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Variation in nutrient utilization by various crops grown in a previously heavily manured Dark Brown Chernozemic soil

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Background

Continuous application of livestock manure on agricultural land can result in the excessive build-up of nutrients, which may lead to nutrient loss to the environment. Crops vary in their ability to utilize soil nutrients and reduce nutrient concentrations in the soil. In this greenhouse study, we examined the effectiveness of six 40-day cycles of barley (*Hordeum vulgare* L.), canola (*Brassica rapa* L.), corn (*Zea mays* L.), pea (*Pisum sativum* L.) and a barley-pea rotation, grown under two soil moisture regimes (100% and 50% field capacity), at removing nitrogen (N) and phosphorus (P) from a calcareous Dark Brown Chernozemic clay loam (Typic Haplustoll) that had received 180 Mg ha^{-1} of beef cattle feedlot manure (wet wt.) annually for 38 years. Manure had been applied each fall following harvest since 1973

Materials and Methods

- Surface soil (see Table 1 for selected properties) collected from long-term manure plots in southern Alberta
- Initial soil properties are presented in Table 1
- Design: Strip-plot with a 5 × 2 factorial treatment layout and three replications
- I.5 kg of soil (< 2 mm) placed in 2-L plastic pots
- Treatments
  - Crop type: barley (*Hordeum vulgare* L.), canola (*Brassica rapa* L.), corn (*Zea mays* L.), pea (*Pisum sativum* L.) and a barley-pea rotation (barley/pea)
  - Soil moisture regime: field capacity (100%) and 50% of field capacity
  - Unseeded controls at the above soil moisture regimes included for comparison
- Greenhouse maintained at a day/night temperature of 23/17℃ and a 16-h photoperiod
- Six crop growth cycles of 7 wk each tested over 240 d
- Plants harvested after each cycle for dry matter yield, and soil subsamples taken for available N and P determination (Schoenau and Karamanos, 1993)
- Plant biomass analyzed for total N and P determination (Parkinson and Allen, 1975)

Table 1. Properties of soil used in the greenhouse

Property	Dark Brown Chernozem
Total P, g kg^{-1}	1.2
Total C, g kg^{-1}	137
Total N, g kg^{-1}	13
C to N ratio	11
NO_3-N, mg kg^{-1}	427
NH_4^+-N, mg kg^{-1}	127
PO_4-P, mg kg^{-1}	555
pH	7.2
EC, dS m^{-1}	5.2
Clay, g kg^{-1}	210
Silt, g kg^{-1}	230
Sand, g kg^{-1}	560

Statistical Analysis

The soil available N and P data were analyzed using the PROC GLIMMIX for repeated measures in SAS (SAS Institute, 2014), with growth cycle as the repeated measure. N and P uptake data were analyzed separately for each crop with growth cycle as the repeated measure

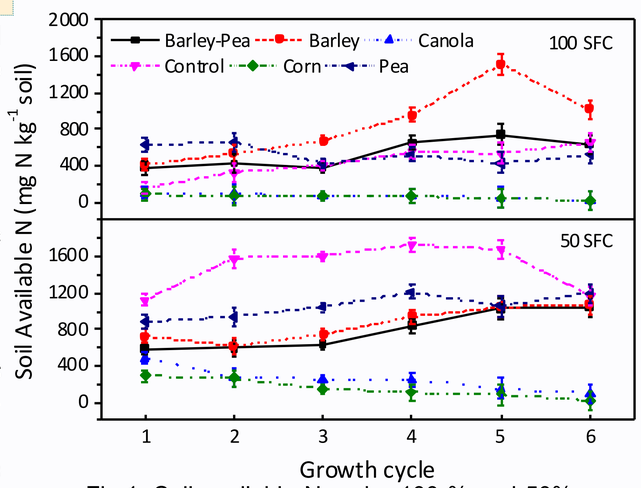

Fig.1. Soil available N under 100 % and 50% soil field capacity (SFC)

