Soil and Canary Seed Yield Response Over Three Years to a Single Application of Poultry Manure on a Heavy Clay Soil Near Regina, SK

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Introduction

The Saskatchewan Centre for Soil Research at the University of Saskatchewan in conjunction with researchers at Prairie Agricultural Machinery Institute (PAMI) have carried out studies in various areas of manure management. The overall aim of these studies is to determine the viability and sustainability of manure application to agricultural land. The objective of this study was to determine the effects of a single application of poultry manure on canary seed and selected soil characteristics on a heavy clay soil near Regina, SK.

Materials and methods

The experiment was initiated in 2001 at a farm located near Regina on a Dark Brown Chernozem (Regina soil association) of heavy clay texture. Poultry manure was collected from a nearby poultry farm and applied to experimental treatments. Six manure rates were used: 0**,** 5, 9, 18, 36 & 72 Tonnes/ha (T/ha, wet). The treatments were arranged in a RCBD with four replications. Soil samples were taken in the spring prior to seeding and in the fall after harvesting. The soil samples were analyzed for various parameters including inorganic N, extractable P (available P), extractable K (available K), pH and electrical conductivity (EC). Crop samples were taken for the determination of grain yield, straw yield and N concentration.

Results and discussion

Table 1 shows levels of available N, available P, available K, EC and pH taken prior to poultry manure application in the spring of 2001. These levels serve as a baseline for these characteristics at the study site. The effect of application rate of poultry manure on soil characteristics was not determined immediately following application. However, soil samples were taken in the fall of 2001 to determine post-harvest levels of available N. Except at the highest rate of manure application (72 T/ha), no differences in available N were observed in treatments receiving manure and the control in the 0-30 cm soil depth (Fig. 1). A three-fold difference in available N was observed at the highest rate of application. In the spring of 2002, a similar trend in available N was observed with only a slight elevation in

Table 1: Levels of available N (Av.N), available P (Av.P), available K (Av.K), EC and pH prior to manure application in spring of 2001.

	0-30 cm	30-60 cm	0-60 cm
Av.N (kg/ha)	30	23	53
Av.P (kg/ha)	22	-	-
Av.K (kg/ha)	2608	-	-
EC (mS/cm)	0.28	0.26	0.27
pH	8.3	8.5	8.4

available N observed for the check and other manure treatments. In contrast a four-fold difference in available N was observed between the plots treated with the highest rate and those treated with the second highest rate (224 vs 51 kg/ha). Post-harvest available N in the fall of 2002 was not different in plots receiving 5 to 36 T/ha from that in the check. Significant difference in post-harvest available N was only observed at the 72 T/ha rate. A similar trend was observed in the spring of 2003. Post-harvest available N in all treatments were not different from that in check plots. In the 30-60 cm soil depth, the majority of the manure-treated plots did not show significant elevation in available N either in the spring or in the fall samplings (Fig. 2). The exception was in 2002 when available N at 72 kg/ha rate was 35 kg/ha compared to the check with 19 kg/ha.

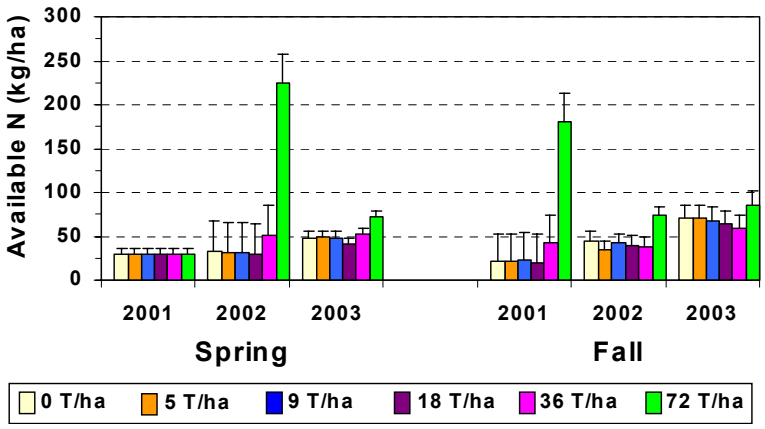

Fig. 1: Effect of a single application of manure at various rates on available N (0-30 cm) in the spring and fall of 2001, 2002 and 2003). Error bars represent SE of the mean difference.

