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RESTORING PRODUCTIVITY OF ERODED SOILS WITH MANURE APPLICATIONS

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The study was initiated in October of 1990 at the NDSU Dickinson Research and Extension Center Ranch Headquarters near Manning, North Dakota. The study included 4 treatments and 3 replications in a randomized block design. Treatments included: (1) no manure; (2) 22.4 Mg/ha applied in the first year of the study only; (3) 22.4 Mg/ha applied in the first and second years of the study; and (4) 22.4 Mg/ha applied in all three years of the study which ended with the growing season of 1993. In October of 1993, a second treatment cycle was initiated with the same treatments but with the manure rate being increased to 44.8 Mg/ha per application (Table 1).

The soils at this site are classified as a complex of Cabba (loamy, mixed (calcareous), frigid, shallow Typic Ustorthents) and Chama (fine-silty, mixed Entic Haploborolls) soils formed from siltstone. These soils occupy a concave hilltop position with slopes of 1-6% with an easterly and southerly aspect. These soils have been severely eroded through long-term cultivation and an approximate 5 ha area directly to the west of this site was previously reseeded to grass due to the low productivity. Depth to siltstone is approximately 45 cm for the Cabba soils and 75 cm of the Chama soils.

Soils are being sampled to a depth of 1.2 m, when possible, for available water and NO_3-N content each spring and fall. Fertility is also being measured on the surface 15 cm each spring and fall. Bulk soil samples are being collected with a flat bottomed shovel to a depth of 5 cm for water stable aggregate and rotary sieve analysis.

Cultural practices include the standard production practices used in the surrounding field. Tillage included moldboard plowing during the first treatment cycle and no-till during the second treatment cycle. Crops grown at this site have included corn (1991), barley (1992), oat hay (1993), corn (1994), oat hay (1995) , and oat hay (1996). Extremely dry weather did not allow for good crop growth in 1991 and 1994. Table 2 shows yield data from 1994 and 1995.

Data sets annotated with the same letters are not statistically significant at 0.05 as determined by LSD. Sets that are not annotated are not significantly different.

The research reported here described the effects of the manure on changes in soil organic matter and available nitrate-N in these soils.

RESULTS AND DISCUSSION

Sampling Depth

Although average sampling depth (Figure 1) varied from plot to plot and season to season based on depth to siltstone and soil moisture, the differences in soil depth from treatment to treatment were generally not significant. Only for the 1991 spring (91S) and the 1993 fall (93F) samplings were significant differences in sampling depths observed between treatments which could be attributed to low soil moisture at the time of sampling. The average sampling depths for treatment 3 tended to be lower across all sampling dates but usually were not statistically significant across most sampling dates.

Soil Organic Matter

Significant differences between treatments were observed for the initial sampling (1990F) and the most recent sampling (1996S) in the 0-15 cm depth zone (Figure 2). The significant differences in 1990 may be due to soil variability across the hilltop. The 1996 differences can all be attributed to the manure treatment.

No significant differences were noted between treatments in the 15-30 cm zone (Figure 3).

Soil Nitrate-N

Soil NO_3-N was examined for 2 profile depths. First a 0-45 cm depth (Figure 4) was selected based on the average sampling depth of the shallowest plots to establish a uniform basis for comparison. Second, the total profile was examined to include soil depth variability.

Significant differences between treatments were observed for the 0-45 cm depth for the 1994 spring and 1995 spring samplings. These results show that repeated applications of manure may be necessary before overwinter mineralization of organic N can provide significant amounts of crop available NO_3-N to improve that aspect of soil productivity factors. Both of these samplings occurred after the initiation of the second treatment cycle.

The treatment effect on total profile NO_3-N (Figure 5) was found to be significant for the 1995 spring and 1996 spring samplings similar to the observations for the 0-45 cm NO_3-N.

SUMMARY

Effects of repeated manure applications required one cycle of treatments and increased manure rates to show significant effects on soil organic matter and plant available NO_3-N. Increasing the manure rate generally showed stepwise increases in NO_3-N for the spring samplings from 1992 on. A lack of manure incorporation into the soil during the second cycle of treatments may have lowered the N availability to plants. Manure applications may benefit from occasional tillage in cropping systems where no-till or reduced tillage is practical.

Table 1. Application Times and Rates of Manure Applications			
Treatment	Manure Rate - T/A -	Times of Application month/year	Total Application - T/A -
2	22.4	10/90	67
	44.8	10/93	

3	22.4	10/90, 10/91	134
	44.8	10/93, 10/94	
4	22.4	10/90, 10/91, 10/92	201
	44.8	10/93, 10/94, 10/95	

Table 2. Forage Yields for 1994 and 1995 Growing Season.

Treatment	Forage Yields[1]	
	Corn (1994)	Oat (1995)
	lb/A	
1	1793 ab	2859 a
2	2566 b	5072 b
3	1497 ab	3744 a
4	1076 a	4831 b

[1]Values followed by the same letter are not significantly different at P as determined by LSD.

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