate | No. of Appl. | Inhibitor | N | Yield | Grain | Stover | Total |
| #/A | | | % | bu/A | | T/A | |
| 0 | - | 0 | 1.64 | 74.2 | 1.76 | 1.19 | 2.95 |
| 80 | 1 | 0 | 1.64 | 82.4 | 1.95 | 1.40 | 3.35 |
| 80 | 1 | N-S | 1.66 | 90.3 | 2.14 | 1.42 | 3.56 |
| 80 | 1 | Dwell | 1.64 | 85.5 | 2.02 | 1.52 | 3.54 |
| 80 | 4 | 0 | 2.80 | 124.2 | 2.94 | 2.22 | 5.16 |
| 160 | 1 | 0 | 1.55 | 76.8 | 1.82 | 1.49 | 3.31 |
| 160 | 1 | N-S | 1.73 | 93.1 | 2.20 | 1.84 | 4.04 |
| 160 | 1 | Dwell | 1.82 | 102.7 | 2.43 | 1.88 | 4.31 |
| 160 | 4 | 0 | 2.76 | 129.4 | 3.061 | 2.34 | 5.40 |
| Significance | | | ** | ** | ** | ** | ** |
| BLSD(.05) | | | .22 | 15.3 | 0.36 | 0.31 | 0.56 |

Table 2. Influence of nitrogen rate, timing of nitrogen application and nitrification inhibitors on nitrogen content and total nitrogen uptake of corn at physiological maturity.

| Treatments | | | Leaf | Grain | Dry Matter Production | | |
|---|---|---|---|---|---|---|---|
| N Rate | No. of Appl. | Inhibitor | N | Yield | Grain | Stover | Total |
| #/A | | | % | bu/A | | T/A | |
| 0 | - | 0 | 1.08 | .44 | 38.2 | 10.5 | 48.7 |
| 80 | 1 | 0 | 1.12 | .37 | 43.5 | 10.3 | 53.8 |
| 80 | 1 | N-S | 1.14 | .43 | 48.7 | 12.2 | 60.9 |
| 80 | 1 | Dwell | 1.12 | .38 | 45.4 | 11.3 | 56.7 |
| 80 | 4 | 0 | 1.27 | .51 | 74.7 | 22.8 | 97.6 |
| 160 | 1 | 0 | 1.09 | .38 | 39.6 | 11.3 | 50.9 |
| 160 | 1 | N-S | 1.13 | .40 | 49.6 | 14.8 | 64.5 |
| 160 | 1 | Dwell | 1.18 | .38 | 57.4 | 14.3 | 71.7 |
| 160 | 4 | 0 | 1.36 | .61 | 83.2 | 28.5 | 111.6 |
| Significance | | | ** | ** | ** | ** | ** |
| BLSD(.05) | | | 0.05 | 0.10 | 9.0 | 4.3 | 10.6 |

# N Rate Studies of Dryland and Irrigated Wheat and Oats, Staples 1979

H. Meredith, M. Wiens, and J. Lensing

1979 was the fifth crop year involving studies of N rates on oats and wheat under intensive irrigation. A dryland study evaluating N rates initiated in 1977 was continued.

Era wheat and Noble oats were used as the test varieties. Nitrogen was applied to wheat at the rate of 0, 60, 120, and 180 pounds per acre, and to the oats at rates of 0, 40, 80, and 120 pounds per acre.

Plots were moldboard plowed on April 24 and seeded on April 25. Oats harvest was completed August 2 and the wheat was harvested on August 12.

One-third of the N was applied to the wheat at planting, one-third at stooling and one-third just prior to heading.

N was applied to the oat plots in two applications. One-half of the desired N was applied prior to seeding and one-half applied just prior to boot formation.

Table 1. Wheat Grain Yield as Influenced by N Fertilization - 1979. (Chemical weed control and intensive irrigation)

| Lbs N/A | Bu/A | Test wt Lbs/Bu | % N in Grain | Lbs N Removed in Grain |
|---|---|---|---|---|
| 0 | 10.9 | 52.5 | 2.55 | 16.7 |
| 60 | 27.5 | 55.0 | 2.56 | 42.1 |
| 120 | 32.6 | 53.5 | 2.90 | 56.5 |
| 180 | 34.6 | 53.2 | 2.86 | 59.2 |
| Signif | ** | N.S. | * | ** |
| BLSD (.05) | 5.4 | -- | .24 | 9.0 |
| C.V. | 13.6 | 2.8 | 5.3 | 11.2 |

