Soil Phosphorus Storage Capacity and Fertilization in Southwest Florida Vegetable Production

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ASA-CSSA-SSSA International Annual Meetings, Oct. 21-24, 2012, Cincinnati, Ohio

INTRODUCTION and OBJECTIVE

Using the Best Management Practice (BMP) program developed by the University of Florida, recommendations for phosphorus (P) fertilizer management are based on soil test P (STP; i.e., Mehlich-1) levels of the production site at the beginning of the season. Most vegetables in southwest Florida are grown on soils belonging to Alfisols or Spodosols with argillic (clay) or spodic (organic hardpan) sub-surface layers. Phosphorus fertilization to these soils may cause accumulation of P in soils and overestimation of plant-available P for BMP recommendations. Moreover, sandy soils in some areas are low in organic matter and Fe/Al-oxides to retain P in soils, and others may be saturated with P due to long-term P fertilization even with high soil pH and extractable Ca contents, possibly causing environmental impacts in the watershed of the region. Soil P storage capacity (SPSC) provides a direct estimate of the amount of P a soil can hold before exceeding a threshold soil equilibrium concentration (i.e., before the soil becomes an environmental risk), which the STP value itself cannot express. Therefore, the objective of this study was to evaluate P retention capacity of soils used for vegetable production in southwest Florida with varying history of P fertilization using SPSC.

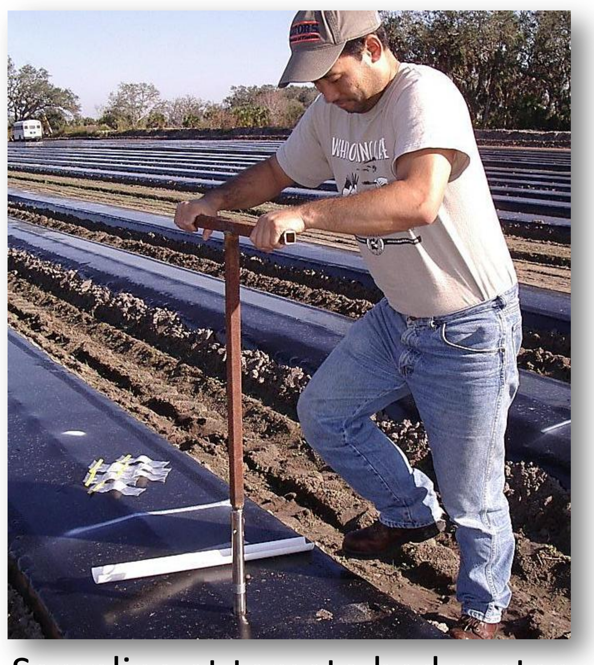
MATERIALS and METHODS

- Soils were sampled from tomato fields at 3 different commercial farms in Immokalee, FL every 30 days during 2008-09 winter and 2009 spring seasons, respectively.
- Soil samples were taken from the center of the tomato bed and divided into top (0-15 cm) and bottom (15-30 cm) depths.
- Fertilizer application rates were 0, 29, 44, and 59 kg P ha^{-1} for each farm and season, respectively, which corresponded to 0%, 50%, 75%, and 100% of the recommended rate for tomato grown on soils with "low category" in Mehlich 1-P at pre-plant.
- Mehlich-1 extractable P, Al, Fe, and Ca in soil (M1P, M1Al, M1Fe, and M1Ca, respectively) were analyzed.
- P saturation ratio (PSR expressed in moles) = M1P / (M1Al + M1Fe + M1Ca)
- Soil P storage capacity (SPSC expressed in mg kg^{-1}) = (0.15–PSR) x (M1Al + M1Fe + M1Ca) x 31 x 1.93 (1.93 is a constant to convert Mehlich 1-extractable to oxalate-extractable data).

Experimental sites in Florida

Tomato field

Seepage irrigated field



Sampling at tomato bed center

Harvesting tomatoes

RESULTS

Table 1. Basic chemical properties of soils at 15 cm-depth at experimental sites

Farm†	pH‡	Total P#	M1P††	M1Ca††	M1Al††	M1Fe††
		mg kg^{-1}				
1	7.4	219	99	829	56	18
2	7.1	918	454	3102	215	44
5	7.0	–	70	825	66	104
5b	7.6	–	112	1073	63	12

† Soil series were Holopaw sand at all farms. # Total P digested with H_2SO_4 and H_2O_2.
‡ pH (1:2 soil:water). †† Extracted by Mehlich-1 solution.

