Post-Harvest Soil Water and N Status in Pulse Fields in Comparison to Chem-Fallow

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Introduction

Annual pulse crops such as field pea (*Pisum sativum* L.), lentil (*Lens culinaris* Medikus), and chickpea (*Cicer arietinum*) have been used extensively in cropping systems in western Canada. One of the features with pulses is to replace conventional fallow, providing "greening" opportunity with more positive environmental impacts. However, little is known about how much soil water and nitrogen are left postharvest pulse crops in comparison with chem-fallow. Also, a quantitative assessment of soil water and N recharged from postharvest to the next spring would help land managers to make sound decisions on crop choice and fertilization. In this study, we quantified the amounts of soil water and N that are available in the preceding pulse crops in comparison with preceding barley and chem-fallow in southwestern Saskatchewan.

Materials & methods

A 3-yr crop sequence study was conducted from 2007 to 2011 at the Agriculture and Agri-Food Canada Research Centre, Swift Current. In the 1st year, spring wheat was grown under no-till management. At harvest, wheat stubble was cut to 15 cm and left standing in the field (**Fig. 1)**. In the 2nd year, ten types of pulse crops were grown between the rows of standing wheat stubble. The pulses along with barley and chem-fallow check were arranged in a randomized, complete block with four replicates. In the third year, durum wheat was uniformly grown on the different residue types. The 3-yr cropping sequences were repeated for three cycles between 2007 and 2011. In each year, soil samples at five different depths (0-120 cm) were taken postharvest the crops and again at planting the following spring crops. Detailed measurements were taken to quantify soil water and available N (NO_3-N + NH_4-N).

Fig. 1 Lentil was no-till grown between the rows of standing wheat stubble, Swift Current

Results & discussion

Soil Water

On average, water left in the 0-120 cm soil profile at harvest was 180 mm in 2009, 191 mm in 2010, and 240 mm in 2011 (**Fig. 2**). The fields with chem-fallow had soil water at 52.3 mm in 2009, 52.2 mm in 2010, and 29.7 mm in 2011, which were, respectively, 22%, 21%, and 11% more than the cropped fields.

Soil was recharged from post-harvest to the next spring. In the 2008-2009 fall and winter, the soil was recharged with 25.8 mm of water in the cropped field and 22.3 mm in chem-fallow; In the 2009-2010 and the 2010-2011 fall and winters, soil water in the cropped fields was increased by 24.2 mm (or 11.2%) and 27.2 mm (or 10.1%), respectively, whereas soil water content did not change in the chem-fallow field.

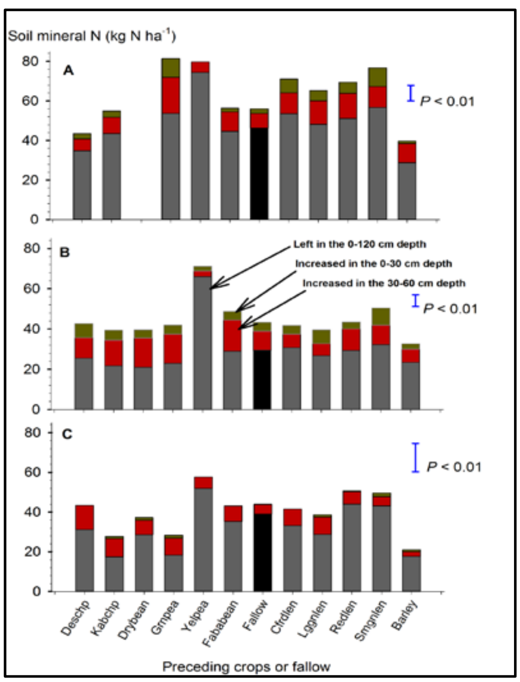

Fig. 3 - Soil mineral N (NO_3 and NH_4) in the 0-120 cm depth in the fields with pulse crops, barley or chem-fallow in (A) 2009, (B) 2010, and (C) 2011; with the dark-grey portion of the bars representing soil N left at harvest, and the red and yellowish-green bars representing soil N increased in the 0-30 cm and 30-60 cm depths from harvest to the following spring. Blue line bars are LSD (0.05) values among means.

