Purdue University Department of Agronomy
Soil Fertility Update

28 February 2022

URL: http://www.kingcorn.org/news/articles_22/Manage_P_K_Fert_2022.pdf

Modify Your Plans When Faced with High-Priced Phosphorus and Potassium Fertilizers

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Summary

- Phosphorus (P) and potassium (K) recommendations are made based on results of recent and representative soil samples. If you have not soil sampled recently, then your best strategy for dealing with high prices is to first invest in soil sampling and analysis.
- If you find soil test levels of phosphorus and potassium are optimal or above (see Table 1), the most profitable rate of P and K fertilizer is zero pounds per acre regardless of fertilizer cost.
- Apply fertilizer P and K dollars on field areas deficient in P and K (see Table 1), where there is a likelihood of getting a yield increase due to the application of fertilizer. The most profitable rate of P and K is less than the standard build-up (or "feed-the-soil") recommendation we would normally make, however an official "feed-the-plant" recommendation for how much less to apply is not yet available. Use caution in reducing the recommended rate when soil test P and K levels are deficient.

Phosphorus (P) and potassium (K) fertilizers are currently about twice the cost they were last year. Therefore, we suggest managing P and K fertilizer differently this year than we do in "normal" years, in the anticipation that fertilizer prices will return to more "normal" levels in the future. The different approaches are dependent on soil test results of recent and representative soil samples[1]. We suggest 1) not fertilizing soils testing optimal or higher and 2) normal fertilization, or perhaps reduced fertilization, of soils that are deficient. Our rationale for suggesting these approaches are outlined below.

If soil test P and K are optimal: If you have done a good job soil sampling and have followed the Tri-State Fertilizer[2] recommendations, or applied more than was recommended, then you have a lot of flexibility in how you fertilize this coming season and can save a lot of money.

The traditional recommendations made in the Tri-State are a "feed-the-soil" approach, designed to build soil test P and K to an optimal soil test value. An optimal soil test level means the concentration of P or K in the soil is enough to support maximum yield, without

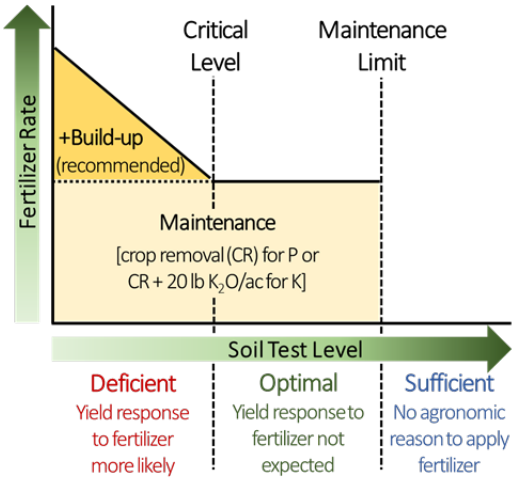

Figure 1. Fertilizer recommendations for P and K based on soil test levels and likelihood of response to applied fertilizer.

adding fertilizer P and K (Figure 1) and is defined as soil test values between the critical level and maintenance limit. The values for P and K critical levels and maintenance limits that define optimal are shown in Table 1 for different soil test methods and (for K) different cation exchange capacities (CEC).

When soil test levels are optimal the recommendation we make under normal circumstances is to maintain soil test P and K in the optimal range by replacing crop removal for P and crop removal +20 lb K_2O/acre for K. Since the soil P and K are sufficient, not applying fertilizer to the crop will not decrease yield. Not applying P and K to fields with optimal soil test P and K results in substantial savings – about $93 per acre for each crop for the cost of maintenance applications of P and K for 200 bu/acre corn and 60 bu/acre soybean[3]. Is it worth paying twice the normal cost of fertilizer to "feed-the-soil" this season?

Table 1. Soil test critical level and maintenance limits for phosphorus and potassium fertilization of corn and soybean for different soil test methods and cation exchange capacity (CEC).