Table 2. Wheat Grain Yield as Influenced by N Fertilization - 1979. (Chemical Weed Control - Dryland

| Lbs N/A | Bu/A | Test wt Lbs/Bu | % N in Grain | Lbs N Removed in Grain |
|---|---|---|---|---|
| 0 | 6.2 | 52.6 | 2.44 | 9.0 |
| 60 | 20.6 | 54.2 | 2.70 | 33.1 |
| 120 | 16.2 | 52.2 | 2.96 | 28.7 |
| 180 | 16.0 | 52.4 | 3.02 | 28.8 |
| Signif | ** | N.S. | ** | ** |
| BLSD (.05) | 4.0 | | .25 | 4.6 |
| C.V. | 18.8 | 2.3 | 5.8 | 12.3 |

Table 3. Oat Grain Yield as Influenced by N Fertilization - 1979. (Chemical Weed Control - Intensive Irrigation)

| Lbs N/A | Bu/A | Test wt Lbs/Bu | % N in Grain | Lbs N Removed in Grain |
|---|---|---|---|---|
| 0 | 38.7 | 36.6 | 1.81 | 22.5 |
| 40 | 56.2 | 36.1 | 1.74 | 31.3 |
| 80 | 68.9 | 34.1 | 1.77 | 39.1 |
| 120 | 75.9 | 33.2 | 1.93 | 47.0 |
| Signif | ** | * | * | ** |
| BLSD (.05) | 16.8 | 2.6 | .15 | 11.4 |
| C.V. | 17.6 | 6.8 | 4.4 | 20.3 |

Table 4. Oat Grain Yield as Influenced by N Fertilization - 1979. (Chemical Weed Control - Dryland)

| Lbs N/A | Bu/A | Test wt Lbs/Bu | % N in Grain | Lbs N Removed in Grain |
|---|---|---|---|---|
| 0 | 25.9 | 35.8 | 1.84 | 15.0 |
| 40 | 38.4 | 32.6 | 1.88 | 23.2 |
| 80 | 57.0 | 31.3 | 2.04 | 37.3 |
| 120 | 56.7 | 32.0 | 2.12 | 38.1 |
| Signif | ** | * | * | ** |
| BLSD (.05) | 8.1 | 3.1 | .18 | 3.4 |
| C.V. | 12.1 | 5.6 | 5.6 | 8.1 |

Table 5. Wheat Grain Yields, Bu/A, Staples Station, 1975-1979.

| | Irrigated | | | | | | | | | | | | Dryland | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chemical Weed Control | | | | Red Clover Underseeding | | | | Plow Down of Red Clover | | | | | | | |
| N, Lbs/A | 0 | 60 | 120 | 180 | 0 | 60 | 120 | 180 | 0 | 60 | 120 | 180 | 0 | 60 | 120 | 180 |
| 1975 1/ | 7 | 18 | 21 | 24 | 5 | 13 | 16 | 17 | | | | | | | | |
| 1976 | 24 | 53 | 66 | 68 | 53 | 58 | 55 | 57 | 59 | 70 | 69 | 67 | | | | |
| 1977 | 27 | 47 | 65 | 69 | 51 | 50 | 52 | 41 | 53 | 58 | 58 | 59 | 9 | 17 | 22 | 20 |
| 1978 | 14 | 35 | 38 | 36 | 26 | 24 | 24 | 22 | 31 | 34 | 35 | 37 | 12 | 24 | 24 | 21 |
| 1979 | 11 | 28 | 33 | 35 | Discontinued after 1978 Harvest Year | | | | | | | | 6 | 21 | 16 | 16 |
| Ave. | 19 | 41 | 50 | 52 | 32 | 33 | 33 | 30 | 48 | 54 | 54 | 54 | 9 | 21 | 21 | 19 |

1/ N rates 0, 40, 80, and 120 Lbs/A in 1975 only.
Late spring, excessively high temperatures May and June

Table 6. Oat Grain Yields, Bu/A, Staples Station, 1975-1979.

| | Irrigated | | | | | | | | Dryland | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chemical Weed Control | | | | Red Clover Underseeding | | | | | | | |
| N, Lbs/A | 0 | 40 | 80 | 120 | 0 | 40 | 80 | 120 | 0 | 40 | 80 | 120 |
| 1975 | 24 | 36 | 41 | 35 | 24 | 45 | 52 | 41 | | | | |
| 1976 | 54 | 84 | 101 | 111 | 86 | 88 | 90 | 93 | | | | |
| 1977 | 45 | 90 | 106 | 114 | 84 | 101 | 110 | 101 | 32 | 63 | 60 | 62 |
| 1978 | 38 | 77 | 100 | 102 | 84 | 88 | 86 | 80 | 32 | 54 | 50 | 61 |
| 1979 | 39 | 56 | 69 | 76 | Discontinued after 1978 Harvest Year | | | | 26 | 38 | 57 | 57 |
| Ave. (Excludes 1975) | 44 | 77 | 94 | 101 | 85 | 92 | 95 | 91 | 30 | 52 | 56 | 60 |

## Potassium Soil Tests

The potassium values were deemed too low to achieve optimum yields under intensified management. Relatively high rates of potassium were added over a three year period, Table 7. Since potassium was not a separate study, a uniform application was broadcast over the entire area.

