CORN MARKETING PROGRAM
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2017 Research Report

Re-Examining P and K Recommendations Across Critical Michigan Watersheds

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Introduction: Water quality concerns in the Saginaw Bay and Western Lake Erie Basin watersheds have been increasing for the last 25 years (USDA, 2016). Whether for drinking, recreation, commercial fishing, irrigation, or aesthetics, the interconnectedness of the water supply interacts with water quality to affect all users (Sharpley et al., 1994; Carpenter et al., 1998). A series of phosphorus (P) induced algal blooms including the 2014 drinking water supply disruption in Toledo, OH continues to raise concern as to the cause of the eutrophication issues and best management practices that may be implemented to correct this issue. The agronomic management of P fertilizers, particularly P fertilizer applications and grower decision-making processes used to guide P fertilizer additions, remains a primary regulatory target. To better address current and future water quality concerns across all Michigan watersheds, there is a critical need to identify and validate corn response to P fertilizer application and effectively communicate criteria used to guide P applications.

Nutrient management strategies, particularly P, continue to be at the forefront of water quality concerns. Corn P fertilizer recommendations broadly follow the build-up, maintenance, and drawdown approach as outlined in the Michigan State University Nutrient Recommendations for Field Crops bulletin (Warncke et al., 2009) and the Tri-State Fertilizer Recommendations (Vitosh et al., 1995). However, these recommendations are now 20+ years old and water quality concerns within the Western Lake Erie and Saginaw Bay watersheds require the re-examination of P recommendations and the grower thought process used to drive P application. A key factor in nutrient management is to avoid accumulating nutrients in excess of crop demand and this strategy may function as a key target concerning dissolved P losses. Two complicating and often misunderstood factors in soil P management are 1) soil test P represents a small fraction of the total P in soil which creates difficulties when interpreting a soil test report,

and 2) the loss of dissolved P cannot be visibly seen as compared to sediment loss creating further grower uncertainty with regards to P losses and P control measures.
Update: *Due to the overwhelming interest in corn P response strip trials, the K portion of this study was removed and additional on-farm P sites were obtained.*

Objective 1: Identify corn yield response to P application at multiple residual soil P levels and soil textures across Michigan to further validate or adjust current recommendations. Our *working hypothesis* is that corn yield response to P fertilizer application will occur when soil test P levels are ≤ 15 ppm above which plant growth but not grain yield responses may occur.

Methods and Procedures: Trials were arranged as a randomized complete block with three replications and growers able to choose individual P application rates. Nitrogen applications were uniform (i.e., one N rate) across the entire testing area. Plot dimensions were determined by individual participants due to equipment limitations. Trial areas were clearly marked and or GPS-referenced at planting to eliminate harvest errors.

Trials contained 6 plots total and testing sites were uniform in slope, soil texture, and drain tile running perpendicular to planting. A broad spectrum (i.e,. low and high) of residual soil test P levels across sites was requested to gauge yield response to P application.

Measureables:

- Soil samples collected before fertilizer application from 0-2 inch and 0-8 inch soil depths. 10-15 soil cores **per replication** collected at 2 depths for a total of 6 soil samples
- 15-20 corn ear leaf samples **per plot** collected at R1for tissue nutrient analysis
- Yield and grain sample collection from **each plot**. Grain yield and moisture must be obtained from individual plots. About 2 cups of grain from each plot must be obtained for nutrient analysis.

Table 1. Example plot layout for corn P-response testing in grower field.

Rep 1		Rep 2		Rep 3	
1	**2**	**3**	**4**	**5**	**6**
Control	**+P**	**+P**	**Control**	**Control**	**+P**

Results and Discussion:

Sixteen on-farm research trials were initiated and completed across 9 Michigan counties investigating corn grain yield response to phosphorus (P) fertilizer application. As a partnership between the soil fertility campus extension specialist (i.e., Dr. Steinke) and MSUE county extension educators (i.e., the 8 county educators listed above), this study evaluated corn P response across a wide-range of soil test phosphorus (STP) levels, multiple soil textures, and numerous crop rotations. At each location, participating growers were given a choice of 1) applying P fertilizer per annual management practice or based on crop P removal, and 2) no fertilizer P application. The two treatments were applied in 100-300 foot strips throughout grower fields. Data collection included: pre-plant 0-2 inch and 0-8 inch soil samples for base nutrient analysis, R1 corn ear leaf samples for tissue nutrient analysis, grain yield and moisture from each plot, and grain subsamples for nutrient removal data.

