**MPSG ANNUAL EXTENSION REPORT**

**Soybeans for Improved Soil Health: Determination of Lower than Predicted Contribution of Pulse Crop Residues to Greenhouse Gas Emissions**

**PROJECT TITLE:**

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| **PROJECT START DATE: 1 April 2015** | **PROJECT END DATE: 31 March 2018** |

**DATE SUBMITTED: 2 June 2017**

***PART 1: PRINCIPAL RESEARCHER***

**PRINCIPAL**

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PART 2: EXECUTIVE SUMMARY

The primary goal of this research project is to gain a better understanding of the role soybeans play in soil health and in reducing the overall environmental footprint and greenhouse gas potential of cropping systems in Manitoba. Where a growing body of research has examined fertilizer-induced nitrous oxide emissions (N2O) from agricultural soils, the contribution of crops residues to seasonal N2O emissions remains uncertain. Based on limited studies is has been suggested that the Intergovernmental Panel on Climate Change (IPCC) should modify methodologies to account for lower emission of N2O-N released from crop residues versus synthetic fertilizers. The following study utilizes a stable isotope approach to quantify the contribution of soybean residues to nitrogen uptake and N2O emission from a subsequent cereal crop. The overall study is 4 years in duration (2014-2018) to capture 2 cycles of a soybean-cereal rotation. Preliminary results indicate N2O emissions from soybean are much less than from fertilized spring wheat. Emissions from soybean are only just slightly higher than from unfertilized wheat (background emissions). Emissions from wheat residues is much greater than from soybean residues. In addition, wheat yield was better following soybean than wheat. The following report summarizes field activities after Year 2 of the project and presents preliminary results from Year 1 activities.

*Outline the project objectives, their relevancy to pulse and soybean farmers, and a summary of the project to date, including methods and preliminary results.*

***PART 3: PROJECT ACTIVITIES AND PRELIMINARY RESULTS***

In 2014 and 2016, main treatment plots had been established in a completely randomized design and consisted of four passes of a research seeder. The experimental sites were at the University of Manitoba Ian N. Morrison Research Station in Carman, Manitoba. Each site were on a different field of the research station in 2014 and 2016. Main plot treatments were as follow; 1) soybeans, 2) wheat fertilized with urea, and 3) non-fertilized wheat to serve as a reference crop. Within each main plot a single seeder pass was dedicated to form a 15N microplot (Figure 1). This microplot received a 7.5 kg N ha-1 treatment of 98% 15N atom excess fertilizer designed to isotopically label the aboveground and belowground residues of wheat or soybean plants. In the same main plot a 14N microplot was also established. However, no isotope-labelled fertilizer was added to this adjacent 14N microplot.

 In the fall of 2014 aboveground residues from each 15N microplot were exchanged with aboveground residues from the adjacent 14N microplot is a specific crossover scheme. Within each main plot we generated several scenarios where it would be possible to determine if 15N labelled soybean or wheat roots and shoots were contributing to N2O emissions in the fall of 2014 or in the subsequent wheat crop grown in 2015. Following the 2014 harvest and initiation of residue crossover layout in the fall of 2014, main plots and microplots were monitored on 1-2 week intervals until winter freeze-up. In the spring of 2015 following loss of snow cover, research plots were again monitored for nitrous oxide emissions leading up to fertilization and seeding. Before seeding, all main plots and microplots were intensively soil sampled. All main plots were fertilized with urea according to soil test recommendations.

 In 2015 the entire trial area was sown to wheat with the objective of monitoring the fate of nitrogen (and N2O emissions) derived from soybean shoots and roots in the 2014 growing season. In 2015 the main plots in the trial initially sown to wheat or soybean in 2014 were seeded to wheat (AAC Brandon) and fertilized according to soil test recommendations. However, due to the residue swap crossover scheme initiated in the fall of 2014, microplots contained within main plots were divided in two, which doubled the amount of gas and soil sample collection across the entire trial (Figure 2). In 2015, wheat was grown and to monitor how nitrogen contained within the soil or derived from soybean and wheat residues was converted into nitrous oxide (N2O), or converted into nitrogen contained within straw, grain and soil samples. In addition, the residue crossover scheme developed would allow us to detect what fraction of N2O emissions detected in Year 2 could be traced to above or belowground residue of soybean and wheat grown in Year 1, and what fraction of N2O emissions could be associated with fertilizer applications in Year 2. In 2016, the 2014 treatments were repeated and N2O was monitored through out the growing season until late fall (September).

   Gas, plant and soil analyses are conducted in each study year. All samples for a year are analyzed in the Soil Ecology Laboratory and by March 31 of the following year. Exception being, 15N samples require much pre-processing and sent for analyses to UC Davis or University of Saskatchewan. Analyses of these samples require more time and require careful data processing. A PhD student, Mike Runzika, has come onto the project as of January 2017 and taking charge of analyzing and processing of the 15N data. Thus, 15N results are forthcoming and will be available for the final report.

 In Summary;

- The project is being carried out as planned with no major problems

- The first trial has been conducted over 2014 and 2015 growing seasons with the repeat trial initiated in 2016

- 15N analyses are forthcoming and it is anticipated analyses and results will be available by the end of 2017.

- Preliminary results indicate N2O from soybean are much lower than from fertilized spring wheat

- Preliminary results indicate N2O from wheat residues is much greater than from soybean residues

- Preliminary results indicate wheat yield was better following soybean than wheat

- The project site can be used for outreach to growers to show the benefit of soybean to reduced greenhouse gas emissions, N addition to soils and improve rotation crop yields

*Outline project activities, preliminary results, any deviations from the original project and communication activities. You may include graphs/tables/pictures in the Appendix*.

***APPENDIX***

Include up to 1 page of tables, graphs, pictures.

Please see attached detailed report for more information on activities and results of this project. Unfortunately pasting figures into this page is no working.

**Table 1.** Summary of sampling and frequency, measurements obtained from analyses and indicator purpose of the measurements.

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| **Sampling** | **Frequency** | **Measure** | **Indicator** |
|  |  |  |  |
| **N2O** |  |  |  |
| N2O gas | Bi-weekly to weekly during growing season | N2O flux rate | Warming potential of treatment |
| 15N2O gas | Bi-monthly | 15N2O flux rate from soybean residue components | Warming potential derived from soybean |
| **Plant** |  |  |  |
| Above ground  | At harvest | Biomass weight | Above ground productivity |
| Grain | At harvest | Wheat and soy yield | Harvest productivity |
| N contents | At harvest | % N above ground and grain | N uptakes |
| 15N contents | At harvest | % 15N above ground and grain | Fixed N by soybean and N uptake by wheat of soybean fixed N |
| **Soil** |  |  |  |
| Extractable N | Bi-monthly during growing season and at harvest  | NH4+ and NO3- concentration | Available plant N and residual N post-harvest |
| Extractable 15N  | Bi-monthly during growing season and at harvest | 15NH4+ and 15NO3- concentration | Available plant 15N and residual 15N post-harvest derived from soybean fixed N |
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