Table 7. Broadcast Potash Annually 1975-1977, Pounds Per Acre.

| Year | $K_2O$ Lbs/A |
|---|---|
| 1975 | 500 |
| 1976 | 600 |
| 1977 | 510 |
| Total | 1610 |

All plots were individually sampled in Block 1 & 1A for four years. Soils were sampled following harvest of grain and removal of the forage. A total of 1610 pounds of $K_2O$ were added which increased the K test to over 400. However after cropping for two years, the K test dropped to under 200. It has long been observed that maintenance of high K values on coarse textured soils on these soils is a difficult task.

Table 8. Potassium Soil Tests from Small Grain Plots.

| | Soil K Tests Block 1 & 1A (Chemical Weed Control) | | | | |
|---|---|---|---|---|---|
| *N/A | 1975 1/ | 1976 | 1977 | 1978 | 1979 |
| 0 | 250 | 242 | 478 | 277 | 225 |
| 50 | | 188 | 452 | 274 | 190 |
| 100 | | 188 | 436 | 310 | 171 |
| 150 | | 183 | 401 | 248 | 175 |
| Average | | 200 | 442 | 278 | 190 |

Soil K Tests - Block 2 & 2A
(Red Clover Underseeding)

| #N/A | 1975 | 1976 | 1977 | 1978 | 1979 |
|---|---|---|---|---|---|
| 0 | 170 | None | 451 | 209 | 167 |
| 50 | | " | 409 | 215 | 167 |
| 100 | | " | 436 | 189 | 149 |
| 150 | | " | 373 | 195 | 153 |
| Average | | | 417 | 202 | 159 |

Soil K Tests - Block 3 & 3A
(Red Clover Plowed Down)

| | | | | | |
|---|---|---|---|---|---|
| 0 | 120 | 202 | 342 | 165 | None |
| 50 | | 210 | 324 | 159 | " |
| 100 | | 180 | 334 | 171 | " |
| 150 | | 168 | 312 | 162 | " |
| Average | | 190 | 328 | 164 | |

Soil K Tests - 4 & 4A (Dryland - No K added)

| #N/A | 1978 | 1979 |
|---|---|---|
| 0 | 137 | 137 |
| 50 | 135 | 106 |
| 100 | 114 | 125 |
| 150 | 127 | 119 |
| Average | 128 | 122 |

1/ Sampled April, all other samplings in late August.

Table 9. Soil pH Tests Reflecting Changes Due to Alkalinity in Irrigation Water.

Soil pH Tests - Blocks 1 & 1A

| #N/A | 1975 1/ | 1976 | 1977 | 1978 | 1979 |
|---|---|---|---|---|---|
| 0 | 5.9 | 6.3 | 6.7 | 6.7 | 7.0 |
| 50 | 5.9 | 6.2 | 6.5 | 6.5 | 6.8 |
| 100 | 5.9 | 6.1 | 6.4 | 6.3 | 6.6 |
| 150 | 5.8 | 6.0 | 6.3 | 6.2 | 6.5 |

Soil pH Tests - Blocks 2 & 2A

| #N/A | 1975 1/ | 1976 | 1977 | 1978 | 1979 |
|---|---|---|---|---|---|
| 0 | | | 6.4 | 6.4 | 6.4 |
| 50 | | | 6.4 | 6.5 | 6.4 |
| 100 | | | 6.3 | 6.2 | 6.2 |
| 150 | | | 6.2 | 6.1 | 6.2 |
| | | | Blocks 3 & 3A | | |
| 0 | | 6.3 | 6.8 | 6.7 | |
| 50 | | 6.4 | 6.8 | 6.7 | |
| 100 | | 6.2 | 6.8 | 6.6 | |
| 150 | | 6.2 | 6.8 | 6.5 | |
| | | | Blocks 4 & 4A | | |
| 0 | | | | 5.7 | 5.8 |
| 50 | | | | 5.7 | 5.8 |
| 100 | | | | 5.5 | 5.6 |
| 150 | | | | 5.2 | 5.4 |

1/ Sampled in April, all other sampling late August

Table 10. Acre Inches Water Applied to Small Grain Plots and Approximate Calcium Carbonate Equivalent Added in Irrigation Water 1975-1979.

