SPRING SPECIAL – NITROGEN FERTILIZER AT $0.10 PER POUND

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Pulse production in western Canada has a long history, but only recently has acreage elevated them to an independent category of their own as opposed to being considered a specialty crop. Acreage of the major annual pulses; field pea, lentil, chickpea, dry bean and soybean has increased dramatically in the last decade. The largest pulse crop produced is field pea. Though acreage has increased, average yields have remained relatively level, despite the introduction of varieties with considerably higher yield potential. One must ask why?

Maximum yield potential is established by the genetic potential of the variety. This biological yield is never realized in field production, being limited by a multiple of yield limiting conditions such as environment, diseases, weeds, insects, etc. However, it is important to remember that the only commercial crop input that will force yield towards its greatest possible yield are nutrients. Therefore it is imperative to ensure that careful attention is paid towards appropriate stand establishment and fertility of pulse crops.

Of prime importance in pulse production is stand establishment. Without appropriate plant populations yield potential is diminished. A survey by Saskatchewan Agriculture & Food of commercial field pea fields indicated that average plant populations were approximately 70% of optimal. Yield loss associated to this lower plant stand could, conservatively, be 15 bu/ac! Producers are encouraged to spend due diligence in all aspects of stand establishment….seed quality, calibration of rates, seeding dates, etc.

Proper pulse nutrition is essential in obtaining high yields. In western Canada the primary nutrients of concern are nitrogen (N) and phosphorus (P). Nitrogen uptake or acquisition by the plant is synonymous with yield and quality, and pulse crops have a high demand for N. Adequate N fertility can be provided through N fertilizer applications, inoculation and/or a combination of both. Research has demonstrated that obtaining yield exclusively by fertilizer N applications is neither economical nor advisable. If properly inoculated most pulse crops can obtain approximately 70-80% of their N requirements through symbiotic N-fixation. Pulse plants will need to acquire the remaining 20-30% deficit of their N demand through soil sources. As functional N-fixation may require 3-4 weeks after plant emergence to begin meeting N demands, research has been conducted to evaluate the effect of “starter” N fertilization.

Starter N evaluations have been conducted in both Alberta and Saskatchewan by AAFC. In Saskatchewan, trials on peas by Drs. Lafond and Johnston in the Black soil zone reported little evidence of starter N benefits. Similarly, In Alberta Dr. Clayton and colleagues found that starter N applications enhanced dry matter production but this greater biomass did not transfer itself into increased seed yield. Dr. Ross McKenzie (Alberta Agriculture) conducted trials in all Alberta soil zones. He concluded that starter N fertilizer was not required in the Black soil zone but maybe warranted in the Brown and Dark Brown soil zones if soil test N levels are less than 20 lbs., in which case an application of 20 lbs. N should be considered. This recommendation would likely be also true for lentils. Dry beans are the poorest N-fixing pulse crop and trials in Manitoba and Saskatchewan have indicated that this pulse crop should be viewed more as an oilseed crop and fertilized with N accordingly.

Nitrogen inoculants are the oldest, manufactured crop input product, first introduced commercially in 1898. Little change in inoculants occurred for the next 80 – 90 years; however the last decade has witnessed remarkable improvements in all aspects on biological inoculants. By natural selection, more efficient N-fixing *Rhizobium* strains have been commercialized within the last decade. Improved strains are required to be superior both in terms of infectiveness and effectiveness than existing commercial strains. Infectiveness refers to the ability of the rhizobial strain to survive, compete and multiply within the proximity of the seed and then out-compete indigenous rhizobia to infect plant root hairs and establish nodule occupancy. Effectiveness refers to the ability of the bacteria, once established within a nodule, to convert atmospheric N to a plant available form.

Inoculants are commercially available in three formulations; liquid and peat-based products intended to be seed applied and granular formulations for in-row application. Each formulation has its own strengths and weaknesses. As a general rule, these formulations are ranked in terms of efficacy in the following order;

Liquids ≤ Peat ≤ Granules

Liquid inoculant formulations are convenient in terms of application and metering. However, they appear to be the most sensitive of formulations. Liquids can be as equally effective to other formulations if ideal conditions occur. If conditions are less than optimal, liquids effectiveness appears to diminish. Part of lower efficacy exhibited by liquids has been their susceptibility to desiccation. *Rhizobium* bacteria are sensitive to drying conditions, and the bacteria numbers applied to the seed with liquid formulations decline rapidly from the time of seed application. This may have been one of the factors for the lack of performance with liquids. The effect of desiccation would likely be magnified if treated seed was planted into less than optimal soil moisture conditions. This potential problem may have been overcome to some extent with the introductions of “extenders.” Extenders are additives that help reduce the negative effect of desiccation and extend the on-seed, and therefore, the planting window of liquid formulations. A further concern with liquids however is when they are used in conjunction with chemical seed treatments. Seed treatments are designed to protect against pathogenic plant disease and/or target insects. These treatments can have a significant effect on the N-fixing rhizobia. With liquids both rhizobia and seed treatments are in direct contact with one another which may reduce potential efficacy of the liquid inoculant application.

