Introduction to “Pulse Crop Ecology in North America: Impacts on Environment, Nitrogen Cycle, Soil Biology, Pulse Adaptation, and Human Nutrition”

Adrian M. Johnston,* George W. Clayton, and Perry R. Miller

The following papers were presented at the symposium “Pulse Crop Ecology in North America: Impacts on Environment, Nitrogen Cycle, Soil Biology, Pulse Adaptation, and Human Nutrition,” held during the 2005 ASA–CSSA–SSSA annual meetings in Salt Lake City, UT.

Pulse crops, also known as grain legumes, have become a major component of the North American diet. While many of us think of pulse crops as something we grow for export and consumption abroad, their use in North American household and restaurant food products continues to grow. And for good reason. Pulse crops have been shown to be an excellent source of protein, dietary fiber, and phytochemicals essential for the human diet. Pulse crops are finding a fit in the crop rotations on many farms in the Northern Great Plains region. Breaking pest cycles common to monoculture, reducing the use of fertilizer N, and increasing the marketing opportunities available to the grower have increased interest and area seeded to pulse crops. The genesis of this symposium was the realization that pulse crops have increased in land occupancy from 400,000 ha in 1991 to 3,000,000 ha in North America in 2006, primarily in the northern Great Plains, and are impacting importantly the agroecology of this region (Statistics Canada, 2005; USDA-National Agricultural Statistics Service, 2005). A North American conference committee was formed to decide on topics for timely review.

Pulse crops provide amino acids, minerals, carbohydrates, lipids, and vitamins. They also have a number of secondary compounds that have been linked to good health, including nonnutritive phytochemicals such as isoflavones, saponins, catechins, and anthocyanidins. Together these pulse grain constituents can play an important role directly in the human diet, and also indirectly via animal production. Future research will characterize the genetic diversity of both nutrient and phytochemical composition in pulse crops, and help to develop breeding and selection strategies to enhance these plant components. There is large variability in the level and absorption of pulse crop nutrients and compounds by animals. This variability extends to the actual plant species, the production environment, and the processing. In addition, soil microbial and nutrient supply and plant exudates also impact the production environment of the pulse crop. Even with this uncertainty, pulse grains have found their way into human and livestock diets in most parts of the world.

From an environmental viewpoint, greenhouse gas emissions are a major issue. The inclusion of pulse crops in rotation with cereal and oilseed crops is considered to have a significant positive impact on greenhouse gas emissions, given the absence of fertilizer N in pulse crop production. Nitrous oxide emissions are water-mediated events, with emissions being very low in dry areas and higher in wet areas. In addition, N2O emissions require a soil supply of nitrate-N, often residual nitrate-N left by the previous crop or the product of recently applied fertilizer or livestock manure. Field research in semiarid regions indicates that N2O emissions were lower from field pea crops when compared with a fertilized cereal, and no difference was observed when cereals were grown on pulse crop versus cereal crop stubble. As a result, there would be a net decline in N2O emissions with pulse crop production, given the reduced N fertilizer used with these crops. Managing N in the soil appears to be the governing factor related to N2O emissions from cropped fields, regardless of crop type.

Pulse crops have a significant impact on soil biology, increasing soil microbial activity from seeding to long after harvest. Along with N fixation, the rhizosphere activity of the crop plays a major role in plant nutrient uptake. Mycorrhizal activity enhances plant phosphorus and zinc uptake. Endophytic rhizobia enter the cells of nonlegume crops in rotation and influence nutrient uptake in nonlegumes. While pulse crop residues do have low nutrient content, microbes can decompose them more easily than cereals. Pulse crops influence nutrient cycling in soils by increasing microbial activity and nutrient content. Future research will focus on the role pulses play in influencing nonpulse crop growth and development, as well as their impact on plant health and soil biology.

Pulse crops are always credited for N fixation and subsequent benefits to crops in rotation. However, grain legumes are high-protein crops, removing the vast majority of the N fixed in the harvested seed. As a result, it is the root and aboveground biomass, as well as the reduced N immobilization of the pulse residues, that contribute to the subsequent crops in rotation.