INFLUENCE OF RECENT ACIDIFICATION ON SOIL PHOSPHORUS EXTRACTION AND SORPTION

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ABSTRACT
Gradual soil acidification in arid soils brings into question the validity of the traditional sodium bicarbonate (Olsen) method for making fertility recommendations. Our objectives were to determine how soil pH influences the soil phosphorus (P) indices after fertilization and sorption capacity of soils with similar levels of available P at varying soil pH levels. Collected soils represented a range of pH (5.2-8.4) and OP (3-40 mg P kg⁻¹). Soils were treated with 0, 100, 200, or 300 lbs P₂O₅ per acre and moistened and maintained at temperature for 6 weeks. Subsamples were collected and analyzed for available P with four different extraction methods: Olsen (OP), Bray (BP1), Morgan (MMP) and Mehlich-III (M3P). Additionally, P sorption isotherms were performed on untreated soils. Data indicated that the slope of the change in extractable P was generally not significant for OP, BP1, MMP, and M3P given a P addition for several soils at different pH but of similar initial available P levels. Grouping soils by pH showed differences in slope with OP (0.27-0.34) yielding the least difference and MMP (0.12-0.33) the greatest related to soil pH. Langmuir parameters of b, sorption capacity, and k, binding energy, showed variability for soils grouped by initial available P for several pH levels. Grouped by pH there was little difference in P sorption in relation to soil pH. Continued use of OP on acidified soils of the Columbia Basin appears to be a viable soil testing strategy.

INTRODUCTION
A common side-effect from continued ammonium fertilizer applications is the production of acidity and a decrease in soil pH. In some arid areas, soil pH values of 5.0 or less are not uncommon. This change in soil pH raises the question of whether the Olsen Phosphorus (OP) extraction can be used reliably on low pH soils because the method was developed for neutral to alkaline soils.

Soil testing laboratories continue to use the Olsen P extraction on recently acidified soils regardless of soil pH. Extraction methods of plant available P for acidic soils includes: Bray, BP1; Mehlich-III, M3P; Morgan, MMP. Data for use in recently acidified soils are lacking for these methods. For this reason the OP method continues to be the preferred method regardless of soil pH.

The extraction procedures for P in this study are availability indices. In other words, an amount of P that is assumed to be directly related to plant availability is extracted and is dependent on soil properties and plant requirements. Therefore, we wanted to compare how recently acidified soils relate to their high pH counterparts in terms of how much P is extracted (using the extraction methods listed) following a fertilizer application and the amount of P sorbed by the soil.

MATERIALS AND METHODS
For this evaluation, 10 soil samples from the Columbia Basin were collected in bulk from 0-12” representing three soil pH ranges (<6.0, 6.2-6.8, >7.0) at three OP levels (<10, 15-25, >30
ppm) within each pH range. Soil samples were moistened and fertilized with 0, 92, 184, 276 lbs P₂O₅ per acre (as MAP, 11-52-0). Following a 6-week incubation the samples were extracted with OP, BP1, MMP, and M3P. Additionally, the untreated samples were analyzed for P sorption. Briefly, the soil samples were added to solutions of known P concentration and shaken for 24 hours and then the solution is measured for P. The difference between what is analyzed following shaking and the initial known P concentration is the P sorbed.

Figure 1 shows the change in tested P for each extraction method vs. the P fertilizer application. In practical terms the slope of this line is the expected change in tested P (ppm) for each pound of P₂O₅ applied per acre. For each extraction method the line slope is given for soils grouped as low (L), medium (M) or high (H) pH. Of the four extraction methods tests, OP shows the least amount of slope variability (0.14—0.17) across soil pH while MMP (0.06—0.16) exhibited the greatest differences.

Sorption data can be found in Figure 2. Separating the data by soil pH it is apparent that soil pH was not a factor in P sorption capacity for the soils tested. The lines shown in Fig. 2 are calculated using the Langmuir Isotherm equation. Comparisons of the terms in this equation further show that sorption maxima across soil pH levels are comparable.

CONCLUSION

The results from this study showed that in the context of extraction consistency, the OP extraction proved the most reliable method across the soil pH range tested while MMP was the least reliable. Phosphorus sorption maximum was very similar for the range of pH tested. This is likely a result of the P chemistry existing as predominantly Ca-P form even when the soil pH low or if Fe/Al-P complexes exist, the amount of P extracted is similar to the assumed Ca-P state. The OP method appears to be a viable test for soils that have become acidified over time that are traditionally thought of as calcareous.
Figure 1. Change in tested P for OP, MMP, BP1, and M3P extraction methods given the addition of $P_2O_5$ fertilizer. The calculated slope for low (L), medium (M) and high (H) pH soils represents the expected change in tested P for each pound of fertilizer applied.
Figure 2. This figure shows the P sorbed vs. the equilibrium P concentration for soils with low (L), medium (M), and high (H) pH. The lines represent the calculated Langmuir Isotherm equation.