Starter Nitrogen in Pulses

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The need for starter nitrogen in pulses varies by crop, but typically an inoculated and well-nodulated pulse crop will supply most of its own nitrogen needs with the balance coming from soil residual nitrogen.

However, small amounts of starter nitrogen may help seedlings remain healthy and vigorous during the period of early development until nodulation kicks in which is approximately three to four weeks after germination. Limited nutrient availability under conditions of low soil nitrogen, restricted root growth, or under cool, wet conditions during early growth could affect the health and vigor of the seedlings. Weak seedlings are more susceptible to diseases such as seedling blights and root rots, and are less competitive with weeds. Stressed plants are also at higher risk for herbicide injury as their metabolism of the herbicide may be reduced. Knowing the soil nitrogen levels will help determine the need or potential benefit from starter nitrogen.

For peas and lentils, on soils with very low nitrogen fertility of less than 15 pounds per acre (lbs/ac) or 17 kilograms per hectare (kg/ha) available nitrogen, a small amount up to 18 lbs/ac (20 kg/ha) of starter nitrogen fertilizer may provide a benefit in some years.

Importance of Nitrogen-Fixation

Pulse crops utilize or take up large amounts of nitrogen during crop growth for the production of seed and protein. Luckily most of the nitrogen uptake comes from nitrogen-fixation and the amount varies by pulse crop.

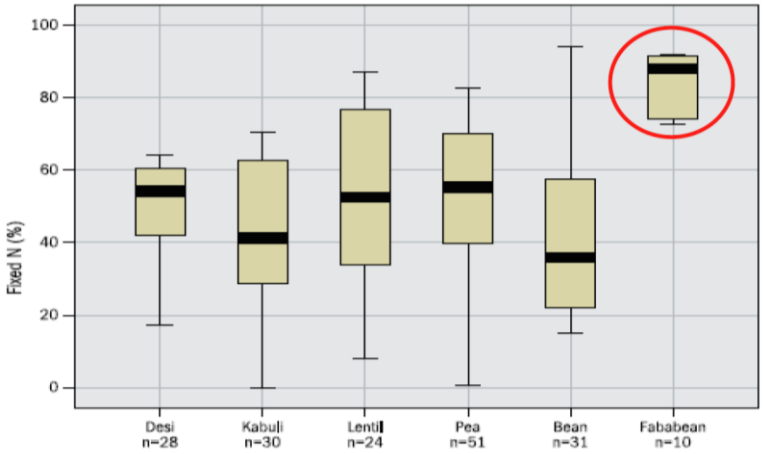
Table 1. Nitrogen Uptake and Removal (Pounds per Acre) by Pulse Crops

Crop	Crop Yield	Uptake	Removal
Pea	50 bu/ac	138 – 168	105 - 129
Lentil	30 bu/ac	82 – 101	55 - 67
Faba bean	50 bu/ac	257 – 314	154 - 188
Soybean	35 bu/ac	160 – 200	130 - 140
Dry bean	1,800 lbs/ac	NA	75

Sources: Nutrient Uptake and Removal. Fertilizer Canada 2001.
Soybean and dry bean from Manitoba Agriculture, Food and Rural Development

Research by Fran Walley at the University of Saskatchewan (U of S) found that pulse crops inoculated with the proper rhizobium (bacterial) strain has the potential to fix 50 to 80 per cent of its nitrogen requirement through nitrogen-fixation, although the amount differs by crop. For example, faba bean was found to fix around 90 per cent of its requirements, while dry bean was less than 40 per cent.

Image 1. Percentage of Nitrogen Derived from Fixation for Pulse Crops Grown in Western Canada.



The data was compiled from published research reports and papers.
The thick dark line indicates the median value, the box represents 50% of all data, and the whiskers contain the remaining 50% of the data. Dr. Fran Walley, University of Saskatchewan.

Safe Seed-Placed Nitrogen Fertilizer Rates

Dr. Jeff Schoenau says pulse crops are sensitive to fertilizer placed in the seedrow, so starter nitrogen fertilizer should be kept away from the seedrow. Small amounts of nitrogen are provided in seed-row placed monoammonium phosphate (11-51-0) and will supply some available nitrogen early on.

