The Ohio State University/ Ohio Agricultural Research and Development Center/ School of Environmental and Natural Resources

Nine-Year Evaluation of Phosphorus and Potassium Fertilizer Recommendations for Corn and Soybean in Ohio

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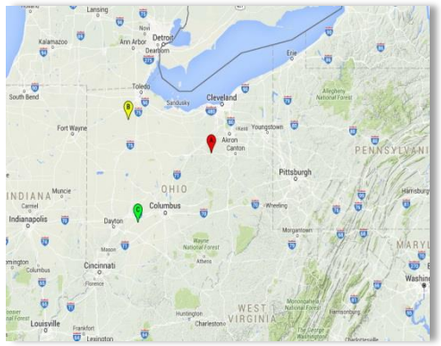
INTRODUCTION

In Ohio, fertilizer rate recommendations for corn and soybean widely follow those outlined in the, "Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat and Alfalfa" (Vitosh et al., 1995). This publication has served as a cornerstone for field crop soil fertility in the region, but after 20 years, a re-examination of these fertility recommendations is necessary, as a number of factors have changed in field crop production. The guidelines of the "Tri-State Fertilizer Recommendations" are based on the buildup, maintenance, and drawdown approach to fertilizer phosphorus (P) and potassium (K) management. Soil test critical levels as well as estimated nutrient removal rates are used to determine the amount of fertilizer P and K needed for adequate crop nutrition. Fertilizer recommendations aimed at replacing nutrients lost through crop removal can be influenced by the long-term trend of soil test values and nutrient budgets. In this study, fertilizer rates that were estimated to equal or exceed nutrient removal were used to examine the grain yield and soil test trends that developed from nine years of crop production in Ohio.

Research Locations in Ohio



Fertilizer P and K rate trials were established in 2006 and continued until 2014 for corn and soybean rotations in: A) Wayne County at the Ohio Agricultural Research and Development Center, B) Wood County at the Northwest Agricultural Research Station, and C) Clark County at the Western Agricultural Research Station

AIM

The objective of this study was to evaluate soil test P and K and grain yield trends that developed during nine years of P and K fertilization of corn and soybean grown in rotation. To address this objective, corn and soybean rotations were established in 2006 at three sites in Ohio. The initial soil properties at each site in 2006 are shown in Table 1. The fertilizer P and K rates evaluated at each site were: 1) zero rates, 2) the estimated nutrient removal rate (i.e., 1x), and 3) twice the estimated nutrient removal rate (i.e., 2x) for each rotation. Estimated crop removal rates were taken from the Tri-State Fertilizer Recommendations (Table 2; Vitosh et al., 1995).

Table 1. Initial Soil Characterization in 2006

Soil Property	Wayne	Wood	Clark
Soil Series	Wooster Silt Loam	Hoytville Clay Loam	Kokomo Silty Clay Loam
pH	5.9	6.1	6.8
CEC (meq/100g)	11	22	13
OM (%)	1.5	2.9	1.7
Bray P (ppm)	28	22	29
K (ppm)	113	198	113

Table 2. Estimated crop removal rates and fertilizer P and K rates. Fertilizer rates were based on the 2005 state average grain yield for corn of 9.0 Mg/ha and soybean of 2.6 Mg/ha

----------Estimated Crop Removal (kg/Mg grain)----------		
	P_2O_5	K_2O
Corn	6.7	4.8
Soybean	13.2	23.3
----------Fertilizer Rate (kg/ha)----------		
Corn	60	44
Soybean	36	63

METHODS

The study was initiated in 2006 at one site in Clark, Wayne, and Wood counties in Ohio and continued until 2014. At each site, a corn-soybean (CS) and a corn-corn-soybean (CCS) rotation was established and subsequently managed according to the phase of each cropping sequence. Fertilizer N was supplied as urea (45 kg N/ha) at planting and urea ammonium nitrate when corn was between the V4 to V6 growth stages. The total fertilizer N rate applied to corn was 202 kg N/ha following soybean and 235 kg N/ha following corn. Soil sampling occurred in the fall prior to the broadcast application and surface incorporation of fertilizer P and K. Three years (2006, 2010, and 2012) were corn years for both CS and CCS; while there was only one year (2011) when soybean was represented in both rotations. The influence of crop rotation on grain yield was evaluated in these four (out of nine) years but was not significantly different between the two rotations. Accordingly, yields were averaged across rotations in these years to simplify the results.

