Pulse Advisor
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Top Dressing to Correct Nutrient Deficiencies

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Pulse and soybean crops use large amounts of nitrogen with most of these needs satisfied through nitrogen fixation. In the rare event that nodulation fails, top-dressing nitrogen may be an option.

Complete nodulation failure is seldom seen with peas and lentils in Saskatchewan because the populations of *Rhizobium leguminosarum* have built up in the soil over the last few decades that these crops have been grown. Even in cases where inoculation was mistakenly forgotten, or compromised because of various environmental factors, some nodulation would be expected from native populations of *Rhizobium leguminosarum* in the soil.

Similarly, on land where chickpeas have been frequently grown, native populations of *Rhizobium leguminosarum* may produce viable nodulation so that complete failure is not likely. However, even on long-term pulse land, growers are still encouraged to inoculate their crop to ensure optimum nodulation and nitrogen fixation. Nodulation with just native Rhizobium bacteria may not be sufficient for optimum yield.

Checking Nodulation

Nodulation efficacy can be verified by examining the pulse crop at early flowering. It may take up to four weeks after seeding for nodulation to reach a point where it can be evaluated. The best way to check for nodulation is to dig up a plant and gently remove the soil from the roots by washing in a bucket of water. Nodules are fragile and readily pull off if the roots are pulled out of the soil.

If the rhizobia are actively fixing nitrogen, the nodules will appear visibly red or pink inside (Figure 1).

Figure 1. Active nodules illustrating pink colour inside.

Soybeans

In Saskatchewan, soybeans my suffer a nodulation failure because many fields are new to soybeans. The bacterium responsible for nodulation on soybeans is *Bradyrhizobia japonicum*, and it is not native in Saskatchewan soils.

Nodules take some time to form, with some nodules and nitrogen fixation starting around the vegetative (V2 to V3) stages. Nodulation should be assessed at the R1 stage of growth (beginning to bloom), and you should find healthy nodules on each plant. Results from a recent Manitoba Pulse and Soybean Growers study evaluating various inoculant products, rates, formulations, and combinations found that at least 10 nodules per plant were required to reach 90 per cent of maximum yield (Figure 2). If poor nodulation is suspected, a rescue application of nitrogen should be considered.

Research in Manitoba and Saskatchewan provides guidance on rates and timing of top dress application. In Manitoba in 2011, Manitoba Agriculture's pulse specialist Dennis Lange conducted research on a virgin soybean field where the inoculant was mistakenly omitted. With 50 pounds of soil residual nitrogen per acre, the farmer broadcast-applied 100 pounds (lb) of nitrogen as urea seven days after seeding to bring up soil fertility to the 150 lb of nitrogen, targeting a 40 bushel soybean crop. Lange set up a trial on the same field and applied 50 or 100 lb of nitrogen as Agrotain-treated urea at early flower (R1) and pod fill (R4).

The farmer-applied treatment did not result in a yield increase compared to the check treatment with no additional fertilizer. The additional nitrogen went to vegetative growth but not yield. The 50 and 100 lb applications at early flower (R1) did not produce a statistically significant yield increase over the control. However the application at the pod fill (R4) stage produced significantly higher yield, with an increase of eight to 10 bushels per acre, compared to the treatment with no added fertilizer.

In Saskatchewan, research led by Chris Holzapfel at the Indian Head Agriculture Research Foundation looked at nitrogen application rates, timing, and inoculation methods to develop nitrogen management recommendations for soybeans. The research was conducted over three years starting in 2015 at Indian Head, Melfort, and Outlook. Part of the research looked at a post-emergent, dribble-banded urea ammonium nitrate (UAN), applied at a rate of 50 lb of nitrogen per acre at the early pod (R3) stage. All treatments received a liquid seed inoculant, and four granular inoculant rates (0, 1x, 2x, and 4x) the label recommended rate of 4.5 kilograms per hectare (kg/ha).

In the absence of granular inoculant, nitrogen fertilization frequently (but not always) led to increased yields. However, yields were almost never increased to what was achieved with good nodulation and subsequent nitrogen fixation. While the responses were not always consistent, R3 applications of 50 lb of nitrogen were reasonably effective for mitigating yield loss. Averaged across eight sites, in-crop nitrogen applications recovered yield to approximately 88 per cent of