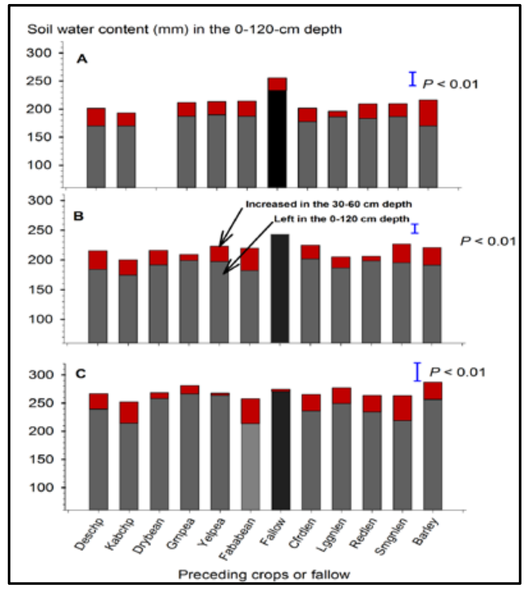

Fig. 2 - Soil water (mm) in the 0-120 cm depth in (A) 2009, (B) 2010 and (C) 2011, with the dark-grey portion of the bars representing soil water left in the field at crop harvest and the red portion representing soil water that was increased from postharvest to planting time the next spring.

The precipitation during the growing season totaled 176 mm in 2009, 354 mm in 2010, and 287 mm in 2011. During that period, chem-fallow fields increased 52.3 mm of water in the 0-120 cm soil profile in 2009, 52.2 mm in 2010, and 29.7 mm in 2011. Thus, about 70.3% of the total precipitation in 2009, 85.3% in 2010, and 89.7% in 2011 were lost through evaporation from chem-fallow fields during the period from crop seeding to harvest.

In 2009, the fields with dry pea and lentil had 17.6 mm (9.7%) more water left unused in the 0-120 cm soil profile than the fields with barley crops (**Fig. 2**). In 2010, no differences were found between crop types postharvest. In 2011, however, dry pea had 42.3 mm (19%) and 30.2 mm (12.9%) more water left unused in the 0-120 cm soil profile than chickpea, and lentil, respectively.

Soil N

The quantity of soil N (NO_3 –N, NH_4 -N) in the 0-

120 cm depth postharvest varied between years and among crops (**Fig. 3**). In 2009, postharvest soil-N was averaged 51.2 kg N ha^{-1} in pulse fields, similar to that in chem-fallow field (46.3 kg N ha^{-1}); they were significantly greater (by 78%) than that in barley field. In 2010 and 2011, pulse fields had the same amounts of N as chem-fallow; they were 30% and 88% greater compared to barley, in the two years. Among the 10 different pulse crops evaluated, yellow pea was outstanding: the total N in the fields with yellow pea was 74.4, 65.9, and 52.0 kg N ha^{-1} at crop harvest in 2009, 2010, and 2011, respectively (**Fig**. **3**). These values were 61%, 124% and 33% greater (P<0.01) than that in the chem-fallow, and 160%, 181% and 194% greater (P<0.01) than that in the barley-grown fields, in the three respective years. On average, pulse fields increased soil-N in the 0-60 cm depth by 15.3, 15.4, and 8.4 kg N ha^{-1} from postharvest to the following spring in 2009, 2010, and 2011, respectively (**Fig. 3**); these values were 39%, 67% and 149% greater compared to barley fields; and 57%, 11% and 69% greater compared to chem-fallow, in the three respective years.

Conclusions

About 70% to 90% of the precipitation was lost through evaporation in chem-fallow fields during the crop growing period. Use of annual pulses to replace chem-fallow can utilize the precipitation effectively. Growing pulses significantly increased soil N through symbiotic N-fixation, as well as through root and straw decomposition from post-harvest to the next spring, providing a nutrient-richening effect equivalent to chem-fallowing. “Greening” chem-fallow with pulses may provide environmental benefits but excessive amounts of soil N can lead to N leaching. More research is required to quantify these effects.

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