Soil residual water and nutrients explain about 30% of the rotational effect

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Introduction

Diversifying crop rotations with pulse crops may provide benefits to agroecosystem by improving the use of soil water and nutrients and decreasing production inputs. The objective of this study was to quantify the effect of pulse-based crop sequences in rotation and preceding crops on soil residual water and nutrients, and the performance of subsequent wheat.

Materials and Methods

Field experiments were conducted in Swift Current, SK and in Brooks, AB, Canada. The 4-yr crop sequence study was completed at three environmental sites. Nine rotation systems were evaluated from 2010 to 2014. Chickpea (*Cicer arietinum* L.), Pea (*Pisum sativum.*) and lentil (*Lens culinaris* Medik.) as preceding crops before wheat (W) or the rotation systems with chickpea, pea or lentil included more than once in the 4-yr rotations (**Table 1**).

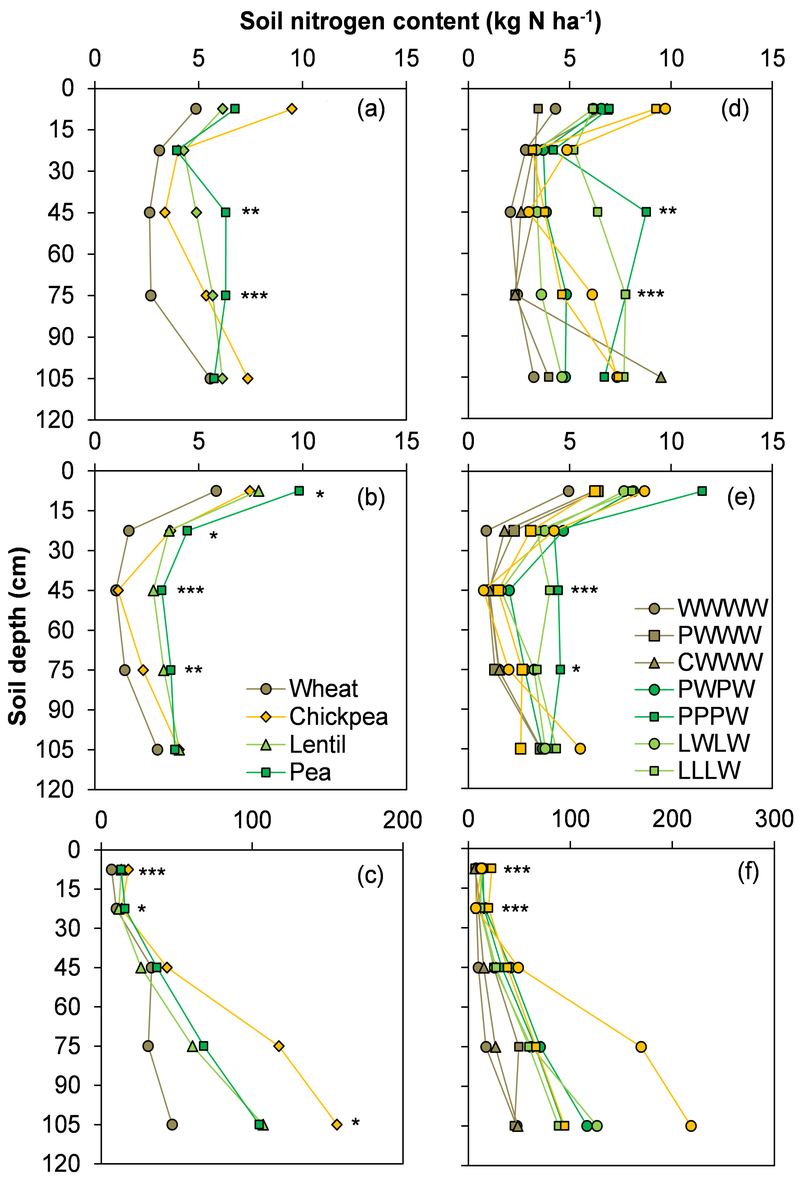

Fig. 1. Effect of the (a–c) previous crop and (d–f) 4-yr rotation sequences on total soil N at different soil depths at wheat sowing, measured at Swift Current in 2013 (a, d), Swift Current in 2014 (b, e), and Brooks in 2014 (c, f). Abbreviations for crops in part e: W, wheat; C, chickpea; L, lentil; P, pea. Significant differences at *, $P < 0.05$; **, $P < 0.01$; and ***, $P < 0.001$.

Table 1. Crop frequencies and sequences used in 4-yr rotation systems.

