Biological nitrogen fixation in short-season soybean varieties for Saskatchewan

Dr. Diane Knight
University of Saskatchewan – Dept. of Soil Sciences

SPG Contributions	Project Status	Duration/Timeline of Project (Year to Year)	Co-funders	Total Project Cost
$173,765.00	Active	December 2017 – June 2023	Western Grains Research Foundation	$347,531.00

Project Description

To quantify biological nitrogen fixation (BNF) and total N uptake In short-season soybean varieties; to determine occupancy in nodules of introduced Bradyrhizobia strain in soybean grown in soils with and without a history of soybean production and to determine if inoculant strain affects nodule occupancy; to determine N uptake rates at different developmental stages of short-season soybean; to determine the impact of low temperatures on biological nitrogen fixation in short-season soybean; to determine BNF, and nodule occupancy in field grown short-season soybean varieties; to quantify BNF in very-late seeded soybean plots to evaluate how eliminating cool spring/early summer temperatures affects BNF and providing cooler temperatures at flowering.

The overall goal for this project is to determine if biological nitrogen (N) fixation in short-season soybean genotypes is limiting seed protein content. The project involves a combination of greenhouse and field trials examining a variety of soybean lines developed for the short growing season in Saskatchewan.

Outcome

Initial greenhouse experiments screened 15 soybean genotypes in a high fertility soil and a low fertility soil at two different soil water contents (optimum and low). No single genotype performed the best in all four soil conditions. Indeed, one line was the “best” line in both soils when there was high water available but was the “worst” in both soils when water was sub-optimal. Another line performed well in the high fertility soil with low water but performed poorly in the low fertility soil with optimal water. The amount of water determined biological N fixation rates, but not seed protein. Field trials conducted at three sites had similar variability in seed protein and biological N fixation among the soybean lines and the amount of biological N fixation was not related to seed protein. A greenhouse experiment examining if N supply was limiting for growth of soybean indicated that N uptake peaked around the time that pods were formed and seed was filling. Biological N fixation was able to provide the majority of the N required at the times that the N was most needed. Applying N fertilizer throughout the growing period did not enhance N uptake. It has been suggested that the cool spring temperatures experienced in Saskatchewan might negatively impact biological N fixation in the short season soybean genotypes grown. While growing the soybean plants in cool temperatures (15°C) for different lengths of time before transferring the plants to 25°C conditions negatively affected growth, only when the cool temperature was maintained to the point when the plants were setting seed was any impact on biological N fixation observed. Considering daytime temperatures in the summer in Saskatchewan are in the low to high 20°C range, it is unlikely that biological N fixation is limiting growth, N acquisition and seed protein.

Research Objective

OBJECTIVE 1
To quantify biological nitrogen fixation (BNF) and total N uptake In short-season soybean varieties.

OBJECTIVE 4
To determine the impact of low temperatures on biological nitrogen fixation in short-season soybean.

OBJECTIVE 2
To determine occupancy in nodules of introduced Bradyrhizobia strain in soybean grown in soils with and without a history of soybean production and to determine if inoculant strain affects nodule occupancy.

OBJECTIVE 5
To determine BNF, and nodule occupancy in field grown short-season soybean varieties.

OBJECTIVE 3
To determine N uptake rates at different developmental stages of short-season soybean.

OBJECTIVE 6
To quantify BNF in very-late seeded soybean plots to evaluate how eliminating cool spring/early summer temperatures affects BNF and providing cooler temperatures at flowering.