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Nitrogen availability and economic returns of various crop rotations with forage and annual crops

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Introduction

A crop rotation study involving various forages and annual crops was initiated in 2013 to evaluate the relative merits of various cropping sequences.

The agronomic benefits of rotations integrating biennial forage legumes for seed production were evident in the succeeding plots of wheat and canola.

This presentation highlights the productivity and profitability of six different crop rotations conducted in western Canada.

Materials & Methods

Location and period of the study: Beaverlodge Research Farm, AAFC (55°N, 119°W); conducted from 2013 to 2016.

Soil: Landry clay-loam that averaged 6.3% organic matter and pH of 5.7 in 2013 at the onset of experiment.

Experimental Design: Split plot design with **crop rotation (R)** as main-plot and **nitrogen levels (N)** as sub-plots, replicated 4 times

Treatments: started with following 6 crop rotations in 2013, each spilt into 0, 45 & 90 kg N ha^{-1} applied at non-legume phases of the rotations:

1. Canola (C) -Canola-Canola-Canola
2. Creeping red fescue (CF)-CF-CF-Canola
3. Red clover (RC)-RC-Wheat-Canola
4. Alsike clover (AC)-AC-Wheat-Canola
5. Pea (P)-Barley-Wheat-Canola
6. Wheat (W)-Canola-Wheat-Canola

Results

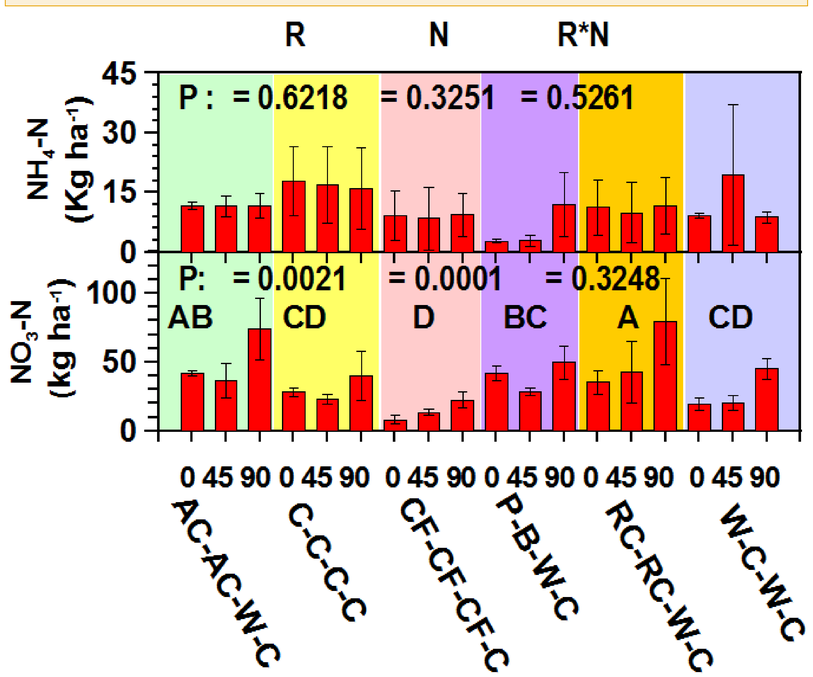

Figure 1: Nitrate-nitrogen (NO_3-N) and ammonium-nitrogen (NH_4-N) at the top 30-cm soil layer of soil samples collected from different crop rotations in spring 2016. The error bars are standard errors.

The Spring soil samples taken prior to planting of fourth phase crop canola showed no significant difference in soil NH_4^- content in different crop rotations (Figure 1).

However, the same samples exhibited significant difference in NO_3^- levels between the crop rotations (Figure 1).

The rotations that had legumes (red clover, alsike clover and pea) as starting crops had significantly higher level of NO_3^- in the soil.

Those differences in NO_3^- levels in the soils were reflected in the yields of wheat and canola in the respective rotations.

In the absence of nitrogen fertilizer, the rotations with alsike and red clover as preceding crops (grown as biennial) had higher seed yield of wheat and canola than the annual crops based rotations (Figure 2).

