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Nutrient availability and biomass yield in soils receiving manure from cattle fed DDGS diet

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Background

The steady rise in bio-ethanol production has led to increased use of dried distiller grain with solubles (DDGS) in feedlot cattle diets. Feeding of cattle with DDGS (DM) diet increases the excretion of nitrogen (N) and phosphorus (P) and the fraction of water soluble P in manure compare to those fed a regular diet (RM). Apart from the diet fed to the animal, the type of bedding material used can also influence the release of these nutrients especially N when they are utilized as a fertilizer source. Managing a balance between crop nutrient demand and the amount of manure applied is key in preventing further build-up of manure nutrients in soil and the eventual loss to the environment. In this greenhouse study, we compared repeated applications of RM versus DM containing construction waste as bedding over five 40-day cycles on canola (*Brassica rapa* L.) dry matter yield, nutrient N uptake, soil available N, and apparent N recovery in a Black Chernozemic loam (Typic Hapocryoll) and a Brown Chernozemic sandy clay loam (Aridic Haploboroll). The study also examined the influence of Nitrapyrin (nitrification inhibitor) in improving manure N utilization of the canola crop

Materials and Methods

- The above soils (0- to 15-cm layer) were collected from sites in south-central Alberta
- Manure was collected from a beef cattle feedlot at the Lethbridge Research Centre in southern Alberta
- Regular manure (RM) was from heifers fed a typical finishing diet of 85% (dry wt.) barley grain, 10% barley silage, and 5% mineral supplement
- DDGS manure (DM) was from cattle fed 45% barley grain, 40% wheat DDGS, and the same amount of silage and mineral supplement as the typical diet
- Initial soil and manure properties are presented in Table 1
- Design: CRD with a 5 × 2 × 2 factorial treatment layout and three replications
- Treatments
  - Amendments: urea plus Triple super phosphate (Fer), DM, DM plus construction waste (DMcw), RM and unamended control (Con)
  - Soils: Black and Brown Chernozems
  - Nitrification Inhibitor: With or without Nitrapyrin [N-Serve®; 2-chloro-6-(trichloromethyl)-pyridine] added as a nitrification inhibitor
- 1 kg of soil (< 2 mm) placed in 2-L plastic pots
- The Fertilizer treatments received 140 kg N ha^{-1} (urea) and 11 kg ha^{-1} P ($Ca(H_2PO_4)_2$). Manured treatments received 60 Mg manure ha^{-1} yr^{-1} (wet weight) each cycle
- Canola (*Brassica rapa* L.) was grown for five cycles
- Soils were leached with deionized water 15 d after amendment application
- Greenhouse maintained at a day/night temperature of 23/17℃ and a photoperiod of 16 h
- Five crop growth cycles of 7 wk each tested over 200 d
- Plants harvested after each cycle for total N determination and soil subsamples taken for NO_3-N and NH_4-N determination
- Dry matter yields determined after each harvest

Table 1. Properties of soil used in the greenhouse

Property	Black Chernozem	Brown Chernozem	RM	DM	DMcw
Total P, g kg^{-1}	0.2	0.1	6.7	8.3	6.1
Total C, g kg^{-1}	56	23	365	337	330
Total N, g kg^{-1}	4.8	2.0	26	28	21
C to N ratio	12	11	14	12	16
NO_3-N, mg kg^{-1}	19	30	0.2	0.1	0.3
NH_4^+-N, mg kg^{-1}	4.0	2.4	778	1556	1751
PO_4-P, mgkg^{-1}	30	28	818	1021	563
pH	7.7	8.0	8.2	7.9	7.3
EC, dS m^{-1}	0.6	0.3	-	-	-
Clay, g kg^{-1}	200	230	-	-	-
Silt, g kg^{-1}	310	280	-	-	-
Sand, g kg^{-1}	490	490	-	-	-
Dry matter content, g kg^{-1}	-	-	271	303	375

