AGR1616: Enhancing the Long-Term Sustainability of Pulse Cultivation Using Systems Approaches

Pulse crops play an important role in diversifying cereal/oilseed dominated cropping systems and improving farmer's profitability in Western Canada. Pulse crops also provide essential ecosystem services in intensified cropping systems. However, high pulse crop frequency in rotations may have negative impacts on organic matter centered soil quality and crop diversification, causing disease outbreaks and limiting system production. To optimize wheat-pulse cropping system performance, we conducted 8-year field studies at Swift Current (SK), Brooks (AB), and Indian Head (SK), along with field surveys and greenhouse studies. Our objectives were: 1) investigate major factors influencing root rot complex on pulse crops; 2) screen antagonists (anti-fungal organisms) that can inhibit pulse root rot pathogens; 3) optimize crop rotations using a systems approach; 4) enhance soil carbon and nitrogen dynamics in cropping systems; 5) minimize harvest losses in pulses through improved agronomic practices; 6) decrease the carbon footprints of agroecosystems; and 7) enhance whole agro-system economic outcomes.

Root rot complex was surveyed across Saskatchewan and we found that rotations with three pulse phases had higher host-specific pathogen pressure compared to rotations with one pulse phase. We screened several antagonistic bacteria isolates from pea and lentil rhizosphere and roots. These bacteria isolates showed strong potential to suppress *Aphanomyces* root rot disease, which could be developed as novel bio-fungicides.

Averaged across the 8-year crop rotation period, pea resulted in greater yield benefits than chickpea for pulse-wheat rotations. However, the high frequency of pea in rotations caused high disease incidence in pea and replacing pea with lentil can effectively reduce the pea disease incidence. In addition, diversified rotations enhanced system stability across multiple site-years. Different types of pulse crops had similar effects on soil available nitrogen (N), but rotations including chickpea had the largest effect on soil micro- and meso-aggregate stability among tested pulse crops. Rolling land before seeding and keeping 15 cm crop stubble could reduce lentil yield loss during harvesting. Environmentally, pea resulted in smaller N_2O emissions than chickpea and lentil, and pulse frequency in rotations had a larger effect on N_2O emissions than CO_2 emissions. Increased pulse frequency can reduce carbon footprint substantially. Economically, pea performed better at Brooks while lentil performed better at Swift Current, and diversified rotations generated better net revenues at both sites.

We developed the sustainability index (SI) using multiple variables highly correlated to yields. The SI generated from the wheat crop phase indicated that a higher pulse frequency rotation was more stable, reflecting the benefits of pulse crops on the following cereals. However, at the cropping system level, diversified crop rotations or crop rotations involving pea were more stable. The current SI is yield-focused and an updated SI reflecting different aspects of sustainability of cropping systems should be developed.

Overall, we conclude that the benefits of pulse-based rotations largely depend on crop diversification and the frequency of pulse phases in rotations. A diversified cropping system with pulse crops can increase production, enhance resource use efficiency, improve profitability, reduce environmental impacts, and stabilize cropping system performance in a changing environment.