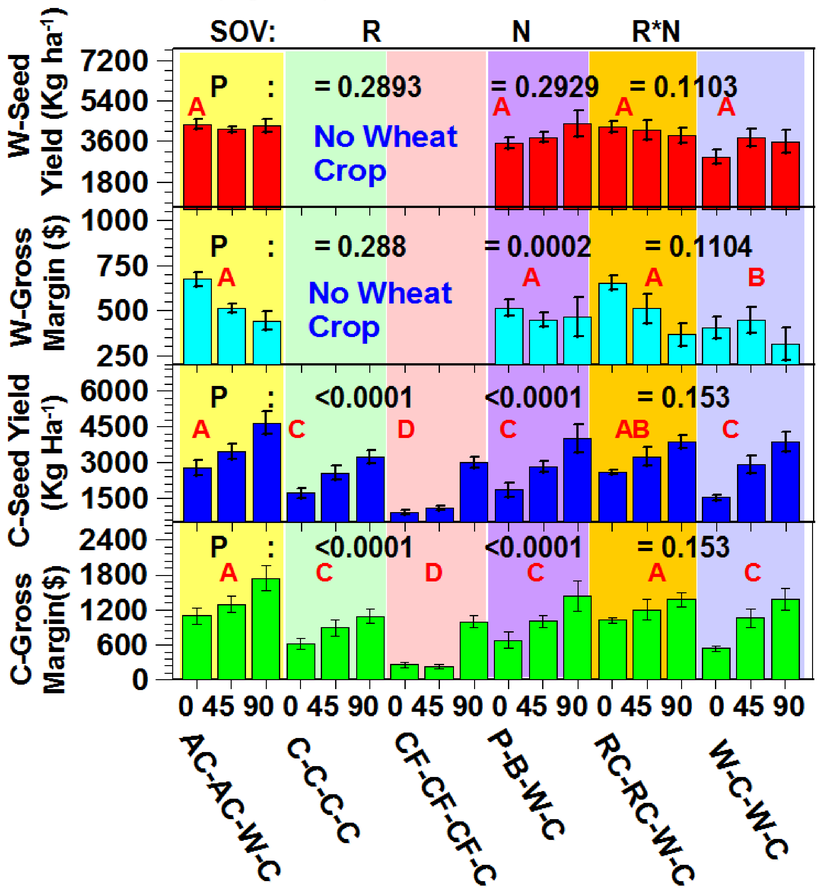

Figure 2: Seed yield and gross margin of wheat and canola in third and fourth phases of the crop rotation cycle. There was no wheat crop in C-C-C-C and CF-CF-CF-C rotations. The error bars are standard errors.

In the absence of a supplemental nitrogen application, wheat plots preceded by biennial stand of red clover produced yield increases of 21% and 45% compared to wheat plots preceded by pea-barley and wheat-canola sequences respectively.

Similarly, without supplemental nitrogen, wheat plots preceded by biennial stand of alsike clover produced yield increases of 24% and 49% compared to wheat plots preceded by pea-barley and wheat-canola sequences respectively.

The biennial legume seed crops of red and alsike clovers replaced the nitrogen fertilizer requirement for succeeding wheat crop by about 90 kg N ha^{-1}.

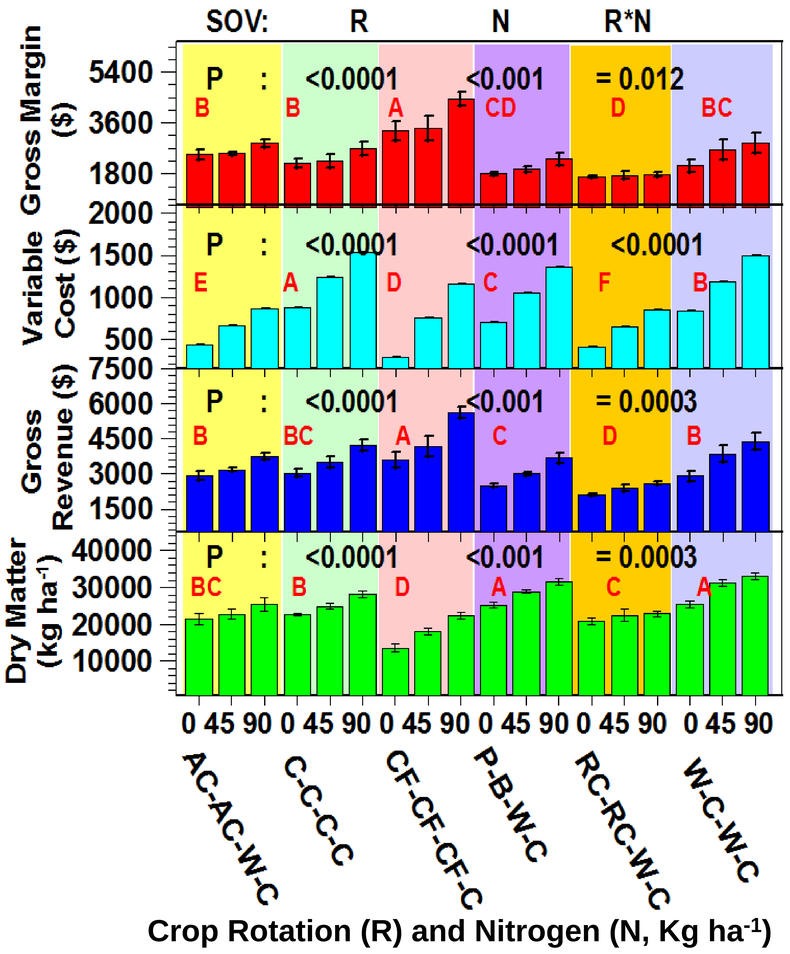

Figure 3: Cumulative cropping systems productivity and profitability of crop rotations with various annual crops and perennial forage seed crops**.** The error bars are standard errors.

Based on cumulative gross margin analysis of the 4-year rotations, **creeping red fescue (CF)**-based rotation produced highest profit followed by **alsike clover (AC)**-based rotation. **Red clover (RC)**- based rotation was the least profitable. Annual crops-based rotations had intermediate profitability (Figure 3).

Differential input requirements for different crop species and the output prices offered for the commodities were major determinants of the gross margin.

Conclusions

In terms of cropping systems productivity and profitability, biennial and perennial forage based rotations are comparable to annual crop based rotations including canola, peas, wheat and barley.

Agroecological sustainability imparted by biennial and perennial forage crops will be evaluated in terms of changes in the soil physical and chemical properties compared to those planted to the annual crops.

Acknowledgements

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