

NEWS & VIEWS

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Phosphorus Nutrition of Wheat—Optimize Production

SPRING AND WINTER WHEAT represent a dominant crop in rotation across large areas of North America. Improvements in plant genetics, pest management, fertilizer management, and agronomic practices have all contributed to progressively increasing wheat yields. Since 1960, average wheat yield has increased by 0.38 bu/A/year in the U.S. and 0.31 bu/A/year in Canada.

Phosphorus (P) fertilization is a major input in crop production in many areas, because some soils lack sufficient P to optimize crop yields and quality. Effective nutrient management requires that nutrients be available in adequate amounts when needed by the plant. Ensuring that P is plant available early in the growing season is of particular importance. Phosphorus is critical in the metabolism of plants, playing a role in cellular energy transfer, respiration, and photosynthesis.

Wheat takes up P throughout the growing season (**Figure 1**). Total P uptake by wheat is about 0.68 lb P₂O₅/bu. Harvesting grain removes P at a rate of about 0.50 lb P₂O₅/bu. Banding near the seed provides ready access to P supplies during early season growth. Maintaining adequate P supplies throughout the soil ensures P is sufficient to meet plant needs during the remainder of the season.


Wheat produces two kinds of stems—the main stem and a variable number of tillers. Early in its life cycle, wheat “decides” which tillers to develop. Factors such as P or N deficiency, hard soil, or planting too deep can create stresses that reduce the initiation of tillers. Early season limitations in P availability can result in restrictions in crop growth from which the plant will not recover, even if P supply is later increased to adequate levels.

Of all the tillers formed, grain from the T1 and T2 tillers (originating from the bases of the first and second leaves, respectively) accounts for about half of the final yield. The

Attention Crop Advisers:

Are you looking for a current resource on P management for wheat? If so, we encourage you to review and download a free PowerPoint presentation and notes. Titled “Phosphorus Nutrition of Wheat”, it is available on the PPI website. This comprehensive presentation reviews the role of P in building wheat yields, P uptake, soil testing, and fertilizer management approaches. Notes and references included with each slide will help you build knowledge for working with clients. Add regional and local information to personalize your presentations. Go to:

>www.ppi-ppic.org/pwheat<



other half comes from grain from the main stem. Tillers originating from the base of the third and fourth leaves (T3 and T4) generally have little to no impact on final grain yield. Early in the season, when wheat is “deciding” how

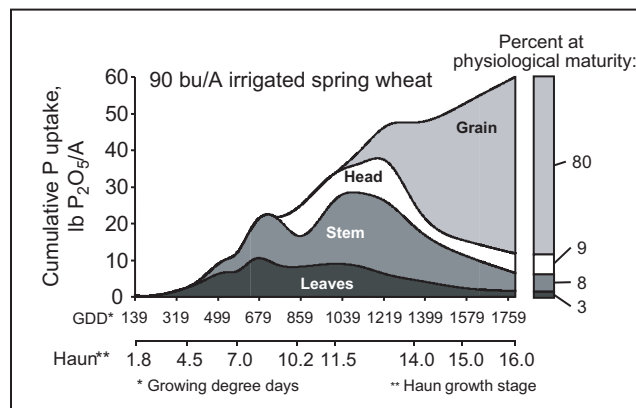


Figure 1. Wheat takes up P throughout the growing season. Grain removes about 0.50 lb/bu harvested.

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many tillers to initiate, P from fertilizer may account for more than 50% of the total P in the plant. If P supplies in the plant become deficient, the initiation of T1 and T2 tillers can be significantly inhibited, cutting into sources of approximately half of the final yield (**Figure 2**).

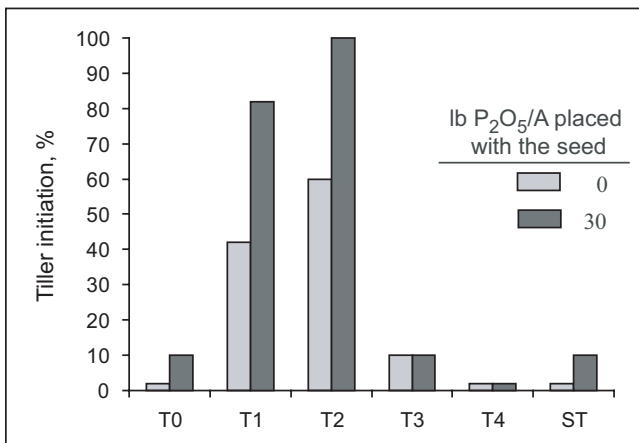


Figure 2. Improved initiation of tillers from 30 lb P₂O₅/A placed with the seed on a soil testing 10 parts per million (ppm) Olsen P (North Dakota). T=tillers; ST=sub-tillers.

