

Using manure from cattle fed dried distillers' grains with solubles (DDGS) as fertilizer: Effects on nutrient accumulation in soil and uptake by barley forage

Xiyi Hao^{1*}, Mônica B. Benke¹, Pam Caffyn¹, H. Henry Janzen¹, Jeff Schoenau², and Tim A. McAllister¹

¹Agriculture and Agri-Food Canada, Research Centre, Lethbridge, AB; ²Saskatchewan Centre for Soil Research, University of Saskatchewan, Saskatoon, SK

(*Corresponding author: xiyi.hao@agr.gc.ca)



Introduction

- Ethanol production generates large amounts of dried distiller's grains with solubles (DDGS).
- DDGS are valuable feedstuff for animals, with high fiber, crude protein and P content.
- Therefore, understanding nutrient accumulation and plant uptake in soils receiving manure from cattle fed DDGS is crucial for their long term use.

Research objective

Investigate nutrient accumulation in soil and uptake by barley forage grown in soil amended with manure from DDGS-fed cattle.

Materials and methods

- This study was conducted in a growth chamber at 20°C and 16 h daylight
- Crop:** barley (*Hordeum vulgare*) grown and harvested as forage feed (at soft dough) for 6 cycles
- Treatments:** Control (CK), NP fertilizer (Fert), manure from typical barley grain diet (REG), manure from diet with DDGS replacing 60% barley grain (DDG) (Table 1)
- Rates:**
 - Fertilizer: 100 kg N ha⁻¹, 50 kg P₂O₅ ha⁻¹
 - REG and DDG Manure: 30, 60, 120, 180 Mg ha⁻¹
- Application frequency:** one time and repeated applications before each growing cycle
- Analysis:** Soil [TN, TP, available N (AN) and P (AP)] and barley forage (yield, TN, TP)

Table 1. Manure and soil chemical properties.

Parameters ^a	Manure		Soil
	DDGS	Regular	
Available-P (mg kg ⁻¹)	1764	697	10
TP (mg kg ⁻¹)	10164	7556	308
NO ₃ -N (mg kg ⁻¹)	45	351	33
NH ₄ -N (mg kg ⁻¹)	2786	561	3
TN (g kg ⁻¹)	17.1	18.7	0.8
TC (g kg ⁻¹)	360	423	8.3
pH (in water)	7.3	7.8	7.9
EC (dS m ⁻¹)	10.9	9.4	0.3

Results and discussion

- With one-time manure application, soil TN from REG180, DDG120 and DDG180 treatments were higher ($P < 0.05$) than the CK (Fig. 1a, 1b and 1c). Manure treatments did not ($P > 0.05$) significantly affect soil AN (Fig. 1d, 1e and 1f). Soil TN contents from DDG manure treatments were similar ($P > 0.05$) to those receiving REG manure application, reflecting similar TN content in both types of manure (Table 1).
- With repeated manure application after each harvest, small but significantly ($P < 0.05$) higher soil TN contents occurred in most treatments compared to CK for all six crop cycles (Fig. 1b and 1c). As with one-time applications, there was no ($P > 0.05$) difference in soil N content between the two types of manure.

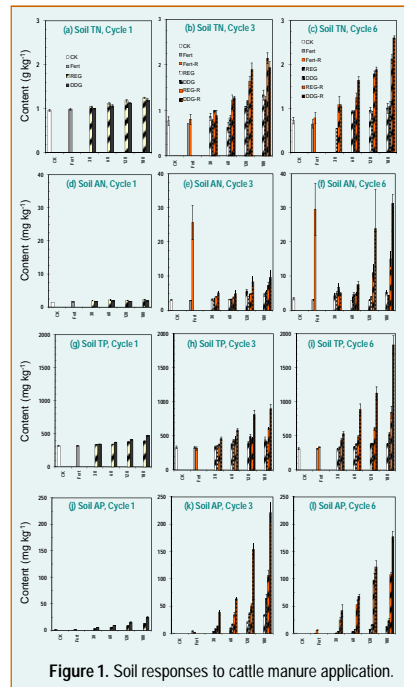


Figure 1. Soil responses to cattle manure application.

- One-time application of cattle manure, regardless of whether the manure was REG or DDG, led to higher ($P < 0.05$) soil TP (only at rates of 120 and 180 Mg ha⁻¹) (Fig. 1g, 1h and 1i) and AP content (Fig. 1j, 1k and 1l) than CK for all cycles. When the effects of both types of manure were compared, DDG manure resulted in much higher ($P < 0.05$) soil AP content than REG manure. This is consistent with the initial higher AP content in DDG than REG manure (Table 1).
- With repeated manure applications, soil TP and AP contents in all manure treatments were higher ($P < 0.05$) than CK after each growth cycle. On average, soil TP and AP contents were 2.0 and 64.7 times higher in REG180 and 3.5 and 133.6 times higher in DDG180 than in CK.
- After a one-time manure application, barley yield (Fig. 2a, 2b and 2c) from the DDG180 treatment was higher than CK with values from cycles 1 and 3 being significant ($P < 0.05$). Inorganic fertilizer and REG and DDG manures did not ($P > 0.05$) affect barley TN content (Fig. 2d, 2e and 2f). Barley TP content from manured treatments (only rates 120 and 180 Mg ha⁻¹) were higher ($P < 0.05$) than in CK (Fig. 2g, 2h and 2i). The TP contents in barley forage were similar ($P > 0.05$) when the two types of manure were compared.
- Following repeated manure applications, barley yields in DDG manure treatments (60, 120 and 180 Mg ha⁻¹) were higher ($P < 0.05$) than in CK for all cycles (Fig. 2b and 2c). Only repeated inorganic fertilizer applications resulted in higher barley TN than in CK (Fig. 2e and 2f). Barley TP content in most manure treatments were higher than in CK (Fig. 2h and 2i). Again there were no ($P > 0.05$) manure type effects on barley TP contents.

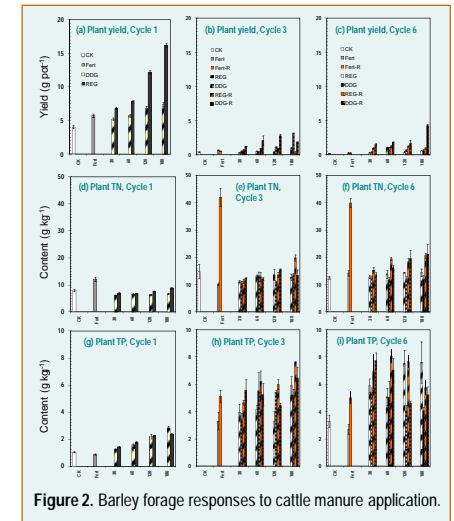


Figure 2. Barley forage responses to cattle manure application.

Conclusions

- The effects of REG and DDG manure on soil TN content were similar.
- DDG manure application resulted in higher soil TP and AP than REG manure.
- Soil AP content from DDG manure treatment was double that in the REG manure treatment, increasing the risk of P offsite transport and pollution.
- The effects of REG and DDG manure on plant TN and TP contents were similar.
- Manure management practices should be adjusted to account for compositional changes in DDGS-fed cattle manure to minimize any possible negative impact on the environment.