All 16 locations were successfully harvested with data obtained from each location. Soil test phosphorus levels ranged from 6 – 117 ppm across locations giving this project a wide soil test phosphorus (STP) spectrum to evaluate responsiveness to P fertilizer application. Preliminary grain yield results indicated six locations were significantly responsive to P fertilizer application while 10 locations were not responsive to P fertilizer application. Across responsive sites, STP levels ranged from 6-36 pm and resulted in a 10-18 bu/A when P fertilizer was added. Across non-responsive P sites, STP levels ranged from 28 – 117 ppm and resulted in a 1-8 bu/A difference. When 0-8 inch STP levels were regressed against grain yield, the linear-plateau model used to fit the curve indicated that the critical STP level across all locations was 16 ppm (Figure 1). Soil samples taken from a 0-2 inch depth did not show a better correlation to corn grain yield. Additionally soil pH did not correlate to grain yield obtained nor 0-8 or 0-2 inch STP levels. Data may indicate that current Michigan and Tri-State soil fertility guidelines recommending a 15 ppm STP critical level are still valid despite changes in corn germplasm.

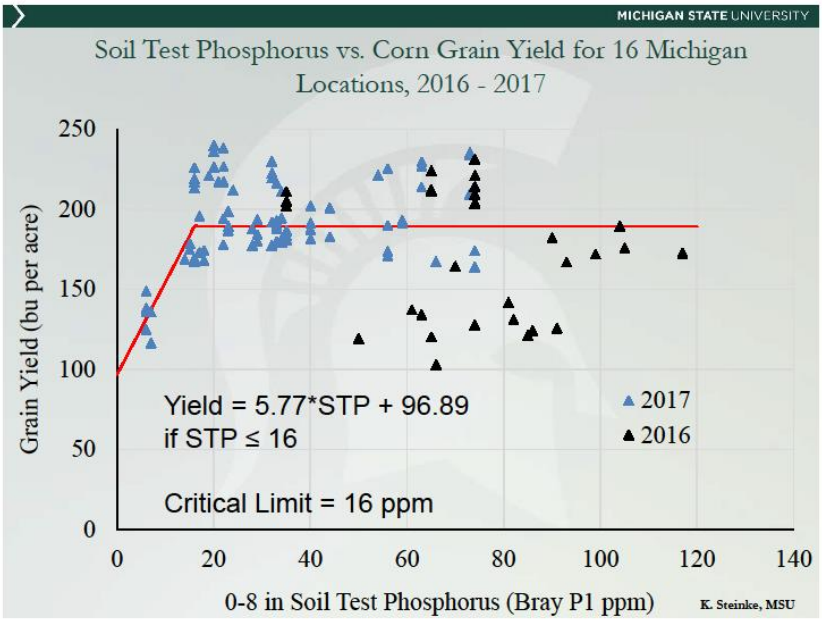

Figure 1. Regression of 0-8 inch soil test phosphorus (STP) levels versus corn grain yield for 16 on-farm Michigan research trials. Data show that the critical STP level for these trials was 16 ppm possibly indicating that the previously recommended threshold of 15 ppm may still pertain to current production systems.

Summary: There is a critical need to identify and validate corn response to phosphorus (P) fertilizer application and effectively communicate these criteria to guide future P applications. Production agriculture can be a part of the solution within critical watersheds. Preliminary data from the current study show the STP critical threshold to be 16 ppm indicating that levels greater than the 15-30 ppm maintenance threshold were NOT likely to result in a corn grain yield response to P fertilizer application. These data are critical in that growers located across Michigan but especially those located within the Western Lake Erie Basin and Saginaw Bay watersheds need to examine soil test reports before indiscriminately applying P fertilizers. Soil testing for phosphorus indicates the likelihood of response to added P, not how much P is in the soil.