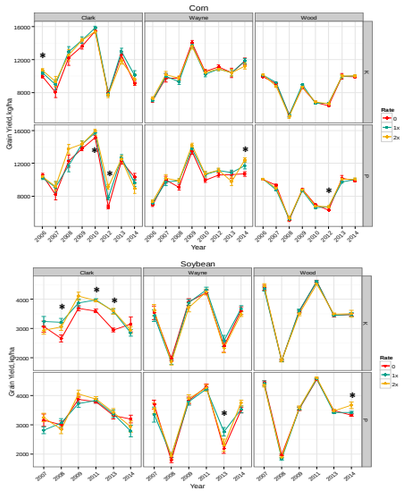
RESULTS

Corn grain yield ranged from 7.9 to 15.4, 7.0 to 14.0, and 5.3 to 9.9 Mg/ha in Clark, Wayne, and Wood counties, respectively, when no fertilizer K was applied from 2006 to 2014 (Figure 1). Corn grain yield was significantly increased as a result of K fertilization in one of 24 site-years. Corn yield responded positively to fertilizer P application more frequently compared to fertilizer K application as four of 24 site-years exhibited a significant yield increase to P fertilization. Soybean yield ranged from 2.6 to 3.6, 1.9 to 4.2, and 1.8 to 4.6 Mg/ha in Clark, Wayne, and Wood counties, respectively, with no fertilizer K application from 2007 to 2014 (Figure 1). Soybean grain yield was significantly increased by K fertilization in three of 18 site-years.

Table 3. Number of positive corn and soybean grain yield responses to fertilizer P and K during the early, mid, and late portion of the nine year study

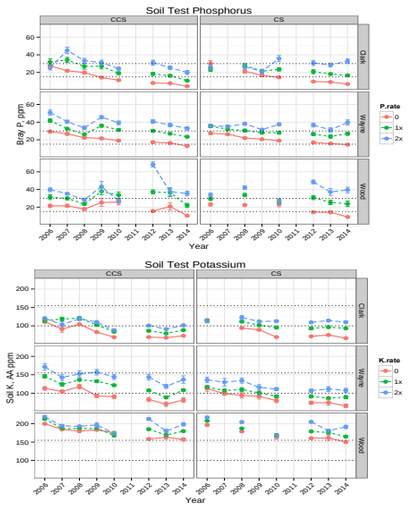
Nutrient	Early (2006-2008)	Mid (2009-2011)	Late (2012-2014)	Total (2006-2014)
Phosphorus	0	1	5	6 out of 42
Potassium	2	1	1	4 out of 42

Figure 1. Grain Yield (2006-2014)



*Asterisk denotes a significant (P < 0.05) positive grain yield response to fertilizer P or K compared to the 0 rate

Figure 2. Soil Test Levels (2006-2014)



*Dotted lines represent the Maintenance Range soil test values

Whereas, soybean grain yield was significantly increased by P fertilization in two of 18 site-years.

Initial soil test P (STP) values in 2006 were within or above the recommended maintenance range of 15 to 30 ppm at all three sites (Figure 2). Nine-year trends in soil test P levels in the 1x and 2x treatments appear to differ across sites and rotations. Soil test P appears to be declining more rapidly in Clark and Wayne Counties as compared to Wood County. This is consistent with yields averaged across years at these sites, as Clark and Wayne yield more than the 2005 state average of 9.0 Mg corn grain/ha and 2.6 Mg soybean grain/ha, while corn grown in Wood County yielded less. (Respective nine-year corn and soybean average yields were: Clark, 11.4 and 3.4 Mg/ha; Wayne, 10.2 and 3.4 Mg/ha; Wood, 8.1 and 3.6 Mg/ha). Initial soil test K (STK) values in 2006 were within or above the maintenance range of 100 to 155 ppm for all three K rates at each site (Figure 2). When no K was applied, the sites in Clark and Wayne County had STK values in 2014 that were below the lower limit (i.e., 100 ppm Ammonium Acetate-K) of the maintenance range.

CONCLUSIONS

Nine-year trends in soil test P and K levels in the 1x and 2x treatments appear to be declining at all three sites. This trend raises questions about estimated crop removal rates and soil test levels. The questions raised by this research are: 1) Do current estimated nutrient concentrations in corn and soybean grain accurately reflect what is removed? and 2) Are soil test P and K levels relatively stable from year to year if nutrient applied approximates nutrient removed? The lack of crop grain yield responses to P and K fertilization suggest the current maintenance range for soil test P and K values are not too low and are able to reflect the status of plant-available P and K for corn and soybean grown in rotation. However, questions remain about observed soil test P and K downward trends, despite application of P and K in excess of two times the estimated crop removal rate.

Reference

Vitosh, M.L., J.W. Johnson, and D.B. Mengel. 1995. Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat and Alfalfa. Extension Bulletin, E-2567.

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