SASKATCHEWAN pulse Growers

# Frequency and sequence of annual pulses in cropping systems. Phase II

**Dr. Yantai Gan**
Agriculture and Agri-Food Canada

| SPG Contributions | Project Status | Duration/Timeline of Project (Year to Year) | Co-funders | Total Project Cost |
|---|---|---|---|---|
| $125,099.00 | Completed | April 2013 – March 2018 | Agriculture and Agri-Food Canada | $453,486.00 |

## Project Description

To determine the optimum frequency and sequence of various pulse crops (pea, lentil, chickpea) in rotation systems; to determine the impacts of crop frequency and sequences on the yield and quality of the pulse crops and the crops following them in cropping systems, on the potential changes of disease and weed spectrum and infestations, on the carbon contribution of crops and cropping systems to the soil, and on soil quality attributes such as fertility, water content and composition and biodiversity of soil microbial communities; to determine the effect of pulse frequency and crop diversity on soil functional gene profile.

## Outcome

This project studied if (i) diverse crop rotations enable the best use of residual soil water and nutrients thus decreasing production inputs; (ii) whether abiotic (soil chemical properties and climate) and biotic (plant host identity) factors influence the spatial and temporal structuring of arbuscular mycorrhizal fungal (AMF) communities; and (iii) the effects of pulses (chickpea, lentil, and pea) on the structure of root-associated fungal communities in wheat-based rotations vs. wheat monoculture, and described the legacy of pulses to the following crop. Fourteen 4-year rotation systems, with pulses included 0 – 3 times per rotation, were evaluated over 7 years at the AAFC Swift Current Research and Development Centre. Pea and lentil preceding wheat or rotation systems with pea or lentil more than once in the 4-year rotation had the highest level of residual soil water and soil nitrogen in the 30–90 cm soil depth whereas continuous wheat was the lowest. Pea and lentil increased the grain yield of subsequent wheat by 26% and 18%, respectively, compared with continuous wheat. Soil residual water and residual nitrogen explained 12.4%–42.7% (average 30%) of wheat yield variation. High-throughput sequencing of amplicons revealed a minimal effect of host plant on the composition of the arbuscular mycorrhizal fungal community in rhizosphere soil. There was a shift in the composition of the arbuscular mycorrhizal fungal community in the roots and the soil legacy in late fall. The root-associated arbuscular mycorrhizal fungal community was correlated with soil phosphate flux and climatic variables. Despite the absence of selective effects of pulse roots on root-colonizing arbuscular mycorrhizal fungal, pea had a legacy effect on the structure of the arbuscular mycorrhizal fungal community associated with the roots of the following wheat crop. Pulses influenced the structure of the non-mycorrhizal fungal community of plant roots. The pathogenic fungal sp. Fusarium tricinctum, and Fusarium redolens, the potentially beneficial endophytic fungi Clonostachys rosea, and the yeast Cryptococcus sp. were specific to certain crops. Species of Mortierella, Cryptococcus, and Paraglomus in wheat rhizosphere soil were positively related with the yield of subsequent wheat crop in the rotation, whereas species of Fusarium, Davidiella, Lachnum, Sistotrema and Podospora were negatively correlated. It took 3 years of pulse crops in a row to influence the bacterial community, based on amplicons of the 16S marker. This shift was associated with soil nitrogen enrichment, and was shown only in the absence of restrictive drought. In conclusion, the effect of pulse crops on the root microbial communities in the following wheat varied with host crop species, rotation patterns, and the magnitude of the effect varied with climatic and soil conditions.

## Research Objective

### OBJECTIVE 1
To determine the optimum frequency and sequence of various pulse crops (pea, lentil, chickpea) in rotation systems.

### OBJECTIVE 2
To determine the impacts of crop frequency and sequences on the yield and quality of the pulse crops and the crops following them in cropping systems, on the potential changes of disease and weed spectrum and infestations, on the carbon contribution of crops and cropping systems to the soil, and on soil quality attributes such as fertility, water content and composition and biodiversity of soil microbial communities.

### OBJECTIVE 3
To determine the effect of pulse frequency and crop diversity on soil functional gene profile.