Post-Harvest Opportunities with Pulse and Soybean Crops

The Bean Report
Your source for soybean and pulse crop agronomy and research.

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Knowing how to capitalize on soybeans, dry beans, field peas and faba beans in your cropping systems allows for experimenting with practices that could save time and inputs for future crops.

KNOW YOUR NITROGEN CREDITS

The amount of nitrogen (N) pulses and soybeans biologically fix, via rhizobium bacteria, and release to subsequent crops is difficult to precisely estimate. Nitrogen contributions are a function of internal factors (crop species, variety) and external factors (soil characteristics, precipitation, temperature, tillage, inoculation and fertilization, cropping sequence and rotation, pathogens) that affect N-fixation and residue decomposition (Xie 2017). It is no surprise, then, that we find enormous variability in the range of N-fixation (Figure 1) and N contributions in literature (Walley et al. 2007, Salvagiotti et al. 2008).

Generally, crops like peas, lentils and faba beans, with a higher proportion of N-fixation relative to their total N-requirement (average of 52, 58 and 84%, respectively), have a small, but positive soil N-contribution compared to dry beans and chickpeas (Walley et al. 2007). Nitrogen nutrition for dry beans in Manitoba is supplemented with fertilizer, as N-fixation is insufficient, and therefore N credits are negligible. Dry bean residue does, however, have a low carbon (C) to N ratio (C:N), so it quickly mineralizes available N to the next crop.

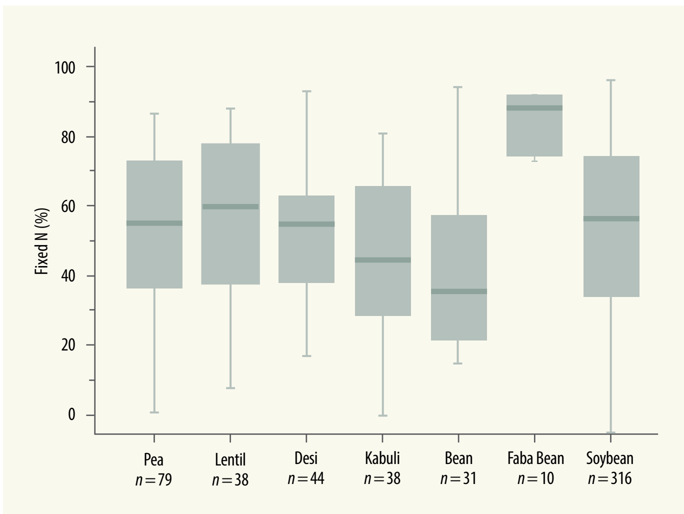

Figure 1. Nitrogen biologically fixed, as a proportion of total crop N requirements (Walley et al. 2007, Salvagiotti et al. 2008).

Soybeans fix, on average, 58% of their N requirement (Salvagiotti et al. 2008), but soybeans remove a large portion of that N through harvested seed compared to pulses. Consequently, growing soybeans results in a neutral or even negative soil N balance. Researchers in Saskatchewan found that wheat yielded similarly when grown on soybean, lentil or pea stubble, but found lower amounts of N (and phosphorus) returned to the

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HOW TO ESTIMATE NITROGEN CONTRIBUTIONS FROM YOUR PULSE COVER CROP

1 Estimate biomass yield (lbs/ac) using one of two options

- Measure the height of the crop: the first six inches will produce 2,000 lbs/ac. Add 150 lbs/ac for each additional inch. Estimate % ground cover using the Canopeo App on your mobile device. Biomass yield = estimated lbs/ac multiplied by % ground cover.
- or… Cut and remove all above-ground portions of the plant within a known area (e.g. a hula hoop or metal-framed quadrat). Allow this sample to air dry for one to two days until they are "crunchy-dry." Then weigh the sample. Biomass yield = lbs of dried sample divided by square feet sampled, multiplied by 43,560 ft^2.

