Yield Response of Spring Wheat to Seed-Placed Phosphorus

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A 24-year Saskatchewan study has shown spring wheat continues to respond postively to seed-placed phosphorus (P) in spite of marked increases in available soil P due to fertilization. Yield increases were related to spring and summer climatic conditions.

WHEAT YIELD RESPONSE to seed-placed P has been observed for many years in the Canadian Prairies. This pop-up effect is particularly notable when soils are cool and wet in early spring. With soil P levels rising from the more frequent use of P fertilizers over the past 40 to 50 years, there is some question as to whether crop response to starter P has been decreasing due to this buildup of soil available P.

For 24 years, we have monitored yield and bicarbonate-extractable soil P (Olsen-P) annually on twelve cropping systems on a medium textured, Orthic Brown Chernozem at Swift Current, Saskatchewan. These data provide an opportunity to reassess crop response to starter P under conditions of soil P buildup. Two of the 12 crop rotations were examined in this study. Both systems were fallow-wheat-wheat (F-W-W), one receiving nitrogen (N) plus P and one receiving only N.

Results

The initial level of soil test P (Olsen P) at the start of the study (1967) was 17 lb/A and, after 24 years of cropping without P fertilizer application, the P test level did not change (**Figure 1**). The P removed in the grain, the only major source of P export from the system, averaged about 7 lb P_2O_5 /A/yr. This amount is about equal to that being generated through P mineralization from soil organic matter and physiochemical transformation of less available forms of inorganic P, because the unfertilized system has not decreased over the 24-year period.

Addition of P fertilizer, at an average annual rate of 13 lb P_2O_5 /A/yr, increased soil test P by about 0.8 lb/A each year of the study. The P exported in the grain in the fertilized rotation averaged about 8 lb P_2O_5 /A/yr of P. Therefore, P_2O_5 input was 5 lb/A/yr greater than export, suggesting that about 36 to 38 percent of the extra fertilizer P had entered the Olsen P fraction of the soil.

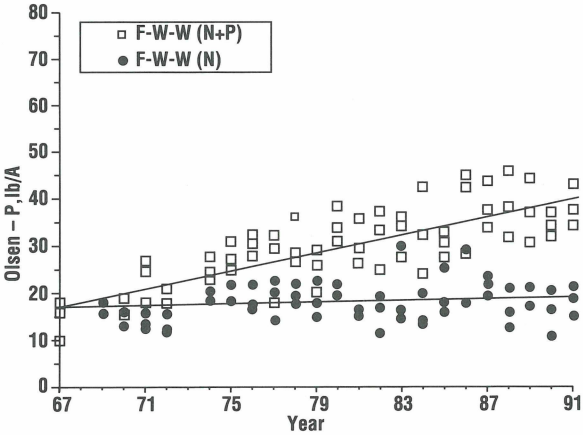

Figure 1. Average annual application rates of 13 lb P_2O_5/A increased soil test P by about 0.8 lb/A each year of the study.

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Phosphorus application produced an average of 2.8 bu/A more grain for wheat grown on fallow, and 2.0 bu/A more grain for wheat grown on stubble (**Figure 2**). These increases were consistent over the 24-year period and occurred as frequently in the latter half of the study as the first half. Thus, the gradual build-up in available soil P due to fertilization did not appear to dampen the response to P fertilizer. This shows that, although frequent use of fertilizers will increase available P levels in prairie soils, farmers may still experience significant yield response to small applications of P fertilizer placed with the seed.

The variability in yield response was closely related to the influence of spring weather conditions. For example, for wheat grown on fallow, yield reponse to P was directly related to temperature between emergence and 3-leaf stage but was depressed when soils were very wet at seeding. The positive relationship between yield and temperature may be because bare fallow soils are often moist and therefore cool in early spring. Because they have been fallowed, they are likely to have sufficient available P but, at low temperature, plant root growth will be slowed, as will available P uptake and translocation within the plant.

The literature suggests that fertilizer P placed close to the seed will be extremely important because early spring is the period when wheat makes maximum use of fertilizer P. In contrast, the importance of soil P increases rapidly from about four weeks after emergence. The negative relationship between yield response to P and precipitation at seeding may be the result of excessive water due to the combination of high levels of stored water plus high early May precipitation. For wheat grown on stubble, response to P was greater when soil temperatures were low at about 3- to 4-leaf stage. This type of response is similar to that obtained in growth chamber studies by other scientists.

Summary

Although prairie soils may have higher levels of soil available P resulting from decades of P fertilizer use, seed-placed P can still offset some yield variability related to climatic conditions and can result in moderate to substantial yield increases. Under excellent growing conditions, seed-placed P can aid plants in reaching higher yield capabilities leading to higher profit potentials. ■

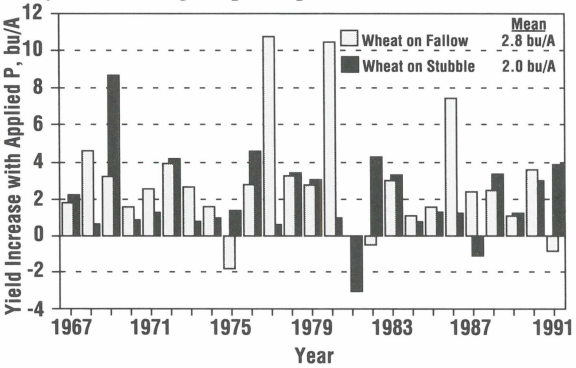

Figure 2. Phosphorus application produced an average of 2.8 bu/A more grain for wheat grown on fallow and 2.0 bu/A more grain for wheat grown on stubble.

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early season drought. Leaf development failure may also serve as a P deficiency symptom, based on results from a greenhouse study evaluating several hard red spring wheat varieties (**Table 1**).

Summary

Most spring wheat varieties will develop eight leaves on the plant main stem. Data indicate that varieties differ in P response for both tiller and leaf development. The significance of this lies with the fact that leaf development loss hasn't been recognized as a small grain production management concern. Like tiller and head count numbers, small grain adventitious roots and mainstem leaves are easy to count and evaluate and are related to crop yield potential.■