The low degree of elevation in available N is attributed to the low level of inorganic N in the poultry manure. Tests conducted on the manure showed that only 15% of the total N in the manure was inorganic. This also explains the low leaching levels showing no elevation in the deeper soil profile even at the highest rate. At 36 T/ha rate, only 72 kg/ha of inorganic N was applied. The crop could have absorbed most of this N. At double this rate, 154 kg/ha of inorganic N was applied, meeting crop demand and leaving a surplus large enough to elevate soil available N levels in the 0-30 cm soil depth.

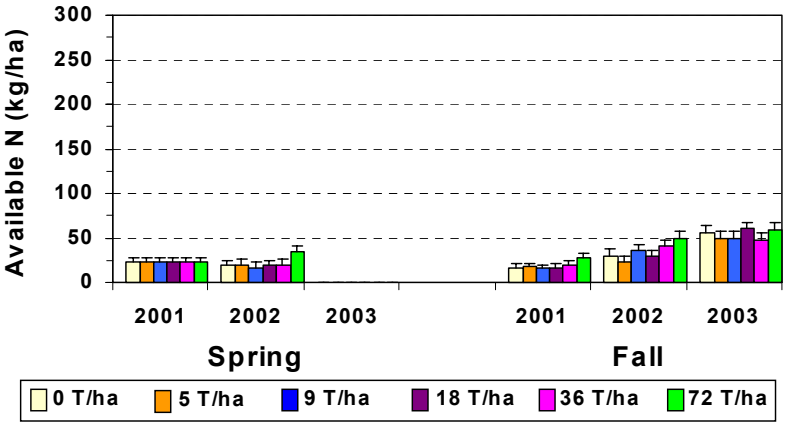

Fig. 2: Effect of a single application of manure at various rates on available N (30-60 cm) in the spring and fall of 2001, 2002 and 2003). Error bars represent SE of the mean difference.

Poultry manure application enhanced grain and straw yield of canary seed. However, only treatments receiving 36 and 72 T/ha of manure showed a significantly higher grain and straw yield than the check (Fig. 3). Although grain yields at the two highest rates were statistically significant, greater absolute increases were observed in straw yield. Data taken in 2002 showed that N yield of the grain and straw and grain protein were higher than in the check in treatments receiving the two upper application rates (Table 2). No significant differences in grain and straw P yield were observed.

Crop responses showed that little additional benefits are achieved when manure application rates were doubled from 36 T/ha to 72 T/ha. Under the droughty conditions of 2002, the total N yield of

canary seed was 40 kg N/ha. Assuming that N yield in treatments receiving the two highest application rates in 2002 was 75% of that in 2001 as indicated by grain and straw yield, it follows that N yield in 2001 was in the neighborhood of 50 kg N/ha. If so, application of 36 T/ha of poultry manure supplied sufficient N for canary under the prevailing dry conditions. Doubling this amount resulted in excess available N causing a significant elevation of available N in the soil as shown in Fig. 1.

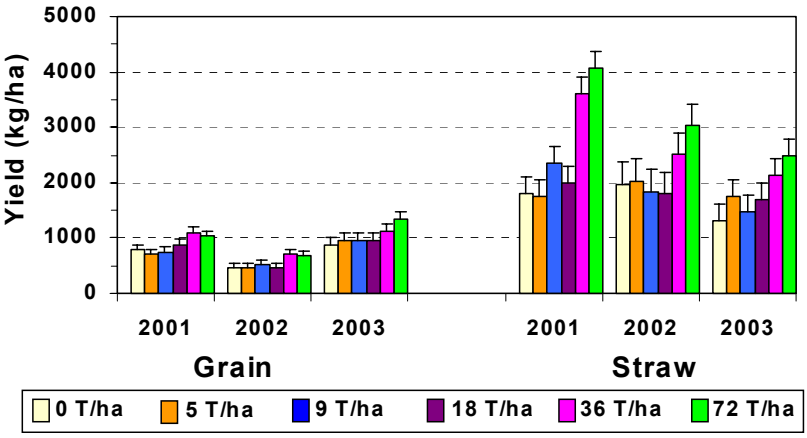

Fig. 3: Effect of a single application of manure at various rates on canary grain and straw yield in the first year (2001) and subsequent years (2002 and 2003). Error bars represent SE of the mean difference.

Other soil characteristics determined showed that application of poultry manure had a significant impact on total P, available P, available K, pH and EC (Table 3). Available K was not significantly affected by manure addition at the lower rates of application (< 36 T/ha). This is not surprising since these soils have very high indigenous K fertility due to their high clay content. Notwithstanding, the high rates produced significant increases in soil extractable K. Available P was significantly higher in the 72 T/ha treatment compared to the rest of the treatments, with the 72 T/ha rate having about 60 kg extractable P/ha in the 0-30 cm depth compared to about 20 kg extractable P/ha in the other treatments. Although no significant increases in available P were observed in the third year (2003), total P was significantly elevated in the third year at the 72 T/ha rate compared to the check or the other application rates. The high rate of 72 T/ha also caused a small but statistically significant increase in EC, which is indicative of some accumulation of soluble salts at this rate. No effect on pH was observed even at the high rate of application.

Table 2: Effect of a single application of manure at various rates on N yield, P yield and protein of canary in 2002.

Manure	N Yield		P Yield		Protein
Rate	Grain	Straw	Grain	Straw	Grain
Tonnes/ha	- - - - - - - - - - (kh/ha) - - - - - - - - -				%
0	13 b	10 c	2.6	1.3	17.1 bc
5	12 b	9 c	2.5	1.2	15.9 c
9	14 b	9 c	2.8	1.4	16.5 bc
18	13 b	8 c	2.7	1.2	16.6 bc
36	21 a	14 b	3.8	1.2	18.3 ab
72	21 a	19 a	3.6	1.6	19.3 a

Table 3: Effect of a single application of manure at various rates on total P, available P (Av.P), and available K (Av.K), pH and EC in subsequent years (2002 and 2003).

Manure	Total P	Av.P		Av.K		pH		EC	
Rate	2003	2002	2003	2002	2003	2002	2003	2002	2003
Tonnes/ha	- - - - - - - - - - - - - - - (kh/ha) - - - - - - - - - - - - - - -							- - - - mS/cm - - - -	
0	3040 c	21 b	13	2158 bc	2404 c	7.2	8.3	0.28 b	0.35 b
5	2845 c	21 b	9	1986 bc	2742 c	7.1	8.3	0.28 b	0.34 b
9	3068 c	19 b	10	1953 bc	3018 bc	7.1	8.2	0.29 b	0.33 b
18	3256 bc	19 b	12	1790 c	2936 b	7.1	8.2	0.27 b	0.34 b
36	3706 b	24 b	10	2481 ab	3591 ab	7.1	8.3	0.36 b	0.37 b
72	5279 a	64 a	13	3088 a	4208 a	6.9	8.1	0.72 a	0.46 a

Conclusions

High rates of poultry manure application enhanced available N, crop yield, and grain protein. Post-harvest available N was significantly elevated only at the 72 T/ha rate. Residual inorganic N was observed only at the highest rate in Year 2 and concentrated in the 0-30 cm profile. These results showed that a single application of 36 T/ha of poultry manure may be best to optimize plant nutrition for the first three years and minimize nutrient and salt accumulation in the soil.

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