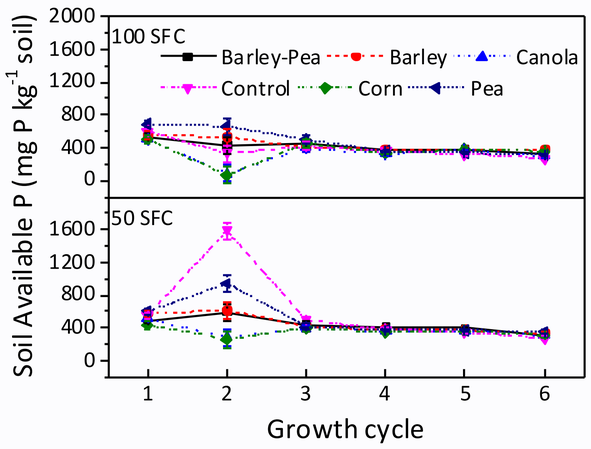

Fig.2. Soil available P under 100% and 50% soil field capacity (SFC)

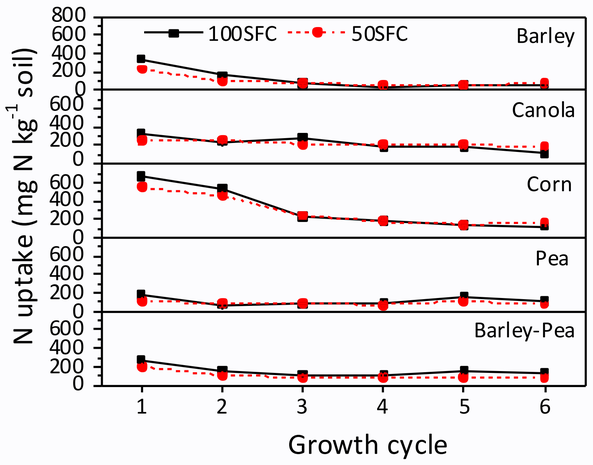

Fig.3. Nitrogen uptake of various crops under 100% and 50% soil field capacity (SFC)

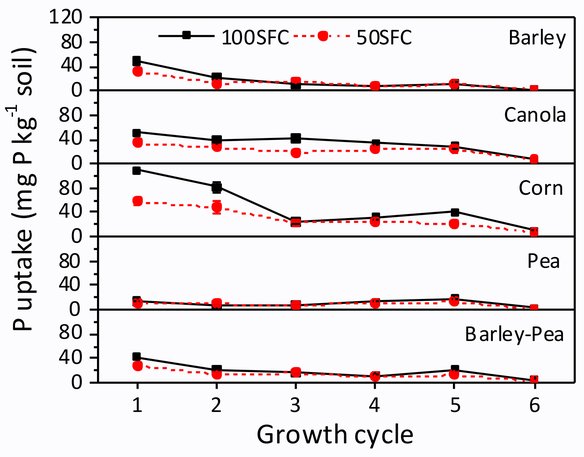

Fig.4. Phosphorus uptake of various crops under 100% and 50% soil field capacity (SFC)

Results and Discussion

- Crop effects on residual available N concentration varied with moisture regime and crop cycle (Fig. 1):
  - at both moisture regimes, available N concentration was lowest under canola and corn
  - at 100% FC, only barley had higher available N concentration at the end of cycle 5 and lower in pea and barley-pea rotation
- No significant crop type effect on Olsen P concentration regardless of moisture regime, except for the control showing an increase in P concentration from cycle 1 to cycle 2 and then a decrease thereafter (Fig. 2)
- N uptake decreased with crop cycle for barley, corn and canola but did not change significantly for the other crops (Fig. 3)
- P uptake decreased with crop cycle for all crops species at both moisture regimes except for barley-pea at 50% FC (Fig. 4)

Conclusions

- Under the two moisture regimes tested in this study, continuous cropping with corn and canola in a heavily manured soil could deplete soil available N if additional N is not applied
- Olsen P concentration was unaffected by crop type under the two moisture regimes
- Canola and corn were the most effective crops at taking up N from the soil up more N from the soil

References

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