| Year | Acre Inches Water Applied | Lbs $CaCO_3$ Equivalent Per Acre Per Year |
|---|---|---|
| 1975 | 13.5 | 470 |
| 1976 | 24.1 | 796 |
| 1977 | 15.8 | 706 |
| 1978 | 13.3 | 617 |
| 1979 | 10.0 | 550 |
| Total | | 3139 |

Table 11. Nitrogen Content in Wheat and Oats Grain as Influenced by Nitrogen Rates, Staples Station, 1979.

| Lbs N/A | N - Percent<br>Wheat-Dryland | Wheat-Irrigated |
|---|---|---|
| 0 | 2.44 | 2.55 |
| 60 | 2.70 | 2.56 |
| 120 | 2.96 | 2.90 |
| 180 | 3.02 | 2.86 |
| Signif. | ** | * |
| BLSD (.05) | .25 | .24 |
| C.V. | 5.8 | 5.3 |

| | Oats-Dryland | Oats-Irrigated |
|---|---|---|
| 0 | 1.84 | 1.81 |
| 40 | 1.98 | 1.74 |
| 80 | 2.04 | 1.77 |
| 120 | 2.12 | 1.93 |
| Signif. | * | * |
| BLSD (.05) | .18 | .15 |
| C.V. | 5.6 | 4.4 |

# PHOSPHATE RATE STUDIES OF IRRIGATED AND DRYLAND WHEAT AND OATS, STAPLES, 1979

H. Meredith, M. Wiens, and J. Lensing

This study was initiated in 1979 to determine the effect of broadcast phosphorus on small grain yields.

Era Wheat and Noble oats were used as the test varieties. Phosphate (0-44-0) was broadcast and incorporated at rates of 0, 30, 60 and 90 pounds of $P_2O_5$ per acre.

There was no significant difference in yield from wheat or oats as a result of the phosphorus addition.

Table 1. Wheat and Oat Grain Yields as influenced by Broadcasts $P_2O_5$ treatments, Staples Station, 1979.

| Lbs $P_2O_5$/A | Yield-bu/A Wheat | Test wt Lbs/bu |
|---|---|---|
| 0 | 21.9 | 49.4 |
| 30 | 21.4 | 47.4 |
| 60 | 24.6 | 51.3 |
| 90 | 27.8 | 48.3 |
| Signif | NS | NS |
| C.V. | 17.6 | 6.8 |
| | Oats | |
| 0 | 85.2 | 36.6 |
| 30 | 72.5 | 36.9 |
| 60 | 84.1 | 36.4 |
| 90 | 70.6 | 36.8 |
| Signif | NS | NS |
| C.V. | 15.3 | 3.4 |

Table 2. Content of Selected Elements in Grain of Wheat as Influenced by Phosphate treatments, Staples Station, 1979.

| Lbs $P_2O_5$/A | PPM (Wheat) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | P | K | Ca | Mg | MN | Zn | Cu | B |
| 0 | .43 | .48 | .12 | .16 | 45 | 41 | 2.8 | 2.3 |
| 30 | .42 | .44 | .13 | .16 | 47 | 39 | 1.8 | 1.2 |
| 60 | .43 | .48 | .12 | .16 | 45 | 38 | 1.8 | 1.4 |
| 90 | .43 | .44 | .13 | .16 | 48 | 39 | 1.8 | 1.2 |
| Signif | NS | NS | NS | NS | NS | NS | NS | NS |
| C.V. | 4.0 | 9.0 | 7.1 | 2.1 | 7.4 | 6.2 | 29.3 | 34.6 |

# Water Quality Studies

H. Meredith, M. Wiens & R. Munter

Water samples from farmers' irrigation wells were analyzed in 1979. Analyses were limited to conductivity, sulfur and calcium carbonate equivalent, Table 1.

Only two samples were taken from pits. Both samples had low calcium carbonate equivalents and both had low conductivity measurements.

Excluding the two pit samples, the average calcium carbonate equivalent was 45 pounds per acre inch of water. If ten acre inches of irrigation water were applied in 1979, the average value would be the equivalent of 450 pounds of finely ground 100 percent calcium carbonate per acre.

Frequently questions arise as to the plant nutrients contained in irrigation water. Table 2 is a partial summary of the major elements contained in irrigation water from the Staples, Minnesota area.

