Western Beef
Development Centre

EFFECT OF COMPOSTED AND NON-COMPOSTED MANURE ON SOIL NUTRIENTS, FORAGE YIELD AND ANIMAL PERFORMANCE

Introduction

The growth of livestock production on the prairies has been accompanied by a growing need to address the issue of animal manure. An increased cost of applying inorganic fertilizers has led to the increased use of cattle manure as a nutrient source. Composted or non-composted manure is an excellent source of nutrients for crop production. Manure also contains organic matter, which can be used to improve soil physical and chemical properties. Organic matter in manure is likely to have far greater value than the nutrients it contains if applied to a low organic matter or eroded soil. Not all of the nitrogen in manure is available for crop uptake at the time of application. Organic nitrogen is available to the plants; however inorganic nitrogen needs to be mineralized by soil microbes before it can be utilized by pasture plants. Manure is beneficial to crops when applied at appropriate rates but can create soil, water and air quality problems when over-applied. Manure is generally applied at rates to meet the nitrogen requirements of crops; however this may leave potential for build-up of phosphorus at the soil surface (P-loading), which is capable of contaminating surface water by runoff. To reduce the effects of "P-loading," studies continue to evaluate the environmental impact of this nutrient (Rynk 1992).

The Western Beef Development Centre is pursuing various ways to manage the manure/compost resource, as well as to take advantage of its nutrient value. In this project, pasture plots were monitored to determine differences in soil nutrient levels, forage production and grazing potential as affected by application of fresh manure or composted material.

Crested Wheatgrass Pasture

In September 2002, solid cattle manure and compost was applied to a 30-acre stand of crested wheatgrass (*Agropyron cristatum*) pasture at the Termuende Research Farm, near Lanigan, Saskatchewan. The field was sub-divided into two 15-acre paddocks each receiving approximately 30 tons per acre of solid manure or compost. An adjacent fifteen acres of the same pasture served as the control area, receiving no manure or composted material.

Nutrients Levels of Manure and Compost Material

Manure samples were analyzed for levels of nitrogen (N), phosphorous (P), potassium (K) and sulfur (S). According to lab analyses, solid manure applied at the rate of 30 tons per acre provided 258 lb N/acre, 54 lb P/acre, 255 lb K/acre, and 66 lb S/acre. When compost was applied at the same rate, lab analyses indicated it provided 840 lb N/acre, 130 lb P/acre, 1280 lb K/acre, and 180 lb S/acre. To equal the nutrients supplied in the fresh manure treatment, the compost application would be reduced to between 9 to10 tons per acre.

Manure Application

The decision to apply livestock manure on established perennial pastures must be timed in accordance with the period of use. In this study, manure was applied mid-summer and pastures were not grazed until the following spring. Following application, the pasture was harrowed to allow for leveling, breakdown and distribution of the manure. Similar rates of both composted and non-composted manure were applied to evaluate if any additional benefit was derived from the high levels of nutrients in the composted manure.

Results

Available soil nutrient contents were measured prior to manure application (0-12 inches) in August 2002 then repeated the following May of 2003 (post-application of manure/compost) for nitrogen, phosphorous, potassium and sulfur. Pre-application levels of nutrients indicated low N, low to moderate P levels and sufficient K and sulfur (Table 1). This would indicate the grass species are utilizing manure nitrogen during fall and spring growth, however much of the fall applied N from the manure is currently not available to the forage or lost to the environment. Past studies have shown that up to 40% of the nitrogen contained in surface applied manure (non-incorporated) is lost to leaching, runoff or volatilization (PPC 2002). However, soil nutrient levels after compost application were shown to increase nearly 8 1/2 times for nitrogen and double for phosphorous and potassium compared to pre-application levels.

Phosphorous levels (P_2O_5) were low (6 lb/ac) on the control area and moderate on the compost (21 lb/ac) and manure (31 lb/ac) pastures before treatments were applied in the fall of 2002. However, after organic nutrients were applied at 30 tons per acre, P levels doubled on the crested wheatgrass pasture receiving compost but were 38 % lower on pastures that received the fresh manure treatment. This may indicate that the manure is supplying phosphorous in a form that is unusable by the plants (PPC 2002).

Table 1. Soil nutrient levels (lb/ac)

	NO_3-N	P_2O_5	K_2O	SO_4
2002				
Control[1]	10	6	632	76
Compost	12	21	737	83
Solid Manure	10	31	786	28
2003				
Control[2]	9	8	677	78
Compost	101	41	>1200	91
Solid Manure	17	12	716	86

[1]soil test August 2002; [2]soil test May 2003

Figure 1. Response of compost (left) and manure (right) on pasture

Two observations from the field that received compost are: (i) the presence of annual weeds which indicates the viability of weed seeds to germinate from the composted product; (ii) the rate at which compost was applied caused some loss of pasture growth (Figure 1). Weed seed survivability indicates that during the active composting phase the manure never reached a core temperature of 55° to 65° Celsius.