Soil testing calibration research has been conducted throughout North America to establish the general relationship between relative yield (percent of yield attainable when P is sufficient) and soil test levels. These data come primarily from studies examining broadcast applications of P. Note the close similarity between relative yield and P for both spring wheat and winter wheat (**Figure 3**). For both crops, wheat yield is optimized when soils are in the 15 to 20 ppm P range (Olsen). If P fertility is built to these levels, continued applications of P will be necessary to maintain soil levels. As a first approximation, apply a rate equal to crop removal, then check periodically to see if soil tests are staying in the desired range.

Although higher soil fertility levels are important for season-long P nutrition, early season P supplies must be

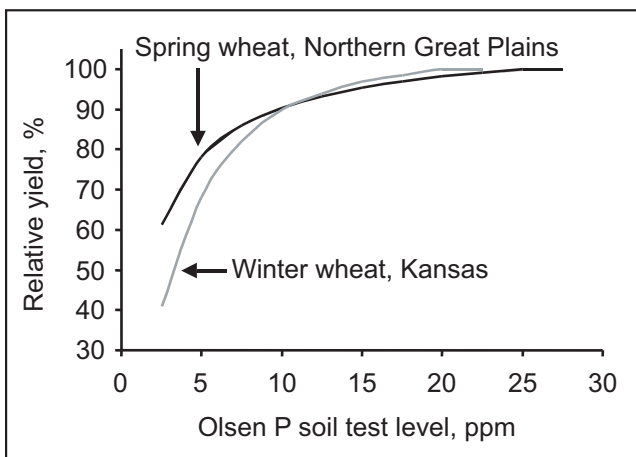


Figure 3. For both spring wheat and winter wheat, yield is optimized when soils are in the 15 to 20 ppm P range.

accessible to the limited root system of the young wheat plant. For this reason, P placed near the seed at planting (starter P) has proven effective, especially in cold soils. The response of wheat to low rates of starter P is often referred to as the “pop-up effect”, and is marked by improved leaf and root growth, tiller formation, and yield. Research from North Dakota provides indications that starter P can provide benefits even at higher soil test levels, probably because of its superior positional availability.

A well-managed fertility program must consider the complete nutritional needs of wheat. As an example, consider how wheat responds to both nitrogen (N) and P, shown in **Figure 4**. Applied alone to this winter wheat crop in Manitoba, fertilizer P resulted in a minor increase in yield. With 55 lb N/A, increasing P rate had a modest impact on grain yield. However, with 110 lb N/A applied, large yield increases were obtained with increasing rates of P fertilizer. **This response to P illustrates the interaction between N and P; fully attainable yield response to N is achieved only when accompanied by sufficient P.**

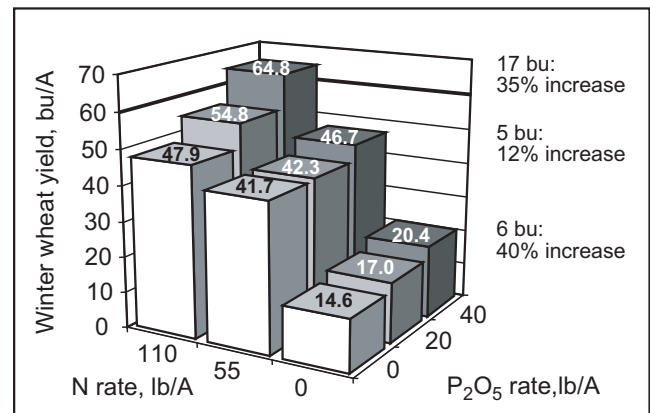


Figure 4. Interaction of N and P results in higher wheat yields.

Summary

Management of P plays a significant role in optimizing spring and winter wheat production. Key points are:

- P nutrition is critical to reaching the attainable yield potential of wheat.
- Early in the growing season, the wheat plant is dependent on sufficient P to establish tillers to build high yield.
- While wheat accumulates P through the entire growing season, early season P deficiencies can be more detrimental than those occurring later.
- **Phosphorus nutrition should be part of a management strategy that considers the importance of other nutrients. ■**

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For more about Phosphorus Nutrition of Wheat, a PowerPoint slide presentation is available free at <http://www.ppi-ppic.org/pwheat>