MANITOBA Pulse Soybean GROWERS

Soybean Fertility Fact Sheet

GENERAL SOIL FERTILITY GUIDELINES SUGGESTED FOR SOYBEANS

NUTRIENT	OPTIMUM SOIL TEST RANGE	NOTES	REMOVAL lbs/bu	REMOVAL lbs/ac*
Nitrogen (N)	Low, <50 lbs/ac	Proper inoculation will eliminate the need for N fertilizer. Soybeans can be grown on fields with high N levels, but it generally reduces nodulation, contributes to iron deficiency chlorosis and can delay maturity.	3.8	152
Phosphorus (P_2O_5)	Medium–High, 10–20 ppm	Soybeans can be grown on fields with various P levels. They are very efficient at extracting soil P and have shown to be non-responsive to P fertilizer in Manitoba. However, a crop rotation strategy that ensures P removal rates of soybeans are balanced with P inputs is encouraged. This may include fertilization of soybeans. The maximum safe rate of seed-placed P is 10 lbs/ac for wide rows or up to 20 lbs/ac for narrow rows with *good* soil moisture.	0.85	34
Potassium (K_2O)	Medium–High, ≥ 100 ppm or 200 lbs/ac	Soybeans take up and remove more K than other annual crops. Soil K should be monitored where crop rotation includes frequent soybeans or forages and on coarse-textured soils. If below critical levels, potash should be applied away from the seed. Deficiency of K appears as yellowing of leaf margins on older leaves (Figure 3). On-Farm Network research is currently underway in Manitoba to validate the critical soil K level and response of soybeans to K fertilizer rate and placement.	1.4	56
Sulphur (S)	Medium–High, ≥ 30 lbs/ac	Soils that receive S fertilizer from other crops in rotation (i.e., corn, canola) generally provide sufficient amounts for soybeans. If grown on coarse-textured soil with low organic matter and no recent fertilization, soybeans may benefit from S application.	0.2	8

* Based on 40 bu/ac soybean crop

INOCULATION STRATEGIES

Soybeans have the ability to meet the majority of their nitrogen (N) requirements through biological N fixation, eliminating the need for N fertilizer. To facilitate N fixation, inoculation with products containing compatible rhizobia (*Bradyrhizobium japonicum*) is required. Inoculants are available in liquid, powder and granular form. Liquid inoculants are placed on-seed and/or in-furrow, while granular inoculants are placed in-furrow with the seed. Granular and powder inoculants contain a peat or clay-based carrier to increase the survivability of the rhizobia. Liquid inoculant is convenient because it can be applied to the seed before planting, but can be more prone to desiccation. The inoculant strategy you use will depend on field history, equipment compatibility and cost.

❶ Double inoculation for fields with **little or no history of soybean**

Using two inoculant formulations or placement techniques (double inoculation) is encouraged for first and second time soybean fields. A typical strategy would include liquid on-seed plus granular or liquid in-furrow. Using two types of inoculant can be considered "extra insurance." Soybean rhizobium is not native to Manitoba soils, so inoculation in fields with little or no history of soybean is very important to ensure adequate rhizobia is introduced to the soil to infect soybean roots and facilitate good nodulation. Research studies in Manitoba show an average yield increase of 10 bu/ac and increased protein for inoculant treatments over the untreated control at sites with *no* history of soybean.

Figure 1. Nitrogen-fixing nodules on soybean roots.

❷ Single inoculation for fields with **a good history of soybean**

Once introduced to the soil, rhizobia survive in the soil for many years. This is why the amount of inoculant required can be reduced once soybeans have become established in a crop rotation. From 2013–2015, 25 replicated On-Farm Network field studies in eastern Manitoba compared double vs. single inoculation in soybean fields that had seen at least two previous soybean crops. Overall, a statistically significant economic yield response to double inoculation occurred in two out of 25 sites or 8% of the time (Figure 2). This data set is consistent with other growing regions and indicates that single inoculation is more economical for mature soybean fields. To help define a "mature" soybean field, use the checklist below. If a field meets *all four* criteria, single inoculation will likely provide a higher economic return.

