The Influence of Soybean Frequency in Rotation and the Persistence of Rhizobia in Manitoba Soils

Bradyrhizobium japonicum persists in Manitoba soils over winter and for years after inoculation. Crop sequence had a minimal effect on *B. japonicum* populations and the microbial community.

NITROGEN IN SOYBEANS is mainly supplied by a symbiotic relationship between the plant and nitrogen-fixing bacteria, *Bradyrhizobium japonicum*, that lives within soybean nodules. These N-fixing rhizobia strains are not native to Manitoba and inoculation is used to introduce the bacteria into the soil.

At present, very little is known about how crop rotations affect microbial communities and rhizobia populations. The objectives of this research were to quantify how *B. japonicum* overwinters in the soil and to determine how the frequency of soybean in rotation will influence rhizobial and microbial populations. This research was built onto a project conducted by Dr. Yvonne Lawley that examined soybean frequency in rotation.

At Carman, St. Adolphe and Melita, four crop sequences were evaluated—continuous soybean, canola–soybean, corn–soybean and wheat–canola–corn–soybean from 2014 to 2017. In 2017, all four crop sequence treatments were in the soybean test crop phase. Microbiomes and *B. japonicum* levels were evaluated at four time points—before planting, VE, R5 and R8, and were analyzed using 16S rRNA sequencing and qPCR, respectively.

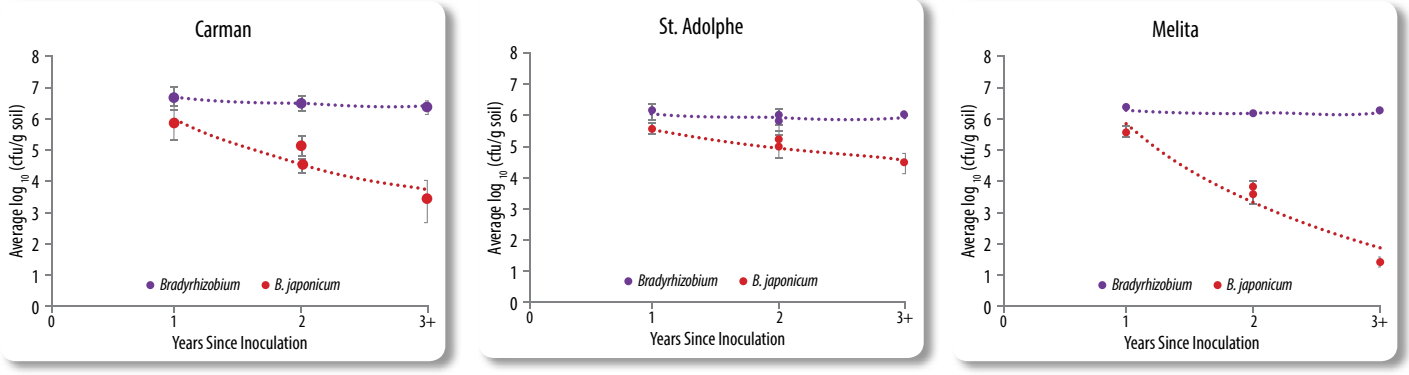
Over winter, the population of symbiotic *B. japonicum* did not significantly decline. Although the rhizobia population persisted in the soil at each site for years after initial inoculation, it declined with time since the last inoculation. The rate of decline was related to the history of soybeans grown in previous years. Fields at Carman and St. Adolphe that had a history of soybeans showed greater persistence of *B. japonicum* over time compared to the first-time soybean field at Melita (Figure 1). The effect of crop sequence on *B. japonicum*, as well as the microbial community, was minimal.

It was also apparent that there are native species of *Bradyrhizobium* present in Manitoba soils that cannot nodulate soybean crops. These non-symbiotic rhizobia also responded to the presence of soybeans and increased throughout the growing season.

This research achieved the first in-depth analysis of microbial communities in Manitoba fields and categorized the entire bacterial population of the microbiome at all three sites in 2017. Carman had significantly higher microbial diversity than St. Adolphe and Melita. The principal reason for observed differences between sites seems to be soil properties, specifically soil type and pH. These results have helped provide a better understanding of the complex plant–microbe and microbe–microbe relationships for future research to build on.

Another study led by Dr. Oresnik from 2016 to 2018 researched if we could determine the minimum population of *B. japonicum* that needs to be present in a field to ensure good nodulation. So far, his work has shown a strong correlation between the qPCR assay and predicting nodulation, but has been unable to find the lower limits of the *B. japonicum* population that would require inoculation. Samples are continuing to be analyzed to determine the lower limit and develop this tool for farmers.

Figure 1. Population of Bradyrhizobium *and* B. japonicum *over years since last inoculation. Reported data are from soil samples that were collected prior to planting. Manitoba locations were Carman, St. Adolphe and Melita.*



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