More Information on Nitrogen Responses by Crop:

Peas

Peas should be grown on fields low in available soil nitrogen. When the combined levels of soil and fertilizer nitrogen reaches 25-35 lbs/ac (28-40 kg/ha), any starter nitrogen will reduce nodulation and nitrogen-fixation, and levels greater than 50 lbs/ac (55 kg/ha) can dramatically delay nodulation and reduce or eliminate nitrogen-fixation.

In research conducted at Agriculture and Agri-Food Canada (AAFC), Gan et al. report that the nitrogen requirements of field peas are met by nitrogen-fixation when the crop is well inoculated with an appropriate inoculant formulation.

Other AAFC research by Clayton et al. found that starter nitrogen application rates of less than 35 lbs/ac (40 kg/ha) were either ineffective or negative to pea seed yield in inoculant treatments that favored relatively high yields (i.e., granular inoculant, and in most instances, peat inoculant).

Lentils

In fields where lentils are grown for the first time, starter nitrogen may be useful, particularly on low nitrogen soils. In dry soil zones this should not cause excess growth.

These recommendations are supported by research across Western Canada. AAFC research by Lafond et al. reported that starter nitrogen at a rate of 27 lbs/ac (30 kg/ha) significantly promoted early growth and increased lentil seed yield when residual soil NO_3-N was around 9 lbs/ac (10 kg/ha). However, there is no effect of starter nitrogen on lentil when conditions are dry or when fields have a long history of continuous cropping with adequate nitrogen fertilizer used in the previous seasons.

Gan found that additions of nitrogen fertilizer to lentils at a rate of 13 lbs/ac (15 kg/ha) advanced days to maturity, reduced nodule dry weight significantly, but there was no effect on seed yield.

Recent research by Alberta Agriculture and Forestry led by Robyne Bowness found that a small amount of starter nitrogen of 13 lbs/ac (15 kg/ha) provided a significant yield benefit, and going above 27 lbs/ac (30 kg/ha) negatively affected nodulation and decreased yields. Starter nitrogen did impact nodulation, with increasing nitrogen rates decreasing nodulation in the Alberta trials. This is consistent with experience in Saskatchewan where additional fertilizer nitrogen above combined soil and fertilizer nitrogen levels of 25-36 lbs/ac (28-40 kg/ha) reduce nodulation and nitrogen-fixation.

Faba Beans

Faba beans are the most efficient nitrogen fixer of pulse crops grown on the Prairies. In a three-year study at Barrhead, Alberta, faba bean nitrogen-fixation ranged from 62 to 200 lbs/ac (70 to 223 kg/ha). This accounted for 80 per cent or more of its nitrogen requirements.

In research conducted by Alberta Agriculture and Forestry, no benefit to starter nitrogen was observed when faba beans were inoculated and good nodulation was achieved.

Chickpeas

Kabuli chickpeas are an excellent nodulator and nitrogen fixer. Desi chickpeas are a good nitrogen fixer under ideal conditions, but may be a little sensitive to adverse environmental conditions.

Research on starter nitrogen on chickpeas has produced varying results. Gan reported that starter nitrogen at the rate of 13 lbs/ac (15 kg/ha) increased seed yield significantly for Kabuli-type chickpea, but did not affect seed yield for Desi chickpea. In addition, the application of the starter nitrogen improved harvestability by increasing plant height and the lowest pod height from the soil surface in both chickpea types. However, the addition of starter nitrogen reduced the number of nodules and nodule weight in both chickpea types. Maturity was marginally affected by starter nitrogen. In other research by Gan, chickpeas receiving fertilizer nitrogen plus granular inoculant produced a similar yield as the crop that received granular inoculant only.

At the U of S, Walley reported that Kabuli chickpea yields were unaffected by starter nitrogen, but that Desi yields may be optimized by the application of low rates of starter nitrogen of 26 lbs/ac (30 kg/ha) and phosphorus at 18 lbs P_2O_5 per acre (20 kg P_2O_5/ha).

Saskatchewan research conducted with four chickpea varieties from 2004 to 2006 showed no differences in seed yield when sown with or without starter nitrogen when granular inoculant was utilized.

