Canola response to swine manure additions in East Central Saskatchewan

J. Charles', J.J. Schoenau[1] andf. Hultgreen[2]
'Department of Soil Science, University of Saskatchewan
'Prairie Agriculture Machinery Institute, Humboldt, Saskatchewan

Introduction

There has been a rapid growth in the swine industry in Saskatchewan in response to the availability of new lucrative markets. Concomitantly, there have been concerns about the environmental impact of this expansion, particularly with respect to the management of manure.

Nutrient management is a key component of a manure management system (USDA-SCS, 1992). The goals of nutrient management include maintaining crop yields at an economically feasibIe level, optimizing the available nutrient sources, and avoiding environmental degradation (Shuyler, 1994). Our research attempts to develop best management systems with respect to the land application of swine manure. The research described in this paper examines optimum application rates for canola on two soil types in East Central Saskatchewan near Humboldt.

Materials and Methods

The two sites chosen were both in the Black soil zone. One site (Dixon) is on a Blaine Lake Association soil type, which is a clay loam, and representative of a good agricultural soil. The other site (Burr) is on a Meota Association soil type, which is a sandy loam, and representative of a more marginal agricultural soil.

A randomized complete block experimental design was employed using four replicates. The plot size was one hundred by ten feet. Swine manure was injected using a twelve inch spacing in late fall (October, 1996) at the Burr site and early spring (April, 1997) at the Dixon site. The manure was applied at three different rates, as were the urea treatments. The urea was side banded at seeding in early May. Plots were seeded with Argentine canola, ***Brassica napus,*** using an air seeder . An unamended (unfertilized) treatment was used as the control.

Soils were sampled to a 24 inch depth in each plot using a punch truck in the spring, after manure application, and in the fall, after harvest. The spring soil samples were air-dried and ground before analysis while the fall soil samples were analyzed at a field moist state. Levels of soil inorganic nitrogen (N), that is, ammonium (NH,+) and nitrate (NO, -) were determined by colorimetry after extraction with 2M potassium chloride (KCl). Additionally, determinations such as pH, and sodium absorption ratio (saturated paste), and % carbon and N (CNS analyzer) were done on the control plots for soil characterization purposes.

Plots were harvested in late August using one meter quadrats from the same area that the soil samples were taken. Plants were harvested, using sickles, just above ground level. Plant samples were dried and weighed for biomass yield. The samples were then threshed, and the collected grain was subjected to further cleaning before grain yield was recorded. A sub-sample of the straw was taken during threshing for subsequent plant tissue analysis. Plant tissue and grain samples were analyzed for %N using a LECO CNS analyzer. Total plant N uptake was taken to be biomass yield x %N (straw and grain analyzed separately and subsequently combined).

The manure samples were analyzed for their constituent nutrients using both inductively coupled plasma emission spectroscopy and colorimetry after sulfuric acid digestion. Sulfate determination for the manure applied at the Burr site was done using anion exchange resin membranes.

The treatments are as follows:

1. Check (no manure or fertilizer) with injector pass @ 12”
2. 1 X swine manure with injector pass @ 12”
3. 2X swine manure with injector pass @ 12”
4. 4X swine manure with injector pass @ 12”
5. 1X urea fertilizer side banded at seeding
6. 2X urea fertilizer side banded at seeding
7. 4X urea fertilizer side banded at seeding

(i) 1 X = 50 lb N/ac urea (both sites), 63 lb N/ac manure (Dixon site) and 182 lb N/ac manure (Burr site)
(ii) 2X = 100 lb N/ac urea (both sites), 126 lb N/ac manure (Dixon site) and 35 1 lb N/ac manure (Burr site)
(iii) 4X = 200 lb N/ac urea (both sites), 252 lb N/ac manure (Dixon site) and 703 lb N/ac manure (Burr site)

It was originally intended that the urea fertilizer and swine manure be applied at equivalent N rates to facilitate comparisons between the two sources of N, but the variability of the swine manure N along with calibration problems encountered when applying the manure at the Burr site caused this goal not to be achieved.

Results and Discussion

Table 1. Characteristics of the soils at both sites (0 - 12 inches)

Site	Association	Texture	pH	Total C %	Total N %	SAR
Dixon	Blaine Lake	Clay loam	7.9	2.34	0.18	0.4
Burr	Meota	Sandy loam	7.8	3.32	**0.19**	**0.58**

Table 1 shows that apart from texture, these two soils have similar characteristics. The Dixon site is likely a superior soil in terms of agricultural production however, due to its higher clay content and lack of gravel lens at depth as found in the Burr site.

Table 2. Average nutrient composition of liquid manure slurry used in the trials

Nutrient	Burr swine manure	Dixon swine manure
Total N	2941.3 (725.2)✳	1931.2 (28.6)
NH_4-N	1153.4 (52.6)	1446.7 (195.1)
Total P	828.6 (853.4)	175.4 (18.4)
Total K	1392.7 (116.8)	1053.2 (11.0)
SO_4-S†	14.11 (4.6)	
Total Cu	22.61 (18.07)	4.5 (0.2)
Total Mn	13.77 (14.99)	2.6 (0.6)
Total Zn	42.23 (36.11)	6.5 (0.6)
Total Fe	172.21 (167.73)	20.3 (2.1)
Total Mg	614.62 (640.66)	171.5 (12.8)

† SO_4-S analysis not done on Dixon site
✳ Data are in ppm (μg nutrient/g manure) wet basis with standard deviations in parentheses

From Table 2 it can be seen that swine manure supplies other nutrients along with N. High standard deviations for total N, phosphorus (P) and copper (Cu) indicate that these nutrient levels are quite variable which makes uniform application very difficult Approximately 40% (Burr) and 75% (Dixon) of the applied swine manure nitrogen existed in an immediately plant available ammonium N form. No detectable nitrate N levels were found in the swine manure applied to both sites.

Table 3. N balance for Burr swine manure trial

Treatments	Total N applied (lb/ac)	Plant available N after manure application at O-24" (lb/ac)	Plant N uptake (seed and straw) (lb/ac)	Plant available N after harvest at O-24" (lb/ac)
control	0	56	25	30
1X manure @ 12"	182	155	96	43
2X manure @ 12"	351	162	133	87
4X manure @ 12"	703	360	100	463
1 X banded urea	50	175	53	55
2X banded urea	100	158	90	67
4X banded urea	200	338	70	236

Table 3 shows that high levels of inorganic N were found at the end of the growing season at the Burr site at high rates of manure (700 lb N/ac) and urea (200 lb N/ac) The ammonium N and the minerahzed N supplied much more N than the plants could take up at these high application rates. Germination problems and stand damage were also observed at these rates which adversely affected plant uptake.

Figure 1. Yield of Burr swine manure trial

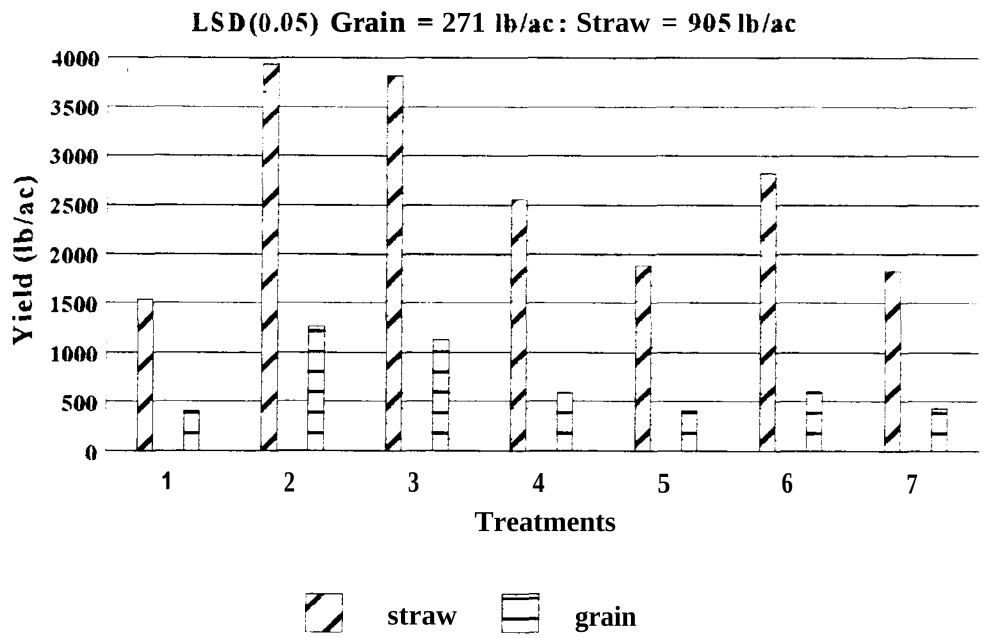
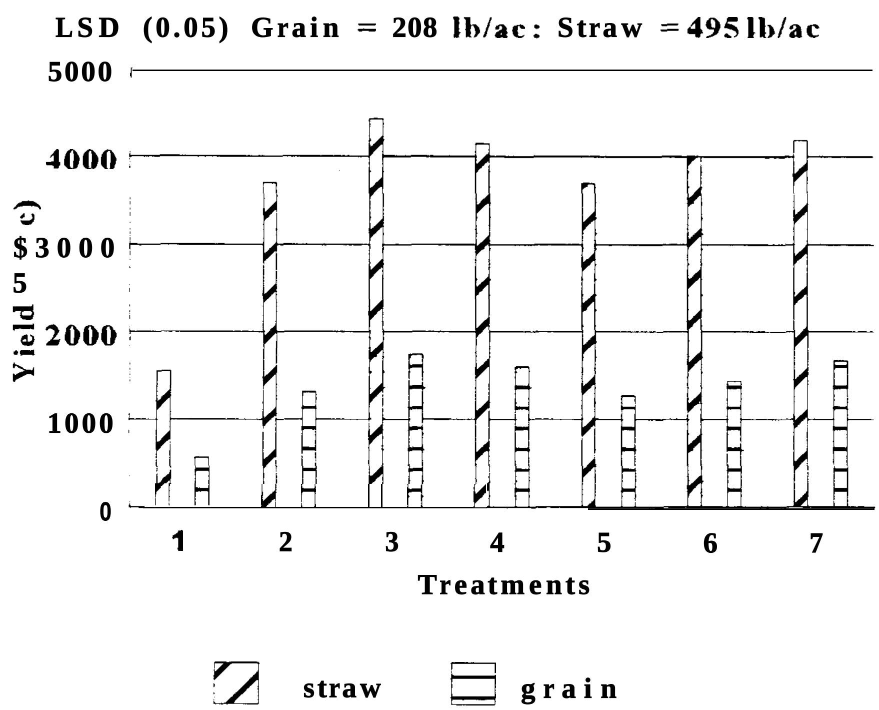


Figure 2. Yield of Dixon swine manure tial



There was greater yield response to the swine manure and urea fertilizer additions at the Dixon site. There were significant differences between treatments at the Dixon site ($p < 0.05$), but not at the Burr site. The optimum rate of total N applied as swine manure to maximize yield would be around 100 lb N/ac at the Dixon site under 1997 growing season conditions (very dry).

The Burr site was drier (sandier soil) which limited yield response to both the swine manure and urea. For this soil, optimum rates of N application would be lower in dry years such as 1997.

Conclusions

Response of residual soil inorganic N levels to swine manure addition is dependent on application rate and plant uptake. Very high application rates (700 lb N/ac swine manure and 200 lb N/ac urea) combined with low available moisture resulted in high residual inorganic N after harvest at the Burr site. Germination problems and stand damage were also observed at these high application rates at this site, and this resulted in decreased plant N uptake and high residual inorganic N levels after harvest. Crop yield response to applied swine manure is dependent on soil type and growing season conditions. Canola yield response at the Dixon site from 60 lb N/ac applied as swine manure was approximately equivalent to 50 lb N/ac applied as urea. Some additional yield response from swine manure compared to urea may be expected due to other nutrients in the manure such as phosphorus (P) and potassium (K).

Acknowledgments

The authors gratefully acknowledge the financial support of the Agri-Food Innovation Fund and the Canadian Commonwealth Scholarship and Fellowship Program. Special thanks are extended to Mr. Sid Farkas for his valuable assistance in the field.

References

Shuyler, L.R. 1994. Why nutrient management? Soil Water Conserv. 49:3-5.

United States Department of Agriculture - Soil Conservation Service. 1992. Agricultural waste management field handbook. Washington, D.C.