Evaluation of Phosphorus Fertilizer Recommendations in No-Till Winter Wheat

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Introduction

Phosphorus, or P, is a common yield-limiting factor for wheat production in Oklahoma. Deficiencies in wheat can result in reduced root development, fewer tillers and stunted plant growth, leading to reduced forage and grain yield. Phosphorus is considered immobile in soils. Thus, phosphorus fertilizer recommendations are based on plant-available soil P concentration rather than the yield goal of the crop. P-fertilizer recommendations from OSU researchers are based on soil tests and the sufficiency index. The soil test provides an estimate of P availability, or the amount of P that could become available to plants during a growing season. This soil test P, or STP, value indicates the percent sufficiency and provides a P fertilizer recommendation for a specific crop (For more details, see PSS-2225, *Soil Test Interpretations*).

Phosphorus availability is affected by soil pH. Aluminum becomes more soluble at low pH and readily binds with P, potentially reducing its availability for plant uptake. This is one of the reasons why lime application is recommended for acidic soils. Some producers may choose not to lime acidic soil due to economic constraints, especially on leased ground. If these soils also have low STP, additional P fertilizer is needed to offset the amount of P that will likely be tied-up by aluminum. Oklahoma State University researchers recommend banding an additional 30 pounds P_2O_5 ac^{-1} with the seed in soils below a pH of 5.5 (See fact sheet PSS-2240, *Managing Acid Soils for Wheat Production* for more information). For example, if a wheat crop will be planted in soil with a STP of 30 (15 ppm), OSU recommends applying 30 pounds P_2O_5 ac^{-1}. If this same soil has a pH of 5.1, an additional 30 pounds P_2O_5 ac^{-1} should be banded with the seed if lime is not applied, bringing the total recommended rate up to 60 pounds P_2O_5 ac^{-1}.

Phosphorus fertilizer recommendations were initially developed with conventional tillage practices. Recent shifts from conventional to no-till management practices have raised concern regarding the efficacy of these recommendations. Field trials were conducted at nine locations over two cropping seasons to determine the efficacy of the current recommendations in no-till grain-only wheat production. This report provides a brief summary of the results from these trials.

Field Methods

Field trials were conducted in north-central Oklahoma over two winter wheat growing seasons, with sites near Garber, Red Rock, Stillwater and Waukomis. Winter wheat was planted at each site by the producer using no-till management practices. Treatments consisted of applications of triple super phosphate fertilizer (TSP; 0-46-0) broadcasted at rates ranging from 0 to 100 pounds P_2O_5 ac^{-1} (approximately 0 to 220 pounds TSP ac^{-1}) post-emergence. An additional treatment using the recommended rate for each soil was also included, allowing the comparison between the rate recommended by OSU researchers and other fertilizer rates. All trials were arranged in a randomized complete block design with four replications. No phosphorus fertilizer was applied by the producers for the duration of the trials.

Results

Crop yield and yield response to broadcast P fertilizer varied between sites (Table 1). As expected, wheat crops grown in soils with sufficient STP (> 65 STP, 32.5 ppm) did not respond to the addition of P fertilizer (Figure 1). Documenting that broadcasting P fertilizer on soils that were already 100 percent sufficient in P according to the P sufficiency index did not result in higher grain yields. Sites with insufficient STP were generally responsive to broadcast P fertilizer. This confirms that broadcasting P fertilizer on soils with below sufficient STP would increase grain yield. Sites with acidic soils (pH below 5.5) and insufficient soil test P were particularly responsive to broadcast P fertilizer. These sites also benefited from the additional 30 pounds P_2O_5 recommended for acidic soils, even though it was broadcast and not banded. Banding P in acidic soils is highly recommended, as other studies have found it to be approximately 25 percent more efficient in terms of plant availability. It is interesting to note that soils at the Stillwater sites tested well below 100 percent sufficiency level, but were unresponsive to P fertilizer additions of up to 100 pounds P_2O_5 per acre. This lack of response is less common, and may be explained by the specific soil types (Huska), which is characterized by a sodic horizon at a depth of 10 inches.

Conclusions

Grain yield of winter wheat grown with P fertilizer recommendations from OSU researchers was not statistically lower than the highest grain yield harvested at any site, suggesting that producers are maximizing grain yields by following recommendations of P fertilizer from OSU researchers. Applying P to crops grown in soils testing 100 percent sufficient did not result in higher grain yield. Therefore, the current soil test based P recommendation is a valid guideline. Soil pH is important to be taken into consideration when interpreting soil

Table 1. A wide range of grain yields was observed within and between sites. The range of treatment mean grain yields and phosphorus rate grain yields are reported in bushels of grain harvested per acre. Recommended phosphorus rates are reported in pounds of P_2O_5 per acre.