Research by Gan et al, though, suggests that starter nitrogen may be used as a maturity management tool in chickpea. Starter nitrogen of 25-50 lbs/ac (28-56 kg/ha) without inoculant resulted in earlier maturity by an average of 13 days in normal to cooler/wet seasons. In dry years, only marginal differences were noted as drought conditions accelerated crop maturity. Research at Swift Current and Shaunavon, SK suggests the best practice may be to apply starter nitrogen instead of inoculating the seed.

Soybeans

Information from Manitoba recommends that soybeans be grown on fields with nitrogen fertility that test less than 50 lbs/ac (60 kg/ha). Inoculation with *Bradyrhizobium japonicum* is important, as this rhizobium does not naturally occur in prairie soils. For the first few years of soybean production, fields should be double inoculated with a seed inoculant (liquid or peat) plus a granular in-furrow inoculant. Most Saskatchewan fields are new to soybean production so a double inoculation as used in Manitoba is recommended for Saskatchewan soybean growers.

Recent research by the Manitoba Pulse and Soybean Growers has found that double inoculation is not necessary if the field has had at least two soybean crops with good nodulation, had soybeans less than three years ago, and the field has not seen flooding since the last well-inoculated soybean crop.

Research led by Dr. Jeff Schoenau at the U of S in 2014 revealed that soybeans derived about 100 lbs/ac from fixation under good growing conditions at a site near Rosthern, SK. In this project the soybeans were double inoculated.

An Agricultural Demonstration of Practices and Technologies demonstration trial at IHARF in 2014 found a significant yield response to starter nitrogen, although researcher Chris Holzapfel says the 2014 growing season was a tough year for soybeans with cool conditions throughout the growing season combined with excess moisture through June and an early fall frost.

Subsequently, a three-year project was started in 2015 and is funded by Saskatchewan Pulse Growers. The research is looking at nitrogen management recommendations and soybean inoculation. Researcher Chris Holzapfel says the preliminary results from 2015 generally found starter nitrogen resulted in increased vegetative growth but did not translate into any yield benefit. The only significant exception was at Indian Head where, in the absence of any granular inoculant (and therefore inadequate nodulation), there was a benefit to applying a surface dribble band of urea ammonium nitrate late in the growing season (mid-flower/early pod fill). In essence, this was a rescue application. In all cases there was no benefit to starter nitrogen in 2015 where a liquid plus one times label rate of granular inoculant was applied, regardless of the form, placement or timing of nitrogen fertilizer. All seed in these trials were treated with a liquid inoculant and all trials were on land that has never been seeded to soybeans.

Dry Beans

Information from the Saskatchewan Ministry of Agriculture recommends starter nitrogen for non-irrigated dry beans. Generally, dry beans are poor at fixing nitrogen in comparison to peas, lentils, faba beans, and chickpeas. Research completed on inoculated dry beans by the U of S and AAFC, Morden Research Station indicated a positive yield response to the application of starter nitrogen at actual nitrogen rates of 22-26 lbs/ac (25-75 kg/ha) when applied in conjunction with an effective rhizobial inoculant. This on-going research also indicates a difference between bean varieties with respect to their ability to fix nitrogen.

The current recommendation for non-irrigated dry bean production in Saskatchewan is to inoculate the crop and use 50 lbs/ac (55 kg/ha) nitrogen.

Key points

- Pulse crops properly inoculated with the right strain specific to that pulse crop and at label rate will produce optimum yield and quality
- A few exceptions where some additional starter nitrogen may produce benefits: fields testing very low in soil test nitrogen (<15 lbs./ac (17 kg/ha) in the top 12 inches and sometimes under very cool/wet spring conditions
- Pulses are sensitive to seed placed fertilizer. If applying starter nitrogen, apply it away from the seedrow so as to not reduce germination and uniformity of emergence
- Starter phosphate also adds some nitrogen, plus the soil nitrogen in the top foot, is generally all that is needed to get pulse seedlings off to a healthy start until the onset of nodules and nitrogen-fixation
- Adopt the 4R Nutrient Stewardship for optimum yield and quality while maintaining long-term sustainable production (Right Source, applied at the Right Rate, Right Time, and Right Placement). In the case of pulse crops the 4Rs related to nitrogen can be obtained with proper inoculation