Table 2. Analyses of Water Samples, Staples, Minnesota.

| | PPM | | | | | | |
|---|---|---|---|---|---|---|---|
| Farmer | P | K | Ca | Mg | Na | Zn | B |
| McAdams | .36 | 3.1 | 53 | 19 | 2.5 | .009 | .06 |
| Cypher | .31 | 7.4 | 81 | 26 | 5.6 | .006 | .05 |
| Werk | <.25 | 3.3 | 66 | 20 | 3.7 | .006 | .02 |
| Lorin | <.25 | 3.9 | 73 | 22 | 2.6 | .031 | .03 |
| Gack | <.25 | 2.9 | 56 | 15 | 3.4 | .006 | .03 |
| Schrader | .34 | 3.6 | 56 | 18 | 10 | .006 | .02 |
| Rack | <.25 | 4.3 | 66 | 17 | 2.5 | .007 | .04 |
| Butler | <.25 | 8.5 | 116 | 31 | 7.6 | .203 | .04 |
| Hanson | <.25 | 3.1 | 37 | 10 | 5.8 | .006 | .06 |
| Nielson | <.25 | 2.1 | 40 | 7.0 | 4.5 | .030 | .03 |
| Heiniche | .30 | 2.9 | 53 | 18 | 18 | .008 | .08 |
| Winger | <.25 | 5.1 | 97 | 37 | 10 | .006 | .08 |
| *Mursu | <.25 | 1.1 | .28 | .11 | 201 | .017 | .03 |

*Sample from kitchen after passing water softener.

Table 5. Irrigation Water Samples, Various, 1978. (Data Expressed in PPM).

| | Name | Date Sampled | County | Township | Section | S | Total Alkalinity | P | K | Ca | Mg | Na | Mn | Zn | Cu | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Staples[1/] | 5/15 | Wadena | Thomastown | 26 | 3.2 | 223 | <.25 | 1.3 | 66 | 23 | 1.7 | .12 | .16 | .01 | .07 |
| 2. | Staples[2/] | 5/2 | " | " | " | <1 | 216 | " | 1.3 | 72 | 19 | 1.7 | .30 | .04 | .12 | .05 |
| 3. | Staples[3/] | 6/14 | " | " | " | 2.6 | 259 | " | 1.6 | 98 | 27 | 2.7 | .45 | .02 | T | .03 |
| 4. | Staples[4/] | 6/14 | " | " | " | 9.3 | 226 | " | 3.7 | 80 | 21 | 2.6 | .54 | .04 | " | .02 |
| 5. | Staples[2/] | 5/24 | " | " | " | 2.1 | 226 | " | 1.6 | 72 | 19 | 1.6 | .28 | .73 | " | .03 |
| 6. | Staples[3/] | 5/24 | " | " | " | 2.2 | 285 | " | 1.7 | 95 | 26 | 2.9 | .48 | .05 | " | .04 |
| 7. | Staples[5/] | 6/14 | " | " | " | 5.8 | 232 | " | .8 | 87 | 21 | 2.4 | .32 | .22 | " | .04 |
| 8. | L.Grove | 5/11 | " | " | " | 3.2 | 238 | " | 2.9 | 74 | 17 | 4.6 | T | .08 | " | .05 |
| 9. | B.Winger | 6/6 | Ottertail | Aurdal | 33,SE¼ | 17.8 | 334 | " | 4.2 | 98 | 34 | 7.6 | .28 | .04 | " | .09 |
| 10. | Staples[1/] | 5/24 | Wadena | Thomastown | 26 | 2.3 | 270 | " | .99 | 81 | 23 | 2.0 | .34 | .05 | " | .04 |
| 11. | Staples[2/] | 5/2 | " | " | " | 1.0 | 224 | " | 1.6 | 65 | 17 | 1.9 | .56 | .41 | .06 | .04 |
| 12. | Staples[3/] | 5/2 | " | " | " | 1.8 | 264 | " | 1.2 | 93 | 25 | 2.5 | .59 | .07 | T | .04 |
| 13. | Malzer | 6/14 | | | | 1.8 | 246 | " | 1.5 | 98 | 27 | 2.8 | .43 | .02 | " | .04 |
| 14. | "A" | 8/1 | Stearns | Paynesville | 17 | - | 225 | " | 2.8 | 32 | 40 | 2.7 | T | .02 | " | .14 |
| 15. | "B" | 7/31 | " | Crow R. | 9 | 13.0 | 202 | " | <.25 | 86 | 34 | 7.3 | T | .78 | " | .03 |

1/ Staples Station, Center Plot Well
2/ " " South " "
3/ Staples Station, North Plot Well
4/ Staples Farm #4 Well
5/ Staples Farm, two-tower well

Table 1. Farmer Irrigation Water Samples by Location, 1979.

