ASSESSING THE STATUS OF SOIL PHOSPHORUS, POTASSIUM AND pH FOR SOYBEAN PRODUCTION IN OHIO

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ABSTRACT

Soybeans are one of the most valuable agronomic crops produced in Ohio, and in 2014, the value of Ohio's soybean crop was $2.7 billion making soybean extremely important for agriculture and the economy. To achieve high soybean yields, it is essential to have the proper soil nutrient and pH levels; however, some nutrients can also have detrimental environmental effects. Phosphorus (P) can cause eutrophication of freshwater systems when high quantities enter waterways, further validating the need to maintain proper levels of fertility. The objective of this study was to determine the status of soil P, potassium (K), and pH levels throughout Ohio. A survey of farmers' fields across all of Ohio was conducted in 2013 through2015 with a total of 198 fields sampled to determine fertility levels. Soil samples were collected from three areas within each field, two from normal or high-yielding areas of the field and one from a lower-yielding area of the field. Thirty-one percent of the soil samples were below the critical level of 15 ppm Bray P. Seventy-three percent of the soil samples were below 40 ppm Bray P and would require a P fertilizer application as recommended by the Tri-State Fertilizer Recommendations. Twenty-six percent of K samples were below the critical level of 125 ppm (ammonium acetate extraction). Eighteen percent and 22% of samples were below the recommended value of 6.0 pH and above 6.8 pH, respectively.

INTRODUCTION

Soybean is one of the most valuable field crops grown in the states of Ohio. Ohio is one of only two corn-belt states with more soybean acreage than corn acreage, making soybean the most widely grown crop in Ohio, with 4.85 million acres planted in 2014. Ohio ranked 5th in yield among all states at 52.5 bushels per acre and 7th in total soybean production at 254 million bushels in 2014 (NASS, 2015). The value of the 2014 soybean crop in Ohio was approximately $2.7 billion and accounted for 42.9% of the value of all field and miscellaneous crops in the state which was the highest percentage among all states (American Soybean Association, 2015; NASS, 2015).

Of the macronutrients required by all plants, P and K are often the most limiting to soybean production in Ohio. Phosphorus is required in very high quantities as it is an important component of DNA, RNA, ATP, NADPH, and phospholipid bilayers (McMahon et al., 2011). Adequate P leads to improved photosynthesis, flowering, nitrogen fixation, and fruiting (Brady and Weil, 2010). Phosphorus can be limiting to plants when it is not present in high enough quantities in the soil or when it is present in insoluble forms that are not available for uptake by plants (Schachtman et al., 1998). To correct this, P is applied either as chemical fertilizer or manure; however, excess P can be lost to runoff and can cause eutrophication of freshwater systems (Filippelli, 2008). Therefore, it is important to maintain soil P levels that support high crop yields, but are not too high and cause detrimental environmental effects. Potassium is required in large quantities by plants to aid in various osmotic processes including the functioning of stomates, making it very important for photosynthesis (McMahon et al., 2011). According to Brady and Weil (2010), K is the most abundant macronutrient in soils, but most of it is unavailable to plants. Consequently, K is often applied as chemical fertilizers to maintain adequate levels to achieve high yields.

Maintaining appropriate soil pH levels is essential to obtaining high yielding soybeans. When soil pH is below 6.0, the availability of some nutrients, such as nitrogen (N), P, K, calcium, sulfur, and magnesium, declines significantly. Additionally, soybean plants forms a symbiosis with *Rhizobia* bacteria. The bacteria fix atmospheric N to a form that is usable to the plant in exchange for sugars received from the plant. According to Rogovska et al. (2009) and Rogovska et al. (2007), as pH drops below 6.0, the bacteria do not function as well and the plant can lose much of that N source. Additionally, as pH levels drop below 5.0, heavy metals including aluminum and manganese can become toxic to plants. As pH levels become more alkaline, greater than 7.0, many micronutrients become less available to plants. Maintain pH values of 6.0 to 6.8 is recommended for optimal soybean production (Vitosh et al., 1995).

MATERIALS AND METHODS

A survey was conducted in 2013 through 2015 to determine the status of P, K, and pH levels in Ohio. Farmers throughout the state volunteered fields for the project, and a total of 198 fields were sampled. Three areas were selected in each field based on field history: two normal or high yielding areas and one low yielding area. Soil samples were taken in the spring around the time of planting from each area. Each sample consisted of 10-15 soil cores collected to an 8 inch depth and 1 inch diameter. For P, samples were analyzed using Mehlich 3 extractant and converted to Bray P. Potassium was extracted using ammonium acetate. This corresponds with the Tri-State Fertility Recommendations (Vitosh et al.k 1995).