Location	*Year*	*Soil pH*	*Grain Yield Range (bu grain ac^{-1})*	*Mean Grain Yield (bu grain ac^{-1})*	*Phosphorus Rate (lbs P_2O_5 ac^{-1})*
Garber	2015	5.5	46 – 56	49	0
Stillwater-1	2014	6.6	36 – 45	42	70
Stillwater-2	2015	6.8	33 – 44	40	57
Red Rock-1	2014	5.3[1]	20 – 45	32	68[2]
Red Rock-2	2014	4.6[1]	43 – 62	53	47[2]
Red Rock-3	2015	5.4[1]	42 – 58	51	47[2]
Waukomis-1	2014	4.8	28 – 35	31	0
Waukomis-2	2014	5.7	19 – 30	26	38
Waukomis-3	2015	5.1[1]	48 – 56	52	48

[1] Soils classified as acidic based on critical pH of 5.5

[2] Recommended phosphorus rates following OSU guidelines for acidic soils (PSS-2240)

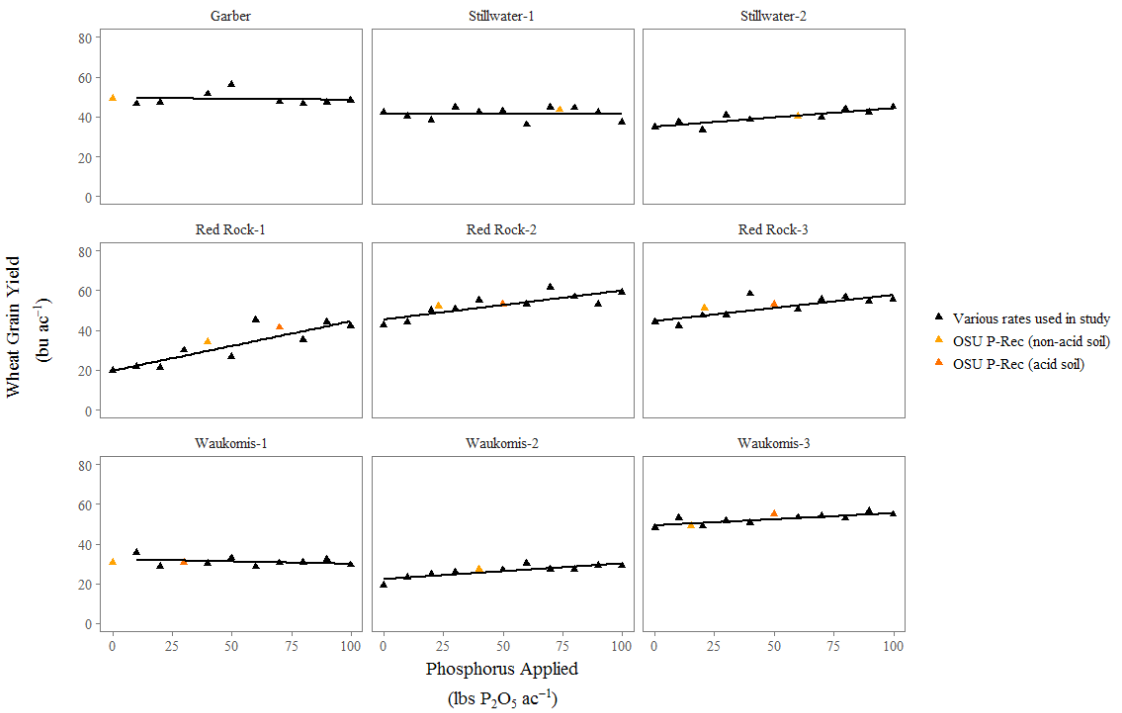

Figure 1. The effects of phosphorus fertilizer application on grain yield in winter wheat across nine site-years. Applied phosphorus reported as pounds of P2O5 broadcasted per acre. Mean grain yield is reported as pounds of grain harvested per acre. Orange marks indicate the phosphorus fertilizer rates recommended by OSU based on soil test phosphorus. Light orange marks indicate OSU phosphorus fertilizer recommendation for non-acid soils, and dark orange marks (acid soils only) indicate OSU recommended rates for acidic soils (pH below 5.5).

test results for phosphorus recommendations. Additional P fertilizer may be required to achieve optimum yield in acidic soils. Research is currently underway to identify the factors contributing to a lack of yield response to P in wheat crops grown in some low STP soils, such as the Stillwater locations included in this trial. Additional information regarding OSU P fertilizer recommendations can be found in PSS-2225 and PSS-2240, or from agronomic Extension personnel.

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