		Critical level	Maintenance limit
Soil test method (CEC)	**Nutrient**	**Parts per million or (pounds per acre)**	
Bray-P1	Phosphorus (P)	15 (30)	30 (60)
Ammonium acetate (5 meq/100g)	Potassium (K)	88 (176)	118 (235)
Ammonium acetate (15 meq/100g)	Potassium (K)	115 (230)	145 (290)
Mehlich-3	Phosphorus (P)	20 (40)	40 (80)
Mehlich-3 (<5 meq/100g)	Potassium (K)	100 (200)	130 (260)
Mehlich-3 (>5 meq/100g)	Potassium (K)	120 (240)	170 (340)

It is true that soil test levels of P and K will decline if crop removal of P and K are not replaced with fertilizer this year, but the decreases will be minimal. We would expect a decrease in soil test P of 2 to 4 parts per million (4 to 8 pounds per acre) and soil test K of 9 to 18 parts per million (18 to 36 pounds per acre) for 200 bu/acre corn or 60 bu/acre soybean[4]. These differences in soil test P and K are too small to measure even with intensive soil sampling and there is little danger of going from optimal soil test levels to deficient levels in one or two seasons unless the initial soil test level was already close to the critical level.

If soil test P and K are deficient: When soil test P and/or K are deficient we expect that adding the deficient nutrient(s) will increase yield. The further below the critical level, the more likely and the larger a yield response is expected. Not applying fertilizer on deficient soils could reduce yield and the cost of the yield reduction might be greater than the savings in fertilizer. So, naturally we recommend that P and K fertilizer dollars be spent on fields with deficient soil test levels. However, the standard "feed-the-soil" recommendation we normally make is designed to provide enough nutrient to maximize yield of the crop and additional nutrient to build the soil test level up to the critical level over a four-year period. This means the amount of P and K we recommend is not designed to maximize profit in that season, but to increase soil test levels to optimal levels so annual fertilizer applications are not required in the future.

Recent research[5] has shown in fields where the soil test K levels were below, but near the critical level, the K fertilizer rate needed to maximize profit was less than the maintenance recommendation. However, on fields with extremely low soil test K levels, maximum profit occurred at K rates as much as

twice the maintenance recommendation. Although we expected this to be true and we have research that demonstrates it to be true, at this time we do not make an official recommendation to reduce the rate of P or K applied to deficient soils. If you feel the need to reduce P and K rates on deficient soils, please be cautious and do not reduce the rate too much that it reduces yield more than the value of fertilizer saved.

Table 2. Phosphorus and potassium recommendations for corn and soybean by different soil test methods and cation exchange capacity at selected soil test levels below the critical level and specific grain yields. Bray and ammonium acetate recommendations shown below are based on original Tri-State Fertilizer Recommendations, but updated to utilize current estimates of crop removal. Mehlich-3 recommendations are from the 2020 Tri-State Fertilizer Recommendations[2].

Soil test method (cation exchange cap.)	Soil test level ppm (lbs/ac)	Nutrient	Corn, 200 bu/ac Nutrient recommended, lbs/ac	Soybean, 60 bu/ac Nutrient recommended, lbs/ac
Bray-P1	10 (20)	P_2O_5	95	73
Ammonium acetate K (5 meq/100g)	65 (130)	K_2O	90	117
Ammonium acetate K (15 meq/100g)	90 (180)	K_2O	80	107
Mehlich-3 P	15 (30)	P_2O_5	95	73
Mehlich-3 K (5 meq/100g)	75 (150)	K_2O	90	122
Mehlich-3 K (15 meq/100g)	100 (200)	K_2O	95	127

References:

[1]Ackerson, J.P. 2018. Soil sampling guidelines. Purdue Extension AY-368-W. https://www.extension.purdue.edu/extmedia/AY/AY-368-w.pdf

[2]Culman, S., A. Fulford, J. Camberato, and K. Steinke. Tri-State Fertilizer Recommendations for Corn, Soybean, Wheat, and Alfalfa. 2020. Bulletin 974. College of Food, Agricultural, and Environmental Sciences. Columbus, OH: The Ohio State University https://ag.purdue.edu/agry/soilfertility/Documents/Tri-State%20Fertilizer%20Recommendations.pdf

[3]Based on crop removal of 0.2 pounds K_2O per bushel of corn and 1.15 pounds of K_2O per bushel of soybean, P_2O_5 @ $0.75 per pound (11-52-0 and 18-46-0 at $900 and $840 per ton, respectively-assuming crediting 50% of nitrogen concentration) and K_2O @ $0.66 per pound (0-0-60 at $795 per ton).

[4]Adapted from: Fulford, A.M., and S.W. Culman. 2018. Over-fertilization does not build soil test phosphorus and potassium in Ohio. Agronomy Journal 110:56-65.

[5]Camberato, J., and A. Helms. 2021. Thoughts on profitable fertilizer rates. Purdue Univ. Dept. Agronomy Soil Fertility Update, Oct. 29, 2021. https://ag.purdue.edu/agry/dtc/Documents/Fertilizer%20Price%20Adjustments%20to%20Fertilizer%20Recommendations.pdf