The Tri-State Fertilizer Recommendations were used to categorize samples. For P, samples below 15 ppm were categorized as below the critical level and likely need P to prevent yield loss. Samples below 40 ppm require P fertilization to either raise or maintain P levels in the soil. Samples above 40 ppm do not require P fertilization, and those levels should be reduced. For K, recommended soil test values vary based on the soil's cation exchange capacity (CEC). For graphical purposes, the critical level of 125 was used which corresponds to a CEC of 20, because the majority of samples were near 20 meq. For soil pH, the desired range for optimal soybean production is 6.0 to 6.8 (Vitosh et al., 1995).

RESULTS AND DISCUSSION

The three year results for P showed that 32% of samples were below 15 ppm and require P fertilization to prevent yield loss. Forty-one percent of samples were between 15 and 40 ppm and require P fertilization to maintain soil P levels that support high yields. The remaining 27% of samples were above 40 ppm and do not require P fertilization (Figure 1). Twenty-six percent of soil samples were below the critical level of 125 ppm and required K fertilization. The remaining 74% of samples were above the critical level of 125 ppm (Figure 2). For pH, 17.8% of samples were below 6.0 pH and require liming to raise the pH to the optimal range. Twenty-three percent of samples were above 6.8 pH, and the remaining 60% of samples were within the optimal range of 6.0 to 6.8 (Figure 3).

SUMMARY

Maintaining proper soil fertility levels is one of the most important factors in obtaining high soybean yields; however, with genetic advancements and new and exciting crop inputs, it can be easy to overlook soil fertility basics. This research indicates the importance of soil sampling and being aware of soil test values for three major reasons. First, adequate fertility levels are required for high yields. Second, economically, it is important for producers to spend money where it is needed and not over apply or apply too little fertilizer. Finally, it is important to be aware of P levels in the soil in order to avoid contributing to environmental problems.