| Name | County | Township | Section | Description | Depth of Well Feet | 1st Yr Pumped | Gal/Min | Prin Crop | S Lbs/A Inch | $CaCO_3$ (Lime) Lbs/A In | *Conduct. µmhos @25° C |
|---|---|---|---|---|---|---|---|---|---|---|---|
| J. James | Hubbard | Nevis | 28 | W½ of SW¼ | 50 | 1971 | 800 | Truck | 1.1 | 50 | 448 |
| R. Waddell | Morrison | Bellevue | 26 | -- | 140 | 1977 | 1125 | Corn | 1.8 | 44 | 390 |
| G. Klein | Ottertail | Parker Prairie | 28 | -- | 52 | 1977 | 550 | Alf Soy-beans | .6 | 58 | 686 |
| L. Hackler | Wadena | Wadena | 13 | W½ of W½ | 15 | 1978 | 600 | Corn | .4 | 17 | 173 |
| B. Winger | Ottertail | Aurdal | 32 | SE¼ | 52 | 1975 | 300 | Hay Garden | 9.0 | 65 | 729 |
| W. Gabling | Benton | Langola | 2 | NW¼ | 160 | 1978 | 1000 | Corn | .7 | 35 | 312 |
| W. Gabling | Benton | Langola | 2 | SE¼ | 153 | 1978 | 1300 | Corn | .9 | 25 | 252 |
| R. Meyers | Wadena | Bullard | 1 | | Pit | | | Cucs | .7 | 6 | 72 |
| D. Hemenway | Hubbard | Hubbard | 32 | E½ | 150 | 1977 | 750 | Corn | .9 | 42 | 364 |
| S. Collins | Cass | Becker | 14 | SW½ | Pit | 1979 | | | .8 | 4 | 120 |
| L. Weyer | Wadena | Thomastown | 10 | | 37 | | 720 | Corn | 1.4 | 45 | 442 |
| L. Weyer | Wadena | Bullard | 34 | | Leaf River | | 500 | Corn | 1.2 | 52 | 452 |
| G. Gablenz | Benton | Langola | 2 | NE¼ | 209 | 1978 | 2000 | Corn | .9 | 65 | 561 |

*Conductivity

Indicates amount of soluble salts in solution
Generally, below 1000 - no problems

Table 3. Farmer Irrigation Water Samples by Location, 1978. (See also Table 1.)

| Name | County | Township | Section | Depth of Well | 1st yr. Pumped | Gal./Min. | Prin. Crop | S Lbs/A | $CaCO_3$ eq. Inch Water |
|---|---|---|---|---|---|---|---|---|---|
| F. McAdams | Hubbard | Todd | 8 | 165 | 1977 | 900 | Corn Alf. | .3 | 42 |
| H. Cypher | Wadena | Aldridge | 33 | Pit | 1977 | 550 | " | 5.1 | 45 |
| A. Werk | Wadena | Aldridge | 12 | Pit | -- | -- | " | 2.3 | 45 |
| W. Torin | Ottertail | Compton | 20 | Pit | 1977 | 550 | " | 1.8 | 51 |
| M. Gack | Hubbard | W. Oak | 29 | 117 | 1977 | 600 | " | .7 | 41 |
| D. Schrader | Wadena | Wing R. | 6 | Pond | -- | -- | -- | 2.2 | 40 |
| L. Rach | Wadena | Aldrich | 27 | 14 | 1977 | 500 | " | 1.1 | 47 |
| C. Butler | Wadena | Wadena | 36 | 20 | -- | -- | -- | 1.5 | 66 |
| D. Hanson | Cass | Pooler | -- | Pit | 1977 | 450 | " | 1.3 | 25 |
| P. Nielson | Wadena | N. Germany | 13 | 20 | 1976 | 40 | " | .6 | 17 |
| D. Heinecke | Cass | May | 7 | 117 | -- | -- | -- | .3 | 54 |
| B. Winger | Ottertail | Ayrdal | 33 | 52 | 1975 | 300 | Veg | 2.8 | 85 |
| G. Bursu | Ottertail | Otto | 36 | 138 | -- | -- | -- | .4 | .06 |

Table 4. Farmer Irrigation Water Samples by Location, 1978.