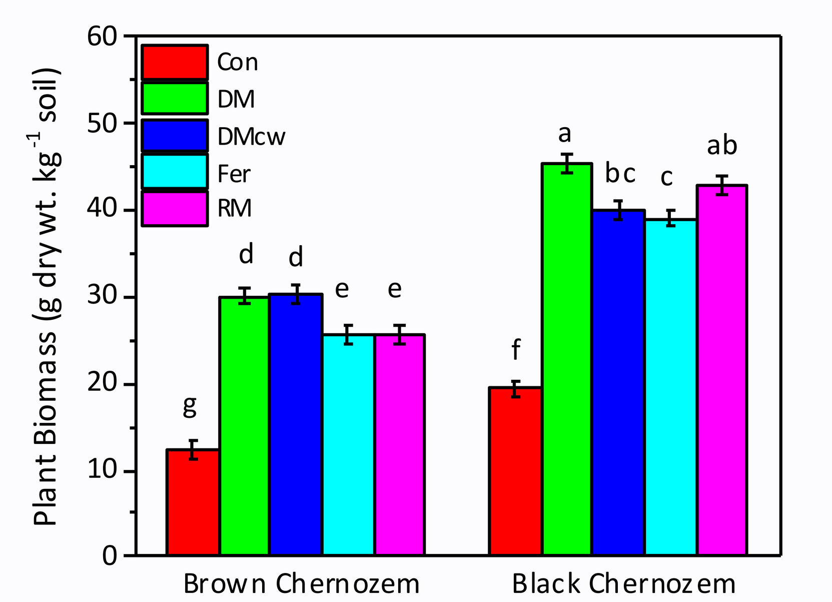

Fig.1. Cumulative dry matter yield of Canola

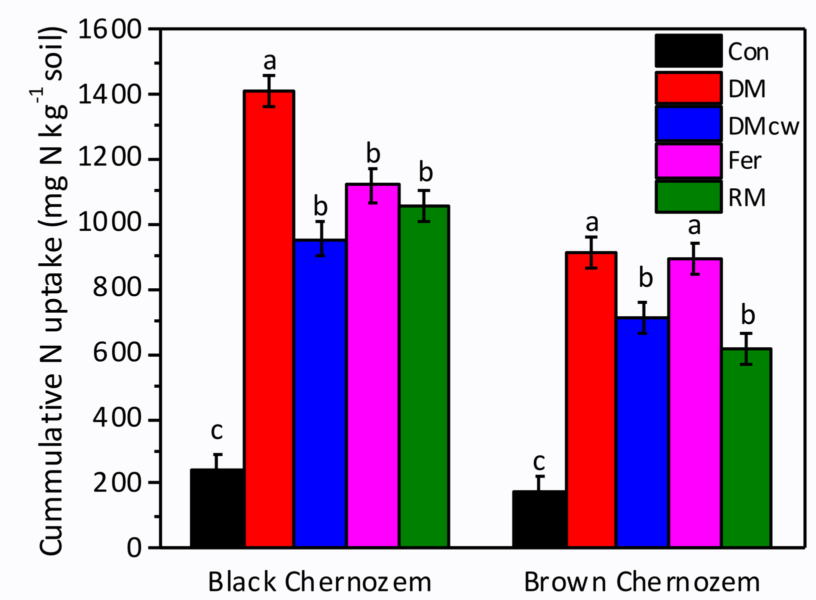

Fig.2. Cumulative N uptake

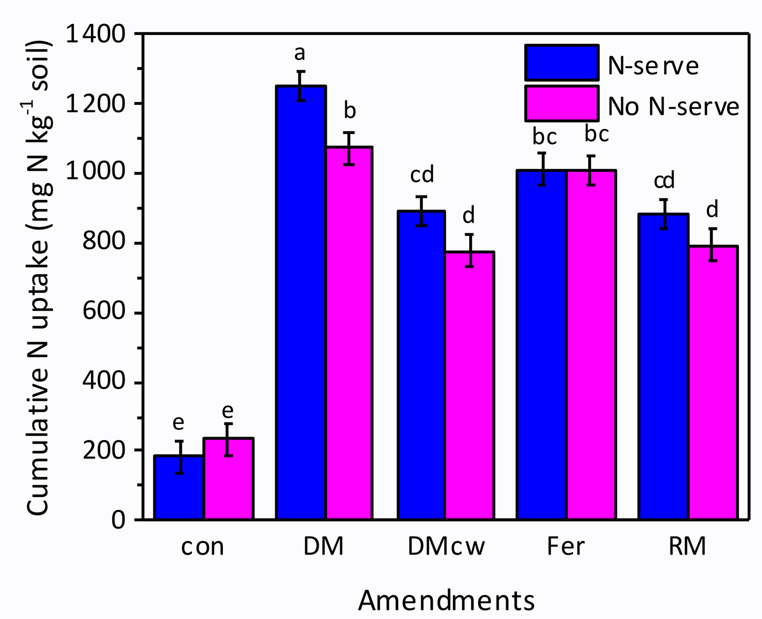

Fig.3. Effect of nitrification inhibitor on Cumulative N uptake

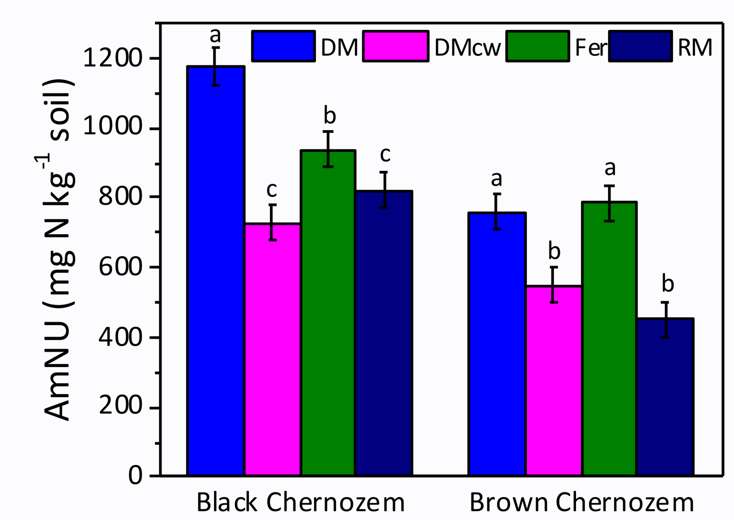

Fig.4. Amendment-derived N uptake

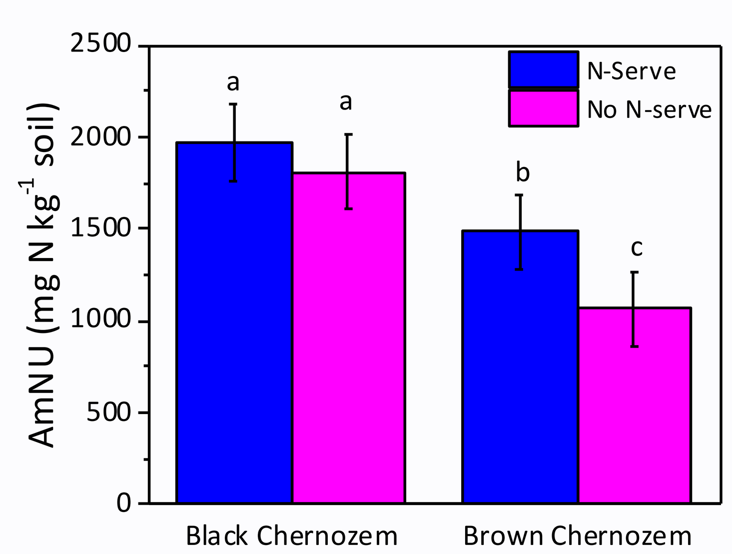

Fig.5. Effect on nitrification inhibitor on amendment-derived N uptake

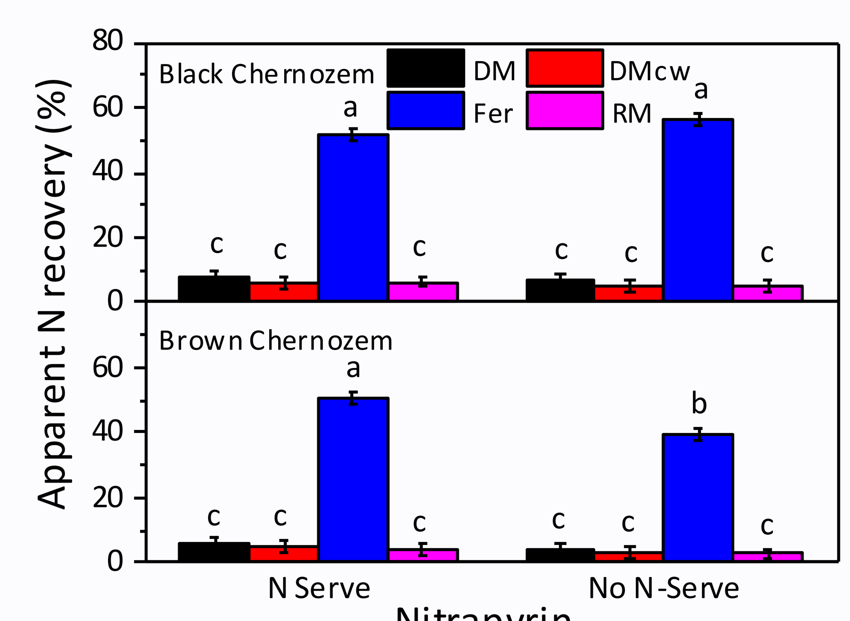

Fig.6. Amendment N recovery of Canola

Acknowledgements

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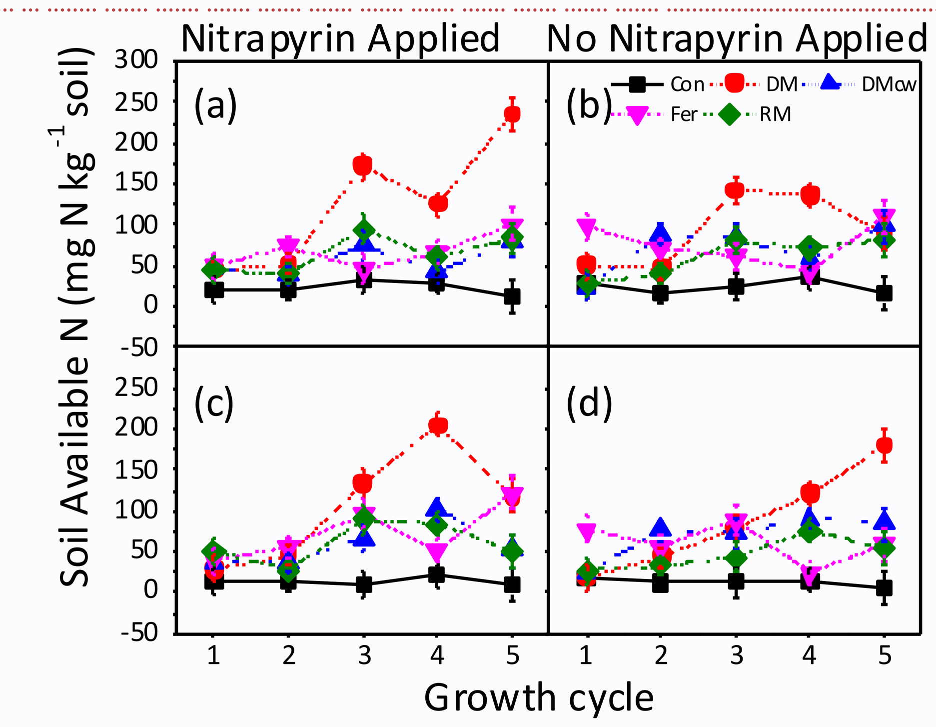

Fig.7.Effect of manure type and nitrification inhibitor on soil available N in Black and Brown Chernozem

Results and Discussion

- Canola dry matter yield was greater for DM and DMcw than for the other treatments in the Brown Chernozem. However, yield was not different between DM and RM in the Black Chernozem (Fig. 1)