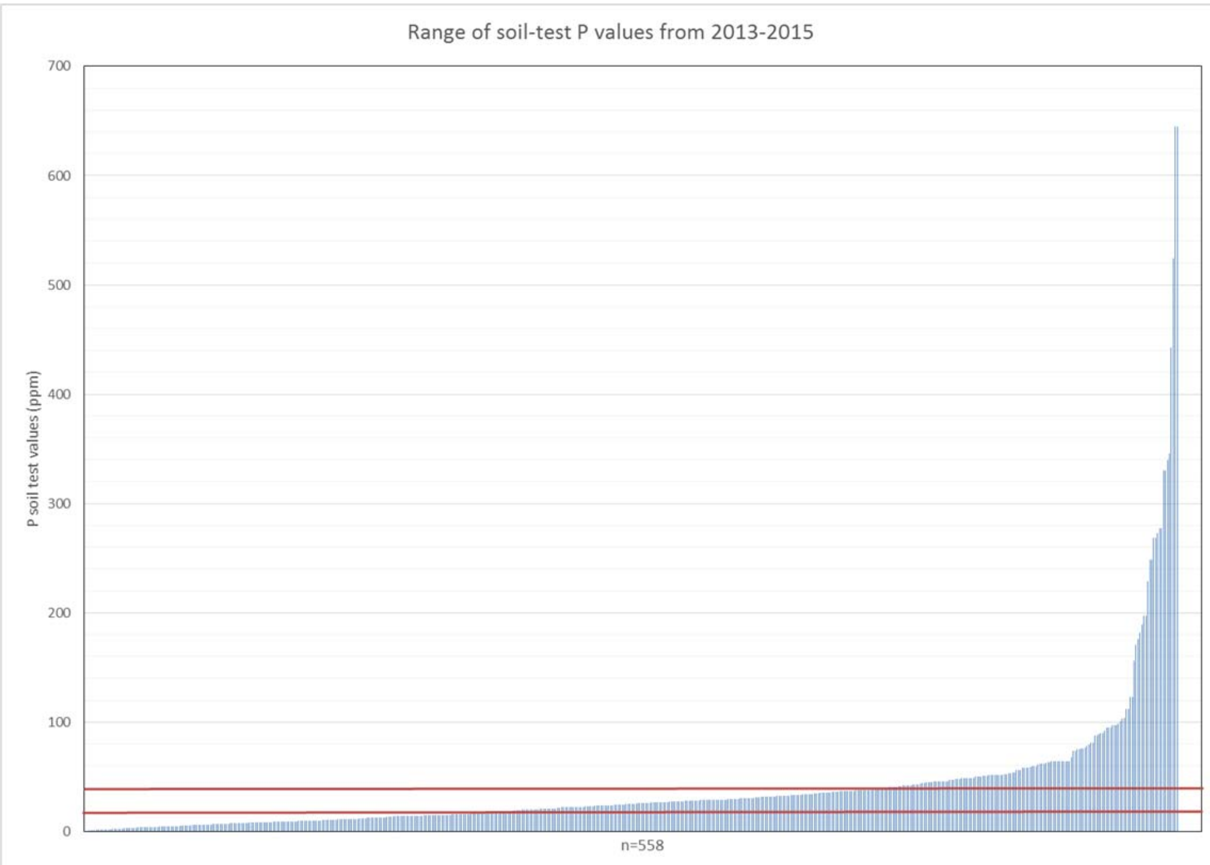

Figure 1. Range of soil-test P values from 2013-2015. Red lines represent the critical levels of 15 and 40 as identified by the Tri-State Fertilizer Recommendations (Vitosh et al., 1995).

