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Influence of pulse crops on arbuscular mycorrhizal fungi in a durum-based cropping system

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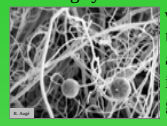
INTRODUCTION

Pulses are an important component in crop rotations in southern Saskatchewan. Besides their capability to fix nitrogen, pulse crops establish a strong symbiotic relationship with arbuscular mycorrhizal (AM) fungi, which have been shown to increase nutrient and water uptake through hyphal extensions in the soil. Incorporating strongly mycorrhizal crops in a rotation may increase inoculum levels in the soil and benefit the growth of a subsequent crop.



The objective of this study is to evaluate the impact of pulses in crop rotations on the soil AM inoculum, mycorrhizal root colonization, and N and P uptake in a durum crop, grown the subsequent year.

MATERIALS AND METHODS

❖ The experiment is a two year field plot study, 2004 to 2006, at the South Farm of the Semiarid Prairie Agricultural Research Centre, in Swift Current.

❖ Three replications of five treatments preceding durum (Table 1) in a brown Chernozemic soil.

Table 1. Crop varieties seeded in experiment are common varieties.

Crop	Variety	Inoculant
Durum	Avonlea	n/a
Canola	Argentine	n/a
Lentil	Sovereign	Nitragin C
Pea	Handel	Nitragin C
Chickpea	Myles	Nitragin GC

Table 2. Samples are taken throughout the growing season for analysis.

Experiment	Evaluation	Method
Anion Exchange Membranes	N and P dynamics	Modified from Ziadi et al. 1999
NH_4/NO_3	Point in time available N	KCl extraction (Maynard and Karla, 1993)
Root Colonization	Percent of root colonized by AMF	Staining (Vierheilig et al. 1998) Gridline intersect measurement
Plant N & P	Nutrient uptake from soil	Digest tissue and autoanalyze (Thomas et al. 1967)

❖ Four soil samples and plant samples per plot were taken at various times throughout the growing season (Figure 1).

❖ The samples were bulked into one composite sample and put through 2 mm sieves before analysis (Table 2).

❖ Root samples were also taken at intermediate stages for AMF colonization determinations.

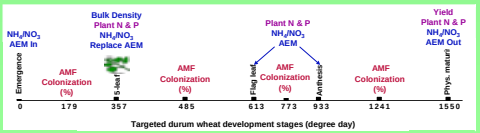


Figure 1. Sampling schedule to be repeated over the two years of the study (AEM - anion exchange membranes). Number degree days required to reach targeted Avonlea growth stages and midpoints are from Hong Wang et al. (manuscript in preparation).

RESULTS

❖ Total durum P uptake was lower following canola and durum, and higher after lentil and chickpea. An interaction (*P=0.02*) showed that differences between treatments varied with time (Figure 2).

❖ Durum grain yield was greatest (P=0.06) after pea and lentil than after any other preceding crops (Fig. 3).

❖ No difference between treatments on the soil available N and P levels was observed (data not shown).

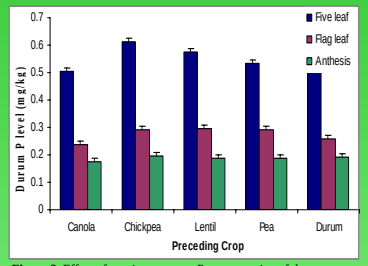


Figure 2. Effect of previous crop on P concentration of durum wheat. Error bars are standard errors of the means (3 replicates).

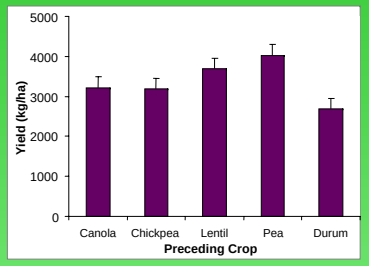


Figure 3. Effect of previous crop in grain yield of durum. Error bars are standard errors of the means (3 replicates).

❖ **AMF colonization** – There was extensive mycorrhizal colonization of durum roots after lentil and pea, but after canola, a non-mycorrhizal species, durum root mycorrhizal colonization was delayed and reached only 6% at the end of the season (Figure 4).

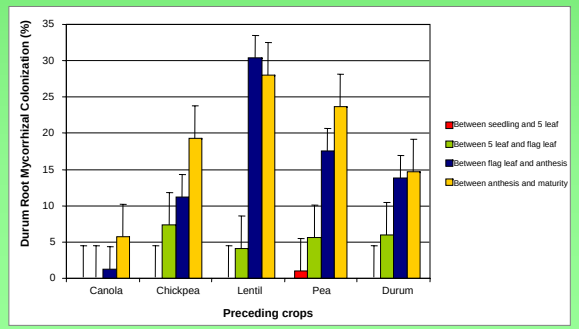


Figure 4. Development of the arbuscular mycorrhizal colonization of durum wheat during the 2004 growing season as influenced by preceding crops. Bars represent standard errors of the means (3 replicates).

DISCUSSION

❖ Since yield levels cannot be explained by differential soil N and P supply, it appears that mycorrhizal fungi may play a role. The durum on pea and lentil stubble had the highest yields, as well as the highest levels of AMF colonization.

❖ Lower levels of plant P uptake in the non-mycorrhizal canola may reflect the ability of AMF to aid in phosphorus uptake in the mycorrhizal crops.

CONCLUSIONS

Including pulses in the durum-based cropping rotation resulted in:

- ✓ **Higher durum yield after pea and lentil**
- ✓ **Higher total P uptake early in the season**
- ✓ **Stimulation of AMF colonization**

TO BE CONTINUED IN 2005

❖ Examine the impact of pulses in crop rotations on the biodiversity of AMF populations and their dynamics to determine if a correlation exists between the plant N and P uptake and the specific AMF populations.

❖ Investigate the possibility of a favorable influence of pulse crops on soil microbial populations using molecular techniques.

❖ Experiment to be repeated in 2005.

Acknowledgements

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