- Cumulative N uptake decreased in the order: DM > DMcw ≈RM ≈ Fer in the Black Chernozem and DM ≈ Fer > DMcw ≈ RM in the Brown Chernozem (Fig. 2)
- Nitrapyrin addition increased cumulative N uptake from DM (Fig. 3)
- Amendment-derived N uptake (AmNU) decreased in the order: DM > Fer > DMcw ≈ RM in the Black Chernozem and DM ≈ Fer > DMcw ≈ RM in the Brown Chernozem (Fig.4)
- In the Brown Chernozem, AmNU increased significantly when Nitrapyrin was added (Fig.5)
- In both soils, Apparent N recovery (ANR) was significantly greater in the Fer (50%) than in the DM (6%), DMcw (5%) and RM (5%) (Fig.6)
- Soil available N was significantly greater for DM than the control in the Black Chernozem when Nitrapyrin was applied in Cycle 4 (Fig.7)
- In the Brown Chernozem, soil available N concentration was significantly lower in Fer and Con than DM in Cycle 4 regardless of Nitrapyrin treatment
- The lower cumulative N uptake and AmNU of DMcw compared to DM could be due to its high C to N ratio resulting in greater net N immobilization
- The increase in soil available N and AmNU with Nitrapyrin suggests its ability to slow down the conversion of N in ammonium form to nitrate therefore reducing nitrate leaching

Conclusions

- Addition of construction waste to DM resulted in the reduction of dry matter yield, N uptake and amendment derived N of DMcw compare to DM
- The low recovery of N from manured soils suggests that residual N is accumulating in the soil, which could result in the loss of excess N to the environment
- Soil available N concentration increased with repeated manure application and was higher in DM
- Nitrapyrin application increased soil available N concentration in DM compared to treatments not receiving this nitrification inhibitor

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