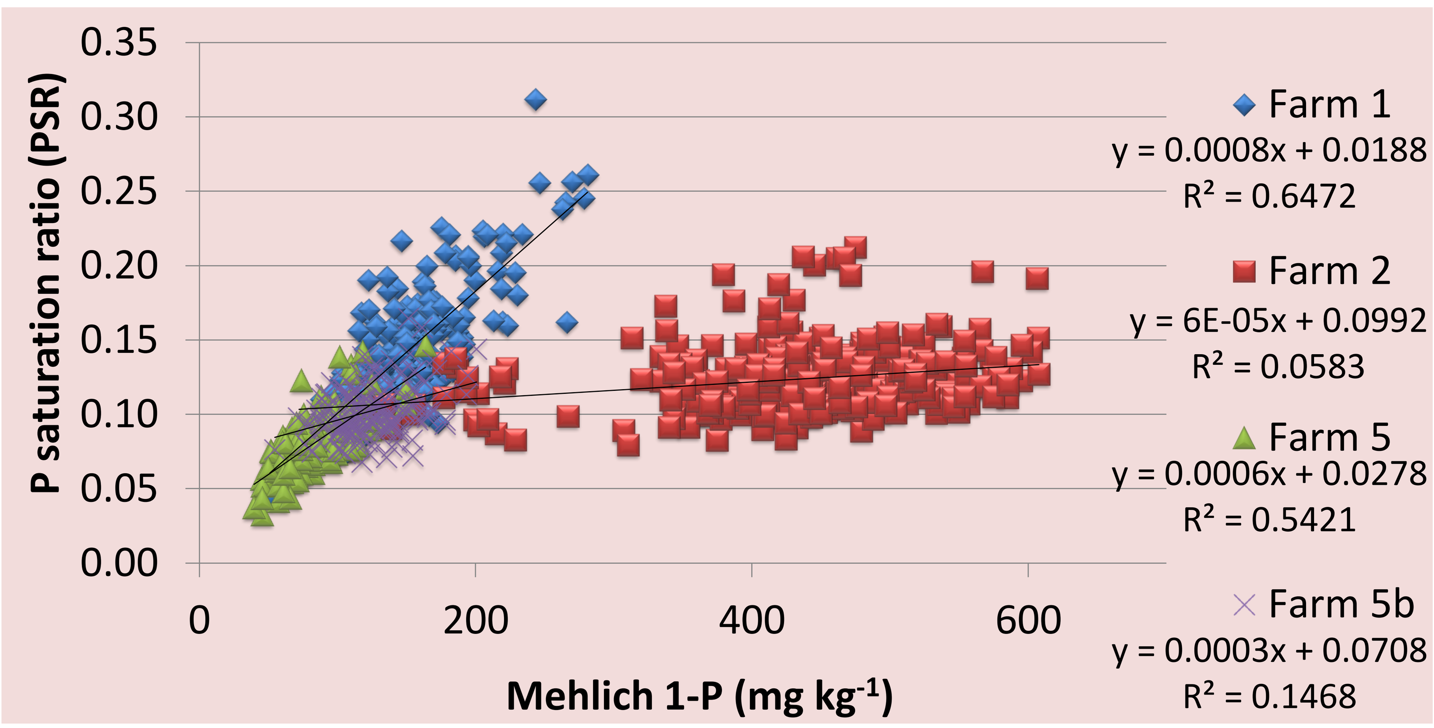


Fig. 1. P saturation ratio and Mehlich 1-P

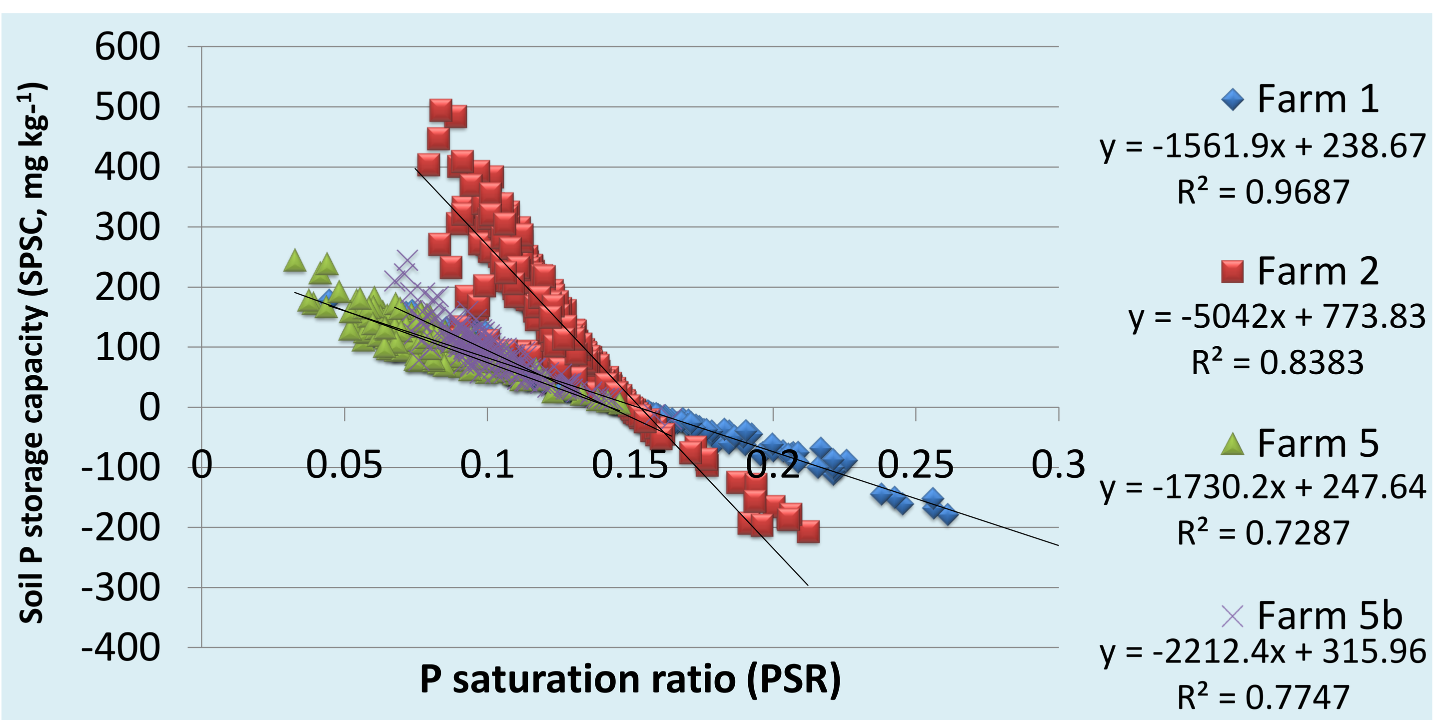


Fig. 2. Soil P storage capacity and P saturation ratio

