Consider pop-up phosphorus and potassium this cool, late spring

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Cool soils limit phosphorus and potassium availability to crops, and wet spring soils in parts of the state may delay seeding. Starter fertilizers are important for crop emergence and early season vigor to bolster yields. Wet and cool soils also limit availability of nitrogen, sulfur and chloride, which are discussed in a separate article.

Phosphorus and potassium are considered immobile nutrients, and their movement is the slowest in cold temperatures. In addition, water-logged soils can increase plant disease and further limit root growth and nutrient uptake.

Phosphorus and potassium fertilizer rates should be based on 6-inch deep soil tests. Generally Olsen P less than 16 ppm, and potassium soil test level less than 250 ppm, are below optimum. Yet, even if soil test levels are sufficient, a low rate of seed-placed phosphorus and potassium can hasten crop emergence, increase early season vigor, speed maturity and increase crop yield.

A fertilizer drop or particle must be within 1.5 to 2.0 inches of each seed to get starter effect. Even liquid fertilizer applied at normal planting speed may appear as a steady stream of fertilizer but there will be spaces between individual drops of fertilizer. Higher fertilizer rates increase the chance that all seedlings will have fertilizer near them. However, with increased fertilizer rate comes increased risk of salt injury. This risk increases with warmer, drier, and coarser soils.

Use the South Dakota State University/International Plant Institute Seed Damage Calculator for seed-placed rate guidelines based on crop and seed bed conditions (http://seed-damage-calculator.herokuapp.com). For example, granular monoammonium phosphate (11-52-0) applied at 20 pounds P_2O_5 per acre (units of P) in-furrow at 7-inch row spacing, will provide fertilizer within 2.0 inch of the seed on average. This rate and row spacing in coarse dry soil may produce 10% canola stand loss. At 12-inch row spacing under the same soil conditions, only 11 units of P are safe to apply in-furrow.

Potassium is often moderate to high in Montana soils and it is often not limiting. Routine starter potash is not suggested, however this cold spring may be an exception. Regional research summarized by Canadian Dr. Karamanos, and Montana's Dr. Jackson, found 13 to 30 units of K_2O seed-placed had a 20 to 50-percent chance of improving small grain yields by two to five bushels per acre; fertilizer cost and grain price will determine if this is worthwhile or not. Starter potassium is most likely to increase yields in barley varieties susceptible to disease. Potassium rates are best based on soil tests and Montana State University's *Fertilizer Guidelines for Montana Crops*. On farm strip trials are always a good way to learn what works for a given production system.

Phosphorus- potassium blends need to consider the nitrogen content in the phosphorus fertilizer. Rates should not exceed the safe rate of nitrogen plus K_2O per acre provided in *Fertilizer Guidelines for Montana Crops*. For example, for wheat, in-furrow nitrogen plus K_2O should not exceed 20 pounds per acre, meaning the amount of nitrogen provided in 11-52-0 needs to be considered. When combining nitrogen with potassium fertilizer, the addition of ammonia toxicity from the nitrogen fertilizer lowers safe seed-placed rates. The crop, row spacing, furrow opening width, tolerated stand loss, and soil moisture and texture must all be considered. Again, use the SDSU/IPNI calculator.

In general, responses from granular and liquid fertilizers are similar if similar rates, placement and timing are used. However, because phosphorus and potassium are immobile in the soil, in-crop granular applications will be wasted for that crop year, so foliar applied liquid might be the only option to correct a serious phosphorus or potassium deficiency. Fertilizer price per pound and available equipment to apply fertilizer should be the deciding factors when selecting fertilizer.

Phosphorus and potassium can be built up in soil 'for a rainy day'. However, with decades of P_2O_5 application and inherent variation in yields and soil conditions across a field, soil phosphorus levels can become highly variable in a field.

Higher crop yields result in higher phosphorus removal. For example, a ton of alfalfa hay removes 11 pounds P_2O_5, 10 bushel of wheat or pulse grain remove about to 8 pounds P_2O_5. Over time small discrepancies in yields across a field can add up to areas with more or less phosphorus in the soil bank.

Phosphorus availability is also determined by the activity of the microbes that are decomposing organic material to create plant available nutrients. Very cold or hot, dry or water-logged, or compact conditions are not favorable for high microbial activity, resulting in lower release of soil phosphorus by microbes.

Finally, field topography relating to soil erosion and runoff impacts soil phosphorus levels. Soil loss by wind erosion can remove 5 tons of soil per acre per year even on no-till fields under dry soil conditions (MSU Extension Bulletin *Nutrient Management in No-till and Minimum Till Systems*). This would take 13 pounds P_2O_5 per acre along with it. Fortunately, dissolved phosphorus in water runoff is generally low in soils with pH greater than 7.5, except from applied- or stockpiled manure.

All these factors can lead to high variation in available soil phosphorus levels across a field. In a 1000 acre field in North Dakota, Olsen P ranged from 6 to 18 ppm, which is from deficient to sufficient. Areas with similar soil P levels were from 3 to 60 acres in size, and scattered randomly across the study field which had little variation in topography (Figure 1).

Variable rate, or zone, phosphorus fertilization may be profitable if it either saves money or increases crop yield/quality compared to uniform application, or to protect surface water quality.

More information on soil fertility is available at the Montana State University Soil Fertility Extension website http://landresources.montana.edu/soilfertility. If you have questions, contact Clain Jones, Extension Soil Fertility Specialist, clainj@montana.edu, or 406-994-6076.

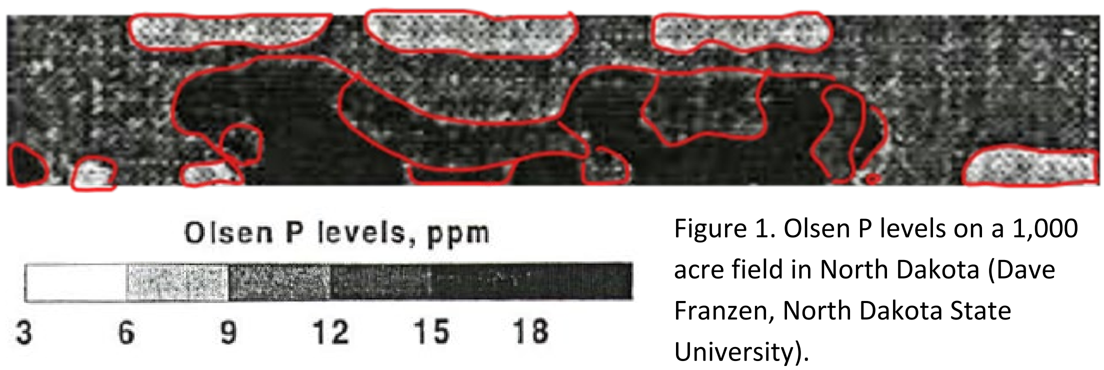

Figure 1. Olsen P levels on a 1,000 acre field in North Dakota (Dave Franzen, North Dakota State University).