# On-Farm Evaluation of Soybean Inoculation Strategies

Christopher Forsythe, Laura Schmidt and Mikayla Melnick
Manitoba Pulse & Soybean Growers
www.manitobapulse.ca

## Introduction

- The bacteria responsible for nitrogen fixation in soybeans, *Bradyrhizobium japonicum,* are not native to Manitoba soils and must be introduced to first-time soybean fields in the form of an inoculant.
- With more soybean field history, populations of *B. japonicum* have been built up in many Manitoba fields.
- As a result, there is the potential to reduce soybean inoculation strategies in fields with sufficient soybean history.
- Soybeans require a minimum of 10 active nodules per plant to achieve sufficient biological nitrogen fixation to support maximum yield potential.

## Objective

- Explore the agronomic and economic impacts of different inoculation strategies on-farm, comparing
  1) double inoculation (seed-applied + in-furrow) vs. single inoculation (seed-applied alone), or
  2) single inoculation vs. no inoculation.

## Materials and Methods

- On-Farm Network trials were established on farmers' fields across Manitoba using the farmers' existing equipment and typical management practices.
- Starting in 2013, 56 on-farm trials have compared double vs. single inoculation on fields that have had at least two previous soybean crops, and the last soybean crop was within the past four years.
- Starting in 2016, as more fields had developed more soybean history, 42 on-farm trials have compared single inoculation to none on fields that have had at least three previous soybean crops, and the last soybean crop was within the last four years.
- Field-scale strip plots were randomized and replicated three to six times. Strips were harvested separately, weighed using a weigh wagon and yields were corrected for moisture.

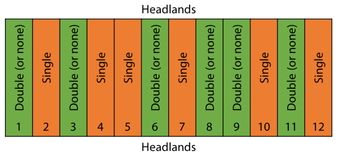


**Figure 1**. An example of a replicated and randomized on-farm inoculant trial layout with two treatments.

## Results

### Double vs. Single Inoculation (2013- 2023)

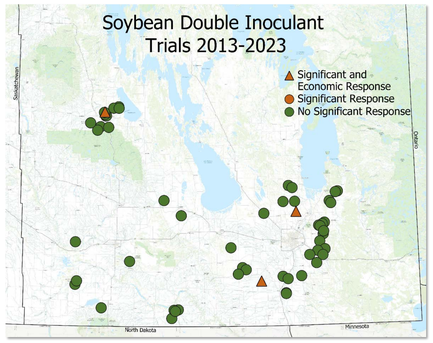


**Figure 2**. Map of double vs. single inoculation trials from 2013-23, colour-coded by significance. Orange trials are statistically significant at $p < 0.05$.

| *Soybean History (No. of Previous Soybean Crops)* | *Number of Trials* |
|---|---|
| **2 crops** | 34 (63%) |
| **3 crops** | 13 (24%) |
| **4 crops** | 2 (4%) |
| **5 or more crops** | 4 (7%) |

| *Years Since Inoculant Last Applied* | *Number of Trials* |
|---|---|
| **1 year** | 12 (22%) |
| **2 years** | 16 (30%) |
| **3 years** | 18 (33%) |
| **4 years** | 7 (13%) |

- A double inoculation strategy has not improved soybean yield vs. single inoculation 95% of the time on fields with more than two previous soybean crops after 11 years of testing at 56 on-farm trials.
- There have been three trials where a significant yield response occurred. At those fields, soybeans had only been grown twice previously and the last crop was four years ago. All three of those yield responses were economical, where the yield increase was large enough to pay for the increased cost of granular inoculant (1.5-3.0 bu/ac increase).
- Nodulation ratings have been similar between treatments at 95% of these trials and agronomically sufficient (>10 nodules/plant).

### Single vs. No Inoculation (2016 – 2023)

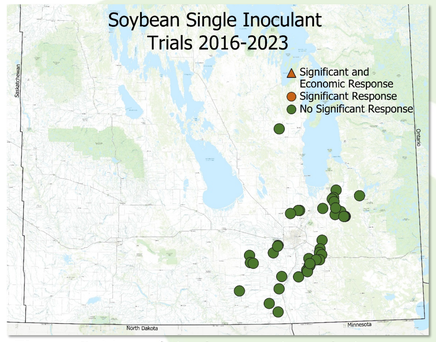


**Figure 3**. Map of single vs. no inoculation trials from 2016-23, colour-coded by significance. There have been no yield responses to-date in these trials.

| *Soybean History (No. of Previous Soybean Crops)* | *Number of Trials* |
|---|---|
| **3 crops** | 11 (26%) |
| **4 crops** | 15 (36%) |
| **5 crops** | 7 (17%) |
| **6 or more crops** | 9 (21%) |

| *Years Since Inoculant Last Applied* | *Number of Trials* |
|---|---|
| **1 year** | 11 (27%) |
| **2 years** | 10 (24%) |
| **3 years** | 15 (37%) |
| **4 years** | 5 (12%) |

- A single inoculation strategy has not improved soybean yield vs. no inoculant on fields with more than three previous soybean crops after eight years of testing at 42 on-farm trials in Central Manitoba.
- Nodulation ratings have been similar between treatments at 95% of these trials and agronomically sufficient (>10 nodules/plant).
- Assuming a cost of $3/ac for liquid inoculant, and a soybean sell price of $12/bu, a consistent yield increase of 0.25 bu/ac is needed to pay for the inoculant. Overall, the average yield difference has been 0.02 bu/ac between single vs. no inoculant.

VIEW THE RESULTS DATABASE →

## Recommendations from this Research

- Naturalized populations of *Bradyrhizobium japonicum* are effectively colonizing root nodules and fixing nitrogen in fields with sufficient soybean history. Assess soybean nodulation in every field, every year.
- Choose a soybean inoculation strategy based on field history. Consider a single inoculation strategy if the:
  - field has had at least two previous soybean crops,
  - previous soybean crops have been well nodulated,
  - most recent soybean crop was within the past four years, and
  - the field has had no significant flooding or drought.
- Granular in-furrow inoculants will have more resiliency and longevity in the soil during years with challenging spring conditions like excessive moisture or drought.
- Although yield responses to inoculant have not occurred to date on soybean fields with more than three previous soybean crops, on-seed inoculant may be considered 'cheap insurance' to avoid a costly nodulation failure.

## Acknowledgements

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