2 Estimate N content (%N)

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Generally, annual legumes contain 3.5–4.0% N prior to flowering. For the most reliable N estimates, send a tissue sample to the lab at the time when the cover crop is terminated (i.e. by frost, herbicide or tillage).

3 Estimate rate of N release

About 50% of the N will be available to the following crop, with an additional 15% available in the second year. If the cover crop is not incorporated with tillage, only 25% will be available to the following crop.

Example – 1500 lbs biomass/ac * 3.5 %N * 50% release rate = 26 lbs N/ac available for the next crop.

soil with soybeans compared to peas or lentils (Xie 2017). Remember that the yield advantage you may see after a pulse or soybean crop may not be due to N credits, but may instead be a function of non-N benefits (e.g. breaking up insect and disease cycles).

Pulse-derived N is also released through decomposition over several years, so assigning a simple fertilizer replacement value can be misleading. Pulse rotational studies across the Prairies consistently found that peas, lentils and faba beans provided a yield and economic benefit compared to cereal-oilseed rotations, and that benefit lasted up to three years after the pulse was grown (Khakbazan et al. 2018). The slow-release nature of pulse-derived N has also been shown to improve protein levels in following wheat crops (Miller et al. 2002). Because pulses are harvested relatively early, a fall or spring soil test will capture only some of the mineralized nitrates from decomposing residue that will be available to the next crop. Factors that increase the rate of N release are tillage and crop residue with a low C:N ratio. Soybeans actually have a higher C:N than other pulses, wheat and canola, meaning their residue will tie up N and release it more slowly.

MAKE YOUR OWN NITROGEN

Peas, lentils and faba beans are absent from most farm rotations, either due to growing condition or marketing limitations. Since soybeans and dry beans provide no net N benefit for subsequent crops, there lies an opportunity to incorporate these other, higher N-producing pulses as cover crops. Compared to soybeans and dry beans, these pulses are also more frost tolerant (as low as -4 to -6°C), have a shorter season and seed is relatively easy to source locally. This makes them perfect candidates for "shoulder season" or fall-seeded cover crops.

Do we have enough time, heat and moisture to make it work? Research conducted in Manitoba found that an acceptable level of pea or lentil biomass production (i.e., approximately 1000 lbs/ac) can be achieved with less than eight weeks from seeding to killing frost (Thiessen Martens et al. 2001, Cicek et al. 2014). Peas produced greater and more consistent levels of biomass compared to lentils. More biomass generally equals more N production. Faba beans have not been tested as a fall-seeded cover crop in Manitoba, but they are the most frost-tolerant and highest N-fixing of the pulses, shown to provide an average of 45 lbs N/ac to subsequent corn crops in northeastern USA when seeded in August (Etemadi et al. 2018).

Harvest of winter cereals in Manitoba wraps up in the first to second week of August and a large portion of spring-seeded cereals are harvested by the third and fourth week. The average first fall frost (0°C) for south, central and parts of eastern Manitoba is most likely to occur during the third or fourth weeks of September (Table 1). Pulses can withstand light frosts, so realistically, fall-seeded pulses have approximately six to eight weeks to grow. Many areas in Manitoba have sufficient heat and precipitation during August, September and October to allow pulses to germinate and grow to the late vegetative stages (Table 1).

Seeding a pulse crop for N production after early harvest of a cereal can provide added benefits of 1) reducing risk of soil erosion in the fall (and early spring, if mulch is not incorporated), 2) alleviating surface soil compaction, and 3) reducing evaporative water loss and improving water infiltration if mulch is left intact. Conversely, transpiration (water use) by the cover crop in fall may reduce soil water stores for the following year's crop.