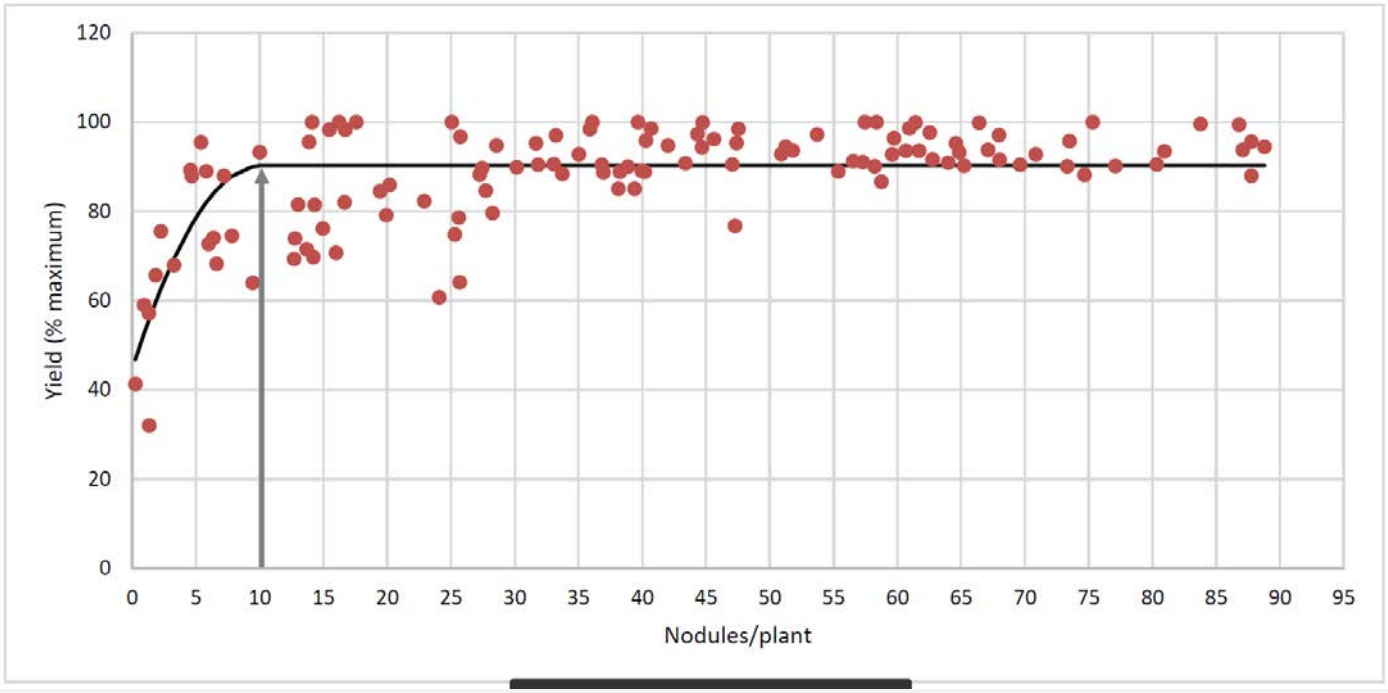

Figure 2. Relationship between number of nodules per soybean plant and relative yield.
Source: Soybean Inoculant Strategies, Manitoba Pulse & Soybean Growers., Final Report, 2016

the yields achieved with dual inoculation while, for comparison, yields with no rescue application were 75 per cent of the inoculated treatments.

Significant leaf burn was observed for UAN top dress applications. The researchers recommend a broadcast urea application for rescue treatments. Timing is best when rainfall is imminent. If rainfall is not forecast, a urease inhibitor may be warranted.

Peas and Chickpeas

In research carried out on peas and chickpeas in Montana in 1999 and 2000, fertilizer was applied after crop emergence to overcome nitrogen deficiency due to inoculant failure. Their conclusions indicated that yield loss due to inoculant failure could be prevented by applying fertilizer within six weeks of seeding, coinciding with the 9 to 12 node stage of peas and the 10 to 13 node stage of chickpeas.

The Saskatchewan Ministry of Agriculture recommends a top dress nitrogen application at a rate of 44 to 55 kg/ha (39 to 49 lb per acre).

Lentils and Faba Beans

Research on rescue treatments for nodulation failure has not been conducted on lentils and faba beans. Currently no recommendations are available for these crops.

Dry Beans

While dry beans can fix a portion of their required nitrogen, the general recommendation is to apply higher levels of nitrogen in the soil, as dry beans tend to be poor nitrogen fixers. No information is available on top dressing nitrogen in dry beans.

Top Dress Micronutrients

In pulse and soybean crops, micronutrients are not a major limitation. Little independent research has been conducted on foliar top dress of micronutrients, individually or in blends. If applying a foliar micronutrient, always leave a check strip and assess whether there was an economic benefit.

An exception is zinc in dry beans. Response to foliar zinc application has been observed in dry beans where soils are deficient in zinc fertility.

A second exception is iron foliar application on Iron Deficiency Chlorosis (IDC) sensitive soybeans. Research near Central Butte, Saskatchewan in 2015 and 2016 by Hangs and Schoenau of the University of Saskatchewan found that foliar iron sulfate produced a positive yield response in the IDC sensitive soybean variety Moosomin, but not in the IDC tolerant variety McLeod (in the 2016 season only).