Peat based on-seed inoculants are the oldest formulation of inoculants commercially available. Early formulations were finely ground peat amended with one or more strains of rhizobia, and were, until recently non-sterile. A sterile liquid or peat on-seed formulation is desirable. Effective N-fixation requires the rhizobia bacteria to multiply numerous times in the soil prior to infection in order to out compete indigenous organisms. There is nothing to be gained by having numerous organisms, many witch may not be *Rhizobium* species, competing in the product bag prior to seed treatment. Sterile peat inoculants maintain higher numbers of effective rhizobia and extend the longevity of the formulation. Peat based inoculants are less susceptible to desiccation as the peat itself has a relatively high moisture content and therefore is less prone to declining on-seed bacteria, compared to liquids. There is also often less sensitivity when used in conjunction with chemical seed treatments as the peat acts as a physical barrier between the *Rhizobium* and the active ingredients of the chemical. Many peat based inoculant are formulated with a self sticking additive that assists the inoculant to adhere to seed.

Granular inoculants are an in-furrow application of peat or clay prills acting as the carrier for the rhizobia. Granular inoculants have been considered the “Cadillac” of inoculants for a couple of reasons. Firstly, they are higher priced primarily because of product volume. As the trend towards higher seeding rates increases, the difference in per acre cost of the three formulations diminishes. Secondly, they perform. Numerous studies have demonstrated that granular inoculants have produced as high, more often higher, yields than other formulations. Reasons for their apparent superiority are numerous;

- potential for higher delivery rates,
- avoidance of chemical seed treatment compatibility concerns,
- and apparent greater ability to withstand moisture stress after planting.

Peat and liquid based inoculants tend to create a majority of nodules on the plant at the crown position on the root. Granular inoculant, applied in-furrow, will also have nodules formed at the crown position but also form additional nodules on lateral roots. Recently, Dr. Fran Walley, and colleagues at the University of Saskatchewan, studying chickpea, demonstrated that these lateral root nodules were more effective than crown nodules with respect to yield contribution. Nodules from the lateral root positions were contributing the majority of the N fixation and transfer to the plants.

All inoculant formulations must be handled in an appropriate manner. The following list outlines some of these procedures.

- For all inoculants, store product in a dark or shaded area. Rhizobium are sensitive to UV light. If application occurs in the yard, tarp the truck and keep treated seed covered. If treating in the field, keep your inoculant out of direct sunlight.
- Store product in a cool area if possible. If you have received inoculant do not store in a facility that will experience freeze-thaw cycles. *Rhizobium* numbers will decline if these conditions repeat.
- For seed applied inoculants it is advisable to plant as soon as possible following application. Extenders will assist with liquid formulations, particularly if planting into dry soil or a soil that is drying quickly. However, it is still wise to plant as soon as possible.
- If treating bulk volumes of seed, inoculate only what you can seed in a day, half day volumes are better.
- For liquid inoculants thoroughly shake the bag prior to application.
- For peat inoculants adhesion to the seed will be enhanced if the product is applied as a slurry. This also applies to those peat inoculants that contain a self sticking agent. If the peat does not contain a sticking agent one will have to be applied, a variety of non-toxic sticking agents are available but it is best to contact the inoculant company itself sore options. If a slurry is considered inconvenient, at least dampen the seed just prior to application. Though a slurry is often viewed as a “messy” application keep in mind your desired results. For effective N-fixation each seed needs to have a high number of rhizobia attached to it, you only have one opportunity to get it right, take time to ensure proper coverage.
- Properly calibrate an air-seeder such that air velocity is just sufficient to handle the volume of seed planting. At high seed volumes it takes a great deal of air flow to distribute seed. This flow may cause desiccation of rhizobia during seeding (particularly liquids) or separate the inoculant from the seed (particularly peats in non-slurry application).
- Ensure that when using a chemical seed treatment the inoculant is compatible with it. Contact the inoculant manufacturer for compatibility information and planting window timelines. Do not use one manufactures compatibility information for another’s inoculant. Each inoculant company uses different strains of *Rhizobium* and their own unique formulation, therefore compatibility to seed treatments will often differ.
- For granular inoculants ensure proper calibration for the row spacing on the seeder.
- For granular do not over fill the cart beyond the manufactures suggested volumes. Do not leave product in the tank overnight, condensation in the tank can cause flow ability concerns.
- Monitor granular flow rates, particularly on humid days.
- Keep granular bags shaded in the field.
- Do not auger peat based granular inoculants.
- With all formulations be cautious with the amount of seed placed fertilizer being applied. Fertilizers will affect either soil pH or have a salt content that can be detrimental to rhizobia. Consider separating the fertilizer from the seed if possible.

During this presentation I will also address the topics of application rates; additional information is presently being assessed and not available at the time of writing.

I will also like to introduce and provide insight into future trends in biological inoculants such as pathogenic biocontrol, growth promotion, fertility enhancement and nitrogen fixation in non-legume crops.