PHOSPHORUS AND POTASSIUM REMOVED, REPLACED

Phosphorus (P) and potassium (K) behave differently in soil compared to N. Nitrogen levels vary widely from year to year based on soil, weather and management practices, whereas P and K levels in soil remain more consistent. Plant-available soil N is subject to fertilizer/manure additions, volatilization, leaching and denitrification losses and crop residue/organic matter mineralization and immobilization. For P and K, the soil behaves more like a bank account, where the major source of withdrawals is usually removal through harvested grain.

As with N in soybeans, the P and K removal rates through harvested seed is high. However, the trouble with maintaining P and K fertility in pulse and soybean rotations is primarily due to limited crop capacity to tolerate seed-placed fertilizers, which is often the preferred and convenient method of application (Table 2). Potash fertilizer, in particular, has a very high level of

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Table 1. Long-term (30-year average) accumulated growing degree days (base temperature 5°C) and precipitation (mm) from August 1 to October 31 across Manitoba. The average date of the first fall frost for each location is included.

Location	GDD	Precipitation	Average date of first fall frost (0°C)
Morden	748	148	Sept. 21 – 24
Winnipeg	673	154	Sept. 21 – 24
Arborg	599	157	Sept. 18 – 21
Brandon	604	140	Sept. 15 – 18

Table 2. Crop P and K removal (through harvested seed) and maximum seed-placed P and K fertilizer rates (source: Manitoba Soil Fertility Guide 2007).

Crop/Yield	P Removal (lbs P_2O_5/ac)	Maximum safe rate of seed-placed P_2O_5/ac	K Removal (lbs K_2O/ac)	Maximum safe rate of seed-placed K_2O/ac
Soybeans (40 bu/ac)	33	10*	56	0
Dry beans (1800 lbs/ac)	25	10*	25	0
Field peas (50 bu/ac)	35	20	36	0

*No fertilizer should be placed in the seed row when soybeans or dry beans are planted on greater than 15-inch row spacing.

seedling toxicity risk relative to other fertilizers and should be placed away from the seed.

Early harvest allows time for a large addition of P and/or K fertilizer or manure in the fall to satisfy uptake requirements and balance nutrient removal for all crops in the rotation. For example, if we expect to grow soybeans, canola and wheat (yielding 40, 50 and 60 bu/ac, respectively) over three years, we would require a total of approximately 140 lbs P_2O_5/ac to replenish the P removed. You could apply 100 lbs P_2O_5/ac in the fall, reserving an application of 20 lbs P_2O_5/ac as starter fertilizer for each of the canola and wheat crops, which are more likely to respond to seed-placed P fertilizer than soybeans. This one-time P application should be incorporated (or even better, banded) to reduce nutrient losses due to surface runoff. This fertilization strategy would maintain soil fertility over the course of the crop rotation, saving time and cart space during seeding.

Soil loss on May 15, 2018 from a field that had soybean residue cultivated and rolled the fall prior.

WHY TILL A LOW-RESIDUE CROP?

Residue management after soybeans, dry beans and field peas doesn't have to follow the usual stubble incorporation methods we prescribe to high-residue cereal and canola crops. Experimenting with eliminating tillage – even for just a year – may seem radical. We have heard the question asked – why till a low-residue crop? Recent on-farm research conducted in Manitoba by Dr. Yvonne Lawley found that when soybean residue was left on the soil surface without incorporation, the residue broke down and ground cover was reduced by 31–57% from fall to spring. Different methods of soybean residue incorporation (discing, cultivating or vertical tilling) had no effect on soil moisture or temperature at the two-inch depth during the emergence period the following spring, compared to the no-till stubble. Ultimately, none of the soybean residue management practices had any effect on yield of the following corn of wheat crops.

Farms equipped with planters or disc drills can cut through the pulse or soybean residue that remains the following spring, or will have GPS-enabled guidance to keep seeder shanks between the stubble rows. So, get lazy and consider parking the cultivator next fall!

Eliminating tillage of low-residue pulse or soybean crops may reduce wind erosion the following spring, with the added benefit of conserving soil moisture and reducing fuel, labour and equipment expenses. ■