

## Breeding for enhanced nitrogen fixation in cereal – legume cropping systems in Saskatchewan

Dr. Pierre Hucl

University of Saskatchewan – Dept. of Plant Sciences

SPG Contributions	Project Status	Duration/Timeline of Project (Year to Year)	Co-funders	Total Project Cost
\$250,000.00	Completed	April 2008 – November 2013	Saskatchewan Ministry of Agriculture – Agriculture Development Fund (ADF); Western Grains Research Foundation	\$500,000.00

### Project Description

Pulse crops before grains are generally found to be beneficial to the following crop, primarily by providing fixed nitrogen in substantial amounts. More recently attention to the soil improvement from higher organic content and beneficial microorganisms has increased. However, production systems-related studies of the effects of lentils and field peas on following wheat crops are needed to find out (i) how well pulses can integrate into crop rotation for Western Canada, and (ii) if there are particular pulse cultivars which contribute more to a following wheat crop, and (iii) if there are particular wheat cultivars which are suited or unsuited to this rotation.

Previous work suggested that cultivars of pulses earlier in a rotation might contribute differently to wheat (durum or bread wheat) yield and harvest characteristics in the following year, and that different cultivars of the wheat crop in the rotation might get different degrees of benefit from pulse stubble. Both possibilities were examined in this trial.

It was hypothesised that:

1. Cultivars of peas will affect yield and harvest characteristics of bread wheat in the following year.
2. Cultivars of lentils will affect yield and harvest characteristics of durum wheat in the following year.
3. Some cultivars of bread wheat will respond better than others to growth on field pea stubble.
4. Some cultivars of durum will respond better than others to growth on lentil stubble.

This field study analysed effects of pea stubble, compared to fallow, on bread wheat, and lentil stubble, compared to fallow, on durum in the following year.

Strip block experiments were set up with three replicates. Three to four site-years (not all traits measured for all site-years) were used. Excessive moisture in 2010 and 2012 damaged some plots and some trials had to be repeated and/or moved. Thousand-kernel weight, test weight, nitrogen harvest index, yield, grain protein concentration, and protein yield of wheat cultivars grown on fallow soils and on pulse stubble were measured. Soil microbiological analysis was also carried out by culturing bacteria and fungi and identifying species by sequencing of short gene regions (ADF).

### Outcome

There were two main parts to the study. The first compared fallow to pea or lentil stubble, in its effects on bread wheat or durum wheat in the following year. It tried to identify wheat cultivars that were particularly compatible or incompatible with growth on stubble.

Pea stubble (CDC Golden) provided 37 kg/ha of nitrogen to the following 36 cultivars of bread wheat. It did not adversely affect wheat yield or other characteristics, compared to fallow. The exception was slightly lower grain protein concentration (13.8% vs. 12.9%), which was attributed to incomplete mineralization of the stubble. No effects on gluten or protein quality were seen.

Lentil stubble (CDC Redberry) provided 43 kg/ha of nitrogen to the following 36 cultivars of durum wheat. It had no adverse impact on durum, relative to stubble, although there was a non-significant reduction in grain protein concentration.

No wheat or durum cultivar effects relative to pulse stubble vs. fallow were found, suggesting that there are no particular combinations of pulse and wheat varieties to be used or avoided. The critical choice is selection of a good wheat cultivar. The newer cultivars with higher nitrogen harvest efficiency generally gave the best yield and grade.

The second part of the study looked at the effects of different cultivars of pulse in the first year on wheat in the following year. The combinations tested were 30 cultivars of field peas on bread wheat AC Barrie, and 30 cultivars of lentils on durum Strongfield in the following year. None of the cultivars of pea significantly affected any harvest characteristics of AC Barrie, nor did the cultivars of lentil significantly affect any characteristics of Strongfield, indicating that there are no cultivars with a particular advantage for the purpose of supporting a wheat crop in the next year. This means that pulse cultivars can be selected for suitability for other purposes and expected to contribute to wheat yield in the following year.

Soil microbiological analysis at the University of Saskatchewan and the University of Napoli (Italy) revealed that pulse stubble improved the populations and diversity of beneficial bacteria and fungi in the soil, although this was not correlated with wheat yields, grain protein concentration, or any other agronomic parameter.

This study has demonstrated that growing wheat on pulse stubble does not have a negative impact on wheat end-use quality attributes relative to growing wheat on fallowed land. Thus, high quality wheat can be produced in the absence of synthetic nitrogen fertilizer when grown on pea or lentil stubble.

The study shows that lentils or field peas can contribute most or all of the nitrogen to wheat in the following year, and yield and grain quality will be as good as on fallow, with the possible exception of grain protein concentration. There appeared to be no effects of the pulse cultivar on the following wheat crop, nor any genotypic effects of

the wheat cultivar following the pulse, so suitable cultivars can be chosen without having to consider this factor.

### **Research Objective**

#### **OBJECTIVE 1**

To develop a system for screening lentil and pea cultivars on the basis of their contribution to yield and quality of subsequent spring wheat and durum cultivars.