CHECK-LIST FOR SINGLE INOCULATION

- ○ Field has had at least two previous soybean crops
- ○ Previous soybean crops have nodulated well
- ○ Most recent soybean crop within the past four years
- ○ No significant flooding or drought
- ○ All four above criteria have been met

The success of inoculation strategies should be evaluated every year by assessing nodulation at R1 (early flower). Gently dig up soybean roots and look for *at least 10 healthy nodules* per plant (Figure 1). Healthy nodules will appear pinkish-red when split open. If there are no nodules present and the crop looks yellowish-green, a rescue application of N should be considered at R2 (full flower) to R3 (early pod). In the event of nodulation failure, an in-season rescue treatment of broadcast granular or liquid N can be used if N is directed below the canopy to the soil surface and rainfall is imminent. Contact with leaf material can burn the foliage and reduce yield.

continued ➤

Figure 2. Yield response to double inoculation compared to single inoculation across 25 On-Farm Network trials conducted in fields with at least a two-year history of soybeans in eastern Manitoba from 2013–2015.

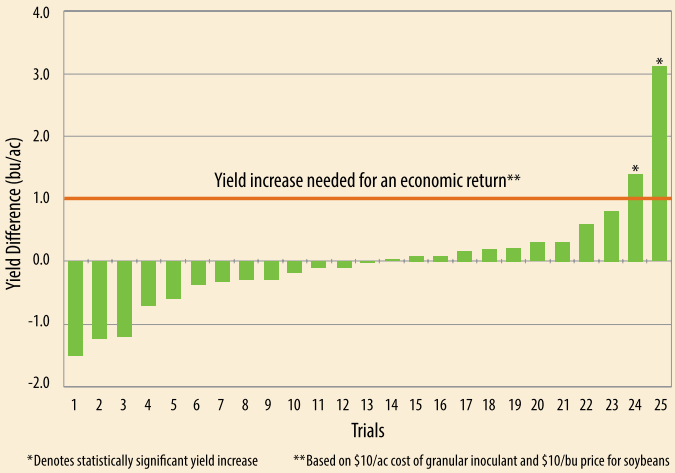

Figure 3. A) Potassium deficiency in soybeans appears as yellowing of outer leaf margins followed by necrosis, beginning in oldest leaves and progressing upwards; B) Iron deficiency chlorosis results in yellowing of new soybean leaves but veins remain prominently green.

IRON DEFICIENCY CHLOROSIS

Manitoba soils contain adequate amounts of iron (Fe) to meet the demands of soybeans. However, some environmental conditions can reduce the availability and uptake of Fe by the soybean plant, leading to the condition known as *Iron Deficiency Chlorosis* (IDC). Conditions that can lead to IDC include excess moisture, salinity, carbonates and/or high nitrate levels in the soil. Symptoms of IDC include yellowing of new soybean leaves between the veins (interveinal chlorosis), and an overall yellowing of soybean fields, particularly during the early vegetative stages in June. It is often a temporary condition that resolves itself when soil dries up. However, if symptoms persist for > 1 week, yield loss can occur. There is no effective in-season management option, but it is important to accurately diagnose the problem and adjust management strategies for future years. Visual diagnosis (Figure 3), tissue testing and knowledge of soil characteristics can help you diagnose IDC.

The best management tool is prevention. Soil risk factors outlined in Table 1 can be used to identify fields that are at risk of IDC ahead of the growing season. If fields designated for soybeans are at moderate-high risk of IDC, choose a soybean variety with a good (low) IDC rating. Varietal reactions to IDC (ratings 1–5) are available in the *Soybean Variety Evaluation Guide*. Other management practices that can reduce the impact of IDC include improved drainage, heavier seeding rates and practices that reduce soil N levels (cover cropping, N management in other crops). Iron chelate products applied in-furrow can reduce IDC; however, however, susceptible soybean varieties may still result in yield loss (Goos, NDSU).

TABLE 1. FIELD RISK OF IDC BASED ON CARBONATE AND SOLUBLE SALT SOIL TEST LEVELS*

SOLUBLE SALTS	CARBONATE LEVEL (%)		
(mmhos/cm)	0 to 2.5	2.6 to 5	>5.0
0 to 0.25	Low	Low	Moderate
0.26 to 0.50	Low	Moderate	High
0.50 to 1.0	Moderate	High	Very high
>1.0	High	Very high	Extreme

*Agvise Laboratories

Further Reading

Bardella, G. 2016. *Phosphorus management practices for soybean production in Manitoba.* M.Sc. Thesis. University of Manitoba.

Heard J. 2006. *Nutrient uptake and partitioning by soybeans in Manitoba*. Proc. Manitoba Agronomists Conference.

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Manitoba Pulse & Soybean Growers. 2013–2015. *On-Farm Network: Assessing effects of using only seed-applied inoculant on soybeans.** Research project.

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Heard, J. and D. Flaten. 2014. Phosphorus balance calculation for a rotation (interactive calculator).*

*Available online at *www.manitobapulse.ca*

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4/17