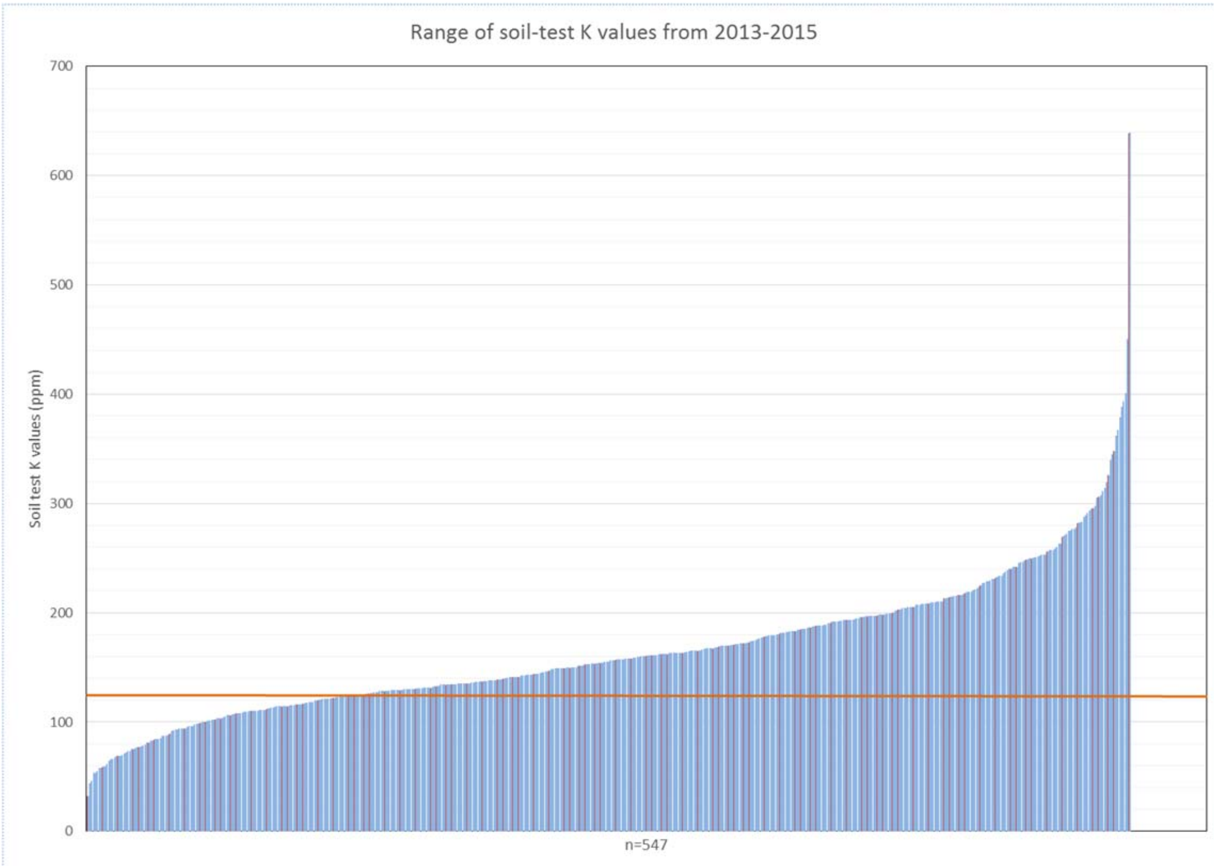

Figure 2. Range of soil-test K values from 2013-2015. Red line represents the critical level of 125 ppm as identified by the Tri-State Fertilizer Recommendations (Vitosh et al., 1995).

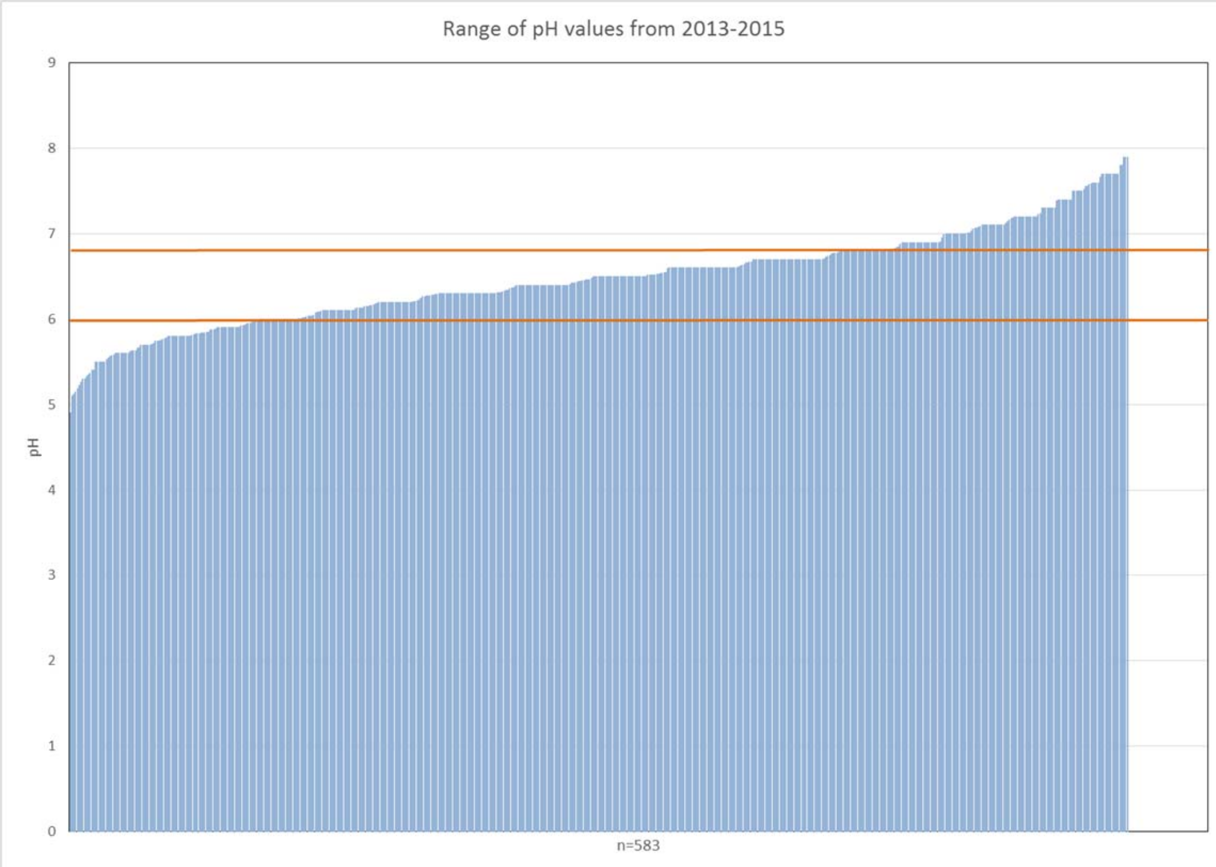

Figure 3. Range of pH values from 2013-2015. Red lines represent the critical levels of 6.0-6.8 as identified by the Tri-State Fertilizer Recommendations (Vitosh et al., 1995).

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