Rotation code	Yr-1	Yr-2	Yr-3	Yr-4
WWWW	Wheat	Wheat	Wheat	Wheat
PWWW	Field Pea	Wheat	Wheat	Wheat
CWWW	Chickpea	Wheat	Wheat	Wheat
CWCW	Chickpea	Wheat	Chickpea	Wheat
CCCW	Chickpea	Chickpea	Chickpea	Wheat
LWLW	Lentil	Wheat	Lentil	Wheat
LLLW	Lentil	Lentil	Lentil	Wheat
PWPW	Field pea	Wheat	Field pea	Wheat
PPPW	Field pea	Field pea	Field pea	Wheat

Results and Discussion

- Fields with pea and lentil as the previous crops and pea- (PPPW) or lentil-intensified (LLLW) rotations had the highest soil water contents in the 60–90 cm layer. Previous pea crops and pea-intensified rotations had the highest soil water contents in the 15–30 and 30–60 cm soil layers (data not shown).
- Pea and lentil as the previous crops and pea or lentil-intensified rotations (PPPW and LLLW) had the highest total N content post-harvest in the soil and wheat as the previous crop or wheat monoculture (WWWW, PWWW, CWWW) had the lowest total soil N (**Fig. 1**)
- Variance partitioning analysis revealed that the soil water and total soil nitrogen explained a high proportion of variation of the yield of wheat grown the following years, with Brooks at 27.5% and Swift Current at 24.0% (**Fig. 2**)
- Rotation sequence explained more of the variance in the performance of wheat compared to the effect of the immediately-previous crops.

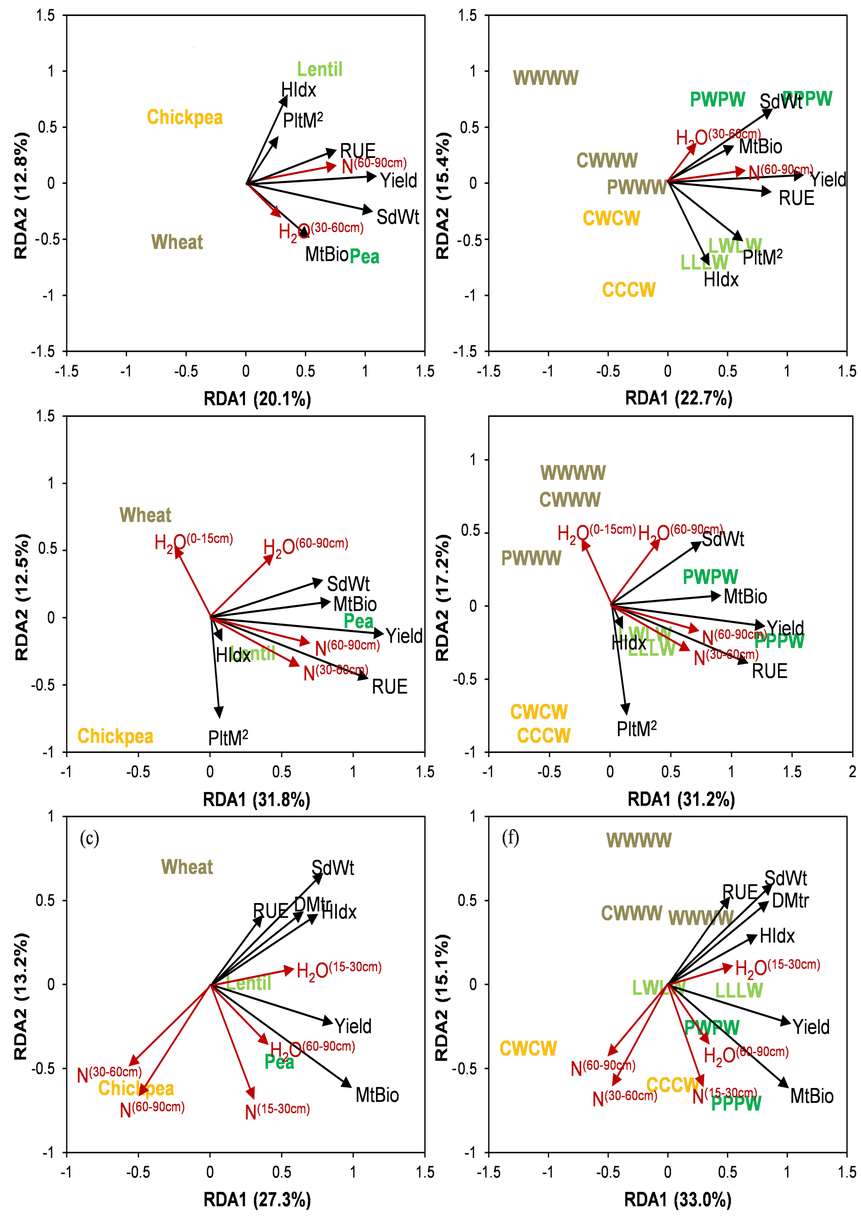

Fig. 2. Redundancy analysis (RDA) of wheat productivity and significant soil properties (water and total nitrogen) as vectors for continuous variables, and previous crop (a-c) and 4-yr rotation (d-f) as points based on centroids. Swift Current 2013 (a, d), Swift Current 2014 (b, e), and Brooks 2014 (c, f). MtBio, mature biomass; Hidx, harvest index; SdWt, 1000 seed weight; $PltM^2$, plants m^{-2}; RWU, rainwater use efficiency.

Conclusions

- The increased residual soil N and water availability after pulse crops explained about 30% of the increased yield of the subsequent wheat and, the rest of the rotational benefits were unexplainable by residual soil water and available N.
- Research on the other aspects of rotational effect such as soil microbiomes and pest infestation may provide further insights as to the large rotational effects of pulses.

Acknowledgement

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