| | Name | Date Sampled | County | Township | Section | S | Total** Alkalinity | B | Ca | Mg | Na | P | K |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Data Expressed in Pounds Per Acre Inch of Irrigation Water | | | | | | | | | | | |
| 1. | L. Hanson | Detroit Lakes | | | | .5 | 53 | T | 14.5 | 4.7 | .6 | .05* | .6 |
| 2. | C. Butler | 7/7/78 | Wadena | Wadena | 36-NW¼ | 1.4 | 50 | T | 16.9 | 5.7 | 1.2 | .05* | 1.4 |
| 3. | G. Mursa | 6/24/78 | Ottertail | Otto | 36- | .7 | 90 | T | .0 | .0 | 43.4 | .05* | .1 |
| 4. | H. Cypher | 6/22/78 | Wadena | Aldrich | 33 | 3.7 | 52*** | | 17.6 | 4.5 | 1.2 | .10 | 2.5 |
| 5. | P. Nielson | 6/22/78 | Wadena | N.Germany | 13 | .9 | 13*** | | 4.5 | .8 | .8 | .11 | .4 |
| 6. | L. Rach | 6/22/78 | Wadena | Aldrich | 23 | 1.0 | 40 | | 12.9 | 2.9 | .8 | .07 | 1.1 |
| 7. | M. Gack | 6/22/78 | Hubbard | W. Oak | 29-NW¼ | .7 | 39*** | | 13.5 | 3.3 | .9 | .07 | .6 |
| 8. | D. Karwatz | 6/22/78 | Wadena | Wadena | 17 SWSE | .7 | 60 | | 13.8 | 3.8 | .7 | .06 | .7 |
| 9. | A. Werk | 6/22/78 | Wadena | Aldrich | 12 | 2.1 | 35*** | | 11.3 | 3.2 | .8 | .08 | .9 |
| 10. | C. Mackay | 6/22/78 | Wadena | N. Germany | 14-S½NE¼ | .8 | 8 | | 5.2 | 1.6 | 4.6 | .06 | 1.1 |
| 11. | G. Lottman | 6/22/78 | Wadena | Shell River | 4-NE¼ | .2 | 44 | | 1.6 | .5 | 1.1 | .05* | .7 |
| 12. | D. Schrader | 6/22/78 | Wadena | Wing River | 6 | 1.2 | 40*** | | 12.0 | 2.6 | .7 | .06 | .5 |
| 13. | F. McAdams | 6/22/78 | Hubbard | Todd | 8 E½ | .7 | 45 | | 10.6 | 3.5 | 2.3 | .20 | 6.8 |
| 14. | D. Hanson | 6/22/78 | Cass | Popbre (?) | 6 | 1.9 | 16*** | T | 11.8 | 4.0 | .7 | .08 | .6 |
| 15. | Modland | 6/22/78 | Ottertail | Compton | 22 | 2.2 | 54*** | .006 | 5.6 | 1.7 | 2.0 | .26 | 1.2 |

*** Pit
** Expressed as $CaCO_3$ equivalent
* Less than .05

Table 6. Irrigation Water Samples, Various, 1978. (Data Expressed in PPM).

| Name | Date Sampled | County | Township | Section | S | Total Alkalinity | P | K | Ca | Mg | Na | Mn | Zn | Cu | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. H. Tawn[1/] | 8/31 | Todd | Morgan | 3 | 2.1 | 305 | <.25 | .55 | 96 | 26 | 3.6 | .18 | .02 | T | .02 |
| 2. D. Nielson[2/] | 8/7 | Wadena | Thomastown | 22 | 3.8 | 190 | " | 1.4 | 54 | 18 | 1.8 | .10 | .03 | T | .01 |
| 3. " | " | " | " | 25 | 3.1 | 190 | " | T | 78 | 22 | 2.0 | .18 | .02 | T | .01 |
| 4. Staples[2/] | 8/29 | " | " | 26 | 7.2 | 130 | " | .78 | 68 | 18 | 1.6 | .2 | .02 | T | T |
| 5. Staples[3/] | 7/7 | " | " | " | 2.6 | 270 | " | 2.0 | 80 | 21 | 5.2 | T | .01 | T | T |
| 6. Staples[4/] | 8/7 | " | " | " | 1.2 | 220 | " | 1.8 | 64 | 18 | 4.4 | T | .01 | T | .01 |
| 7. Staples[5/] | 7/7 | " | " | " | 2.7 | 250 | " | .47 | 64 | 19 | 2.4 | T | .08 | T | .01 |
| 8. Staples[4/] | 7/10 | " | " | " | 1.6 | 230 | " | .50 | 27 | 17 | 1.7 | T | .03 | T | T |
| 9. - | - | Meeker | - | - | | | T | 1.8 | 76 | 21 | 1.9 | .29 | .28 | T | .05 |
| 10. | | " | - | - | | | T | 2.4 | 75 | 21 | 2.5 | .28 | .25 | .02 | .05 |

[1/] Creek

[2/] Pit

[3/] N. Plot Well

[4/] S. Plot Well

[5/] Center Plot Well

# SOUTHERN EXPERIMENT STATION - WASECA
## WEATHER DATA - 1979

| Month | Period | Precipitation 1979 | Precipitation Normal | Avg. Air Temp. 1979 | Avg. Air Temp. Normal | Growing Degree Days 1979 | Growing Degree Days Normal |
|---|---|---|---|---|---|---|---|
| | | inches | | °F | | | |
| January | 1-31 | 1.76 | .73 | -2.4 | 12.9 | | |
| February | 1-28 | 1.10 | .96 | 4.7 | 17.5 | | |
| March | 1-31 | 4.93 | 1.94 | 24.4 | 28.5 | | |
| April | 1-30 | 2.66 | 2.48 | 40.2 | 45.6 | | |
| May | 1-10 | 1.43 | | 48.0 | | 40.0 | |
| | 11-20 | 0.36 | | 53.6 | | 88.5 | |
| | 21-31 | 0.93 | | 59.3 | | 133.0 | |
| | Total | 2.72 | 3.86 | 53.8 | 57.7 | 261.5 | 323 |
| June | 1-10 | 0.52 | | 64.4 | | 148.5 | |
| | 11-20 | 2.26 | | 67.2 | | 169.0 | |
| | 21-30 | 2.50 | | 66.2 | | 162.5 | |
| | Total | 5.28 | 4.75 | 66.0 | 67.1 | 480.0 | 521 |
| July | 1-10 | -0- | | 70.2 | | 200.0 | |
| | 11-20 | 1.00 | | 69.6 | | 195.5 | |
| | 21-31 | 8.64 | | 70.5 | | 226.0 | |
| | Total | 9.64 | 4.02 | 70.2 | 71.4 | 621.5 | 637 |
| August | 1-10 | 2.93 | | 71.2 | | 210.0 | |
| | 11-20 | 0.87 | | 62.8 | | 136.0 | |
| | 21-31 | 3.89 | | 66.4 | | 181.5 | |
| | Total | 7.69 | 3.60 | 66.8 | 69.7 | 527.5 | 583 |
| September | 1-30 | 0.90 | 3.45 | 61.0 | 60.3 | 392.5 | 310 |
| October | 1-31 | 3.11 | 1.89 | 47.1 | 50.3 | 41.5 | 44 |
| November | 1-30 | 2.43 | 1.25 | 31.6 | 32.9 | | |
| December | 1-31 | 0.69 | 1.02 | 23.9 | 19.0 | | |
| Year | Jan-Dec | 42.91 | 29.95 | 40.6 | 44.4 | 2324.5 | 2418 |
| Growing Season | May-Sept | 26.23 | 19.68 | 63.6 | 65.3 | 2283.0 | 2374 |

Notes:

1) Highest temp. on June 7 -- 95°

2) Highest 24-hour precipitation on July 23 -- 4.55"

3) Third highest growing season rainfall on record

4) Frost on October 7

# CONTINUOUS CORN TILLAGE STUDY

Waseca, 1979

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A field experiment was initiated in 1969 to evaluate tillage systems for continuous corn production in south central Minnesota. Eleven tillage treatments were established in a randomized complete-block design with four replications. Each treatment has been superimposed on the same plot since establishment. The experiment is located on a Nicollet clay loam soil with a 2-5% south-facing slope. Tile lines spaced 75' apart lie perpendicular to the rows within all plots.

Beginning in 1975, 7 of the 11 original tillage treatments were dropped. The four that were continued from 1975 are: (1) fall plow-field cultivate, (2) fall chisel-field cultivate, (3) disk only (spring secondary treatment) and (4) continuous no tillage (Table 1).

Fall primary tillage operations were conducted on October 25. All plots were stalk chopped before tillage. Broadcast P and K (0+50+180 lb $N+P_2O_5+K_2O$/A) were applied in the fall of 1978. Nitrogen (175 lb N/A as ammonium nitrate) was broadcast on the surface on May 15. The spring secondary tillage treatments were performed on May 17.

Corn (Pioneer 3732) was planted at a rate of 26,100 ppA on May 18. A John Deere plateless planter with fluted coulters was used to plant all plots. Starter fertilizer was not applied. An insecticide (1 lb active Counter/A) was applied at planting time. Chemical weed control consisted of 3 qt Lasso/A (A.I.) and 2½ lb atrazine/A (A.I.) applied preemergence. None of the plots were cultivated. Yields were taken by hand harvesting 2-25' rows from each plot on October 8.

## RESULTS

Grain yield, grain moisture and final population were affected significantly in this tenth year of continuous tillage (Table 1). Yield differences among the moldboard plow, chisel plow and spring disk tillage treatments were not significant, although the yields with the moldboard tillage were approximately 8 bu/A higher. Continuous no tillage resulted in about a 40 bu/A yield loss and in significantly higher grain moisture than the other treatments. Even with the use of fluted coulters final plant population was significantly lower with no tillage. This along with somewhat poorer weed control may have been part of the reason for the reduced yields with continuous no tillage. Grain N was not influenced by the primary tillage treatments.