Pasture Production

The study site was a long established (>30 year) stand of crested wheatgrass averaging less than a ton per acre of production (Table 2). Pastures were evaluated under the various treatments and dry matter yield (DMY) was determined in July by clipping ten 0.25 m^2 quadrats per paddock or treatment area. Comparisons were made between treated pastures and the control field, which received no manure or compost. Paddocks that received fresh manure or compost yielded 81% and 131% greater production than the control area, respectively.

Compost application increased forage crude protein by 75% compared to the control; however, energy values of the pasture samples were similar between treatments (Table 2).

Table 2. Forage yield and quality of crested wheatgrass pastures

Pasture Treatment	Lb/Ac	Ton/Acre	CP[2]	TDN[3]
Control[1]	1360	0.68	8.0	58.6
Fresh	2464	1.23	9.8	60.8
Compost	3147	1.57	14.0	61.1

[1]yield estimates taken mid-July; [2]CP=crude protein; [3]TDN=total digestible nutrients

The use of manure as a nutrient source on established forage stands is an alternative to inorganic fertilizers. Because of rising prices for inorganic fertilizers, producers are realizing the benefits of utilizing livestock manure for crop production nutrition. However, this project would suggest manure application rates greater than 30 tons per acre are not recommended due to potential buildup of P and excessive losses of nitrogen. Also the high rate of manure application affected pasture growth and grazing behaviour of the animals.

Grazing Management

Above normal rainfall was received at the study site in the fall of 2002 and spring moisture conditions allowed the treatment areas to be grazed the following summer. Electric fencing was used to subdivide treatment areas.

Animal weights were recorded at the start and end of the grazing periods for each treatment pasture. Twenty-five Angus cow-calf pairs were allocated to each of three fields starting on July 16 and ending July 30, 2003. Cow body weights averaged 1357 pounds and calf weights averaged 308 pounds. Pastures were monitored daily and the animals were removed from each area when available forage was less than four inches in each pasture.

The control, manure and compost pastures were grazed by cow-calf pairs for five, eight and fourteen days, respectively. Total animal grazing days (AGD) were 14, 22 and 38 AGD for the control, non-composted and composted pastures, respectively (Table 3).

Table 3. Cow and calf performance grazing treatment pastures

	Grazing Days	ADG[2] (lbs)	
		Cows	Calves
Control	14	0.66	3.23
Fresh Manure	22	1.26	3.50
Compost	38	3.14	3.58

[1]ADG=average daily gain

Cows grazing the pasture that received compost gained 2.4 lb/day more than the cows grazing the control area. Calf gain was similar between pastures. However, the short grazing periods make it difficult to assign any definitive assumptions from these results. The greatest number of grazing days was observed on the pasture that received composted manure. Application of the compost more than doubled the time cow-calf pairs grazed the field compared to cows in the control pasture. To better assess the value of composted or non-composted manure on pasture yield and subsequent cattle performance, data will continue to be analyzed each year.

Economic Comparison

The quantity and availability of nutrients transported to the field are key factors in determining the economics of applying manure or compost to rejuvenate old pasture stands. The increase in pasture productivity after application of non-composted and composted manure was 1104 and 1788 lb/acre or 81 and 131%, respectively, compared to the control. The amount of organic N available to the crop is estimated to be 30% of the total in the first year after application (PPC 2002). Therefore, total N in solid manure was estimated at 258 lb N/acre which would suggest 77 lbs of N is available from the non-composted manure which resulted in 14 lb additional dry matter production (DMP) per pound of N applied. Total N in the compost was 840 lb N/acre of which only 30% or 252 lb of N/ton are available from the compost which resulted in only 7 lb additional DMP per pound of N applied.

The increased costs associated with composting as compared to handling raw manure include hauling to a composting site, windrow turning, maintenance and loading for transport to the field. These costs total $6-8 per ton of compost (Larney 2000). Costs associated with this project were $25/acre to apply the organic nutrients at 30 tons per acre. With respect to the area receiving non-composted manure, by spending $25/acre, pasture production increased by 1104 pounds, which is a cost of 2.3 cents per pound of extra production. For the area receiving composted manure, by spending $31/acre (hauling + composting cost), pasture yield increased by 1788 lbs. Therefore at 30 tons per acre, the increased yield cost was 1.7 cents per pound of additional production. Finally, the response from application of either composted or non-composted manure was an increase in soil nitrogen, forage yield and animal performance. Annual monitoring of the study site needs to be conducted to determine any additional benefits.

References

1. Larney, F. 2000. An overview of manure composting at Lethbridge Research Centre.
2. Prairie Province Committee (PPC) on Livestock Development and Manure Management. 2002. Tri-provincial manure application and use guidelines: Calculating manure application rates. SAFRR, AAFRD, MAF.
3. Rynk, R. 1992. On-farm composting handbook. Natural Resource, Agriculture, and Engineering Service (NRAES) Cooperative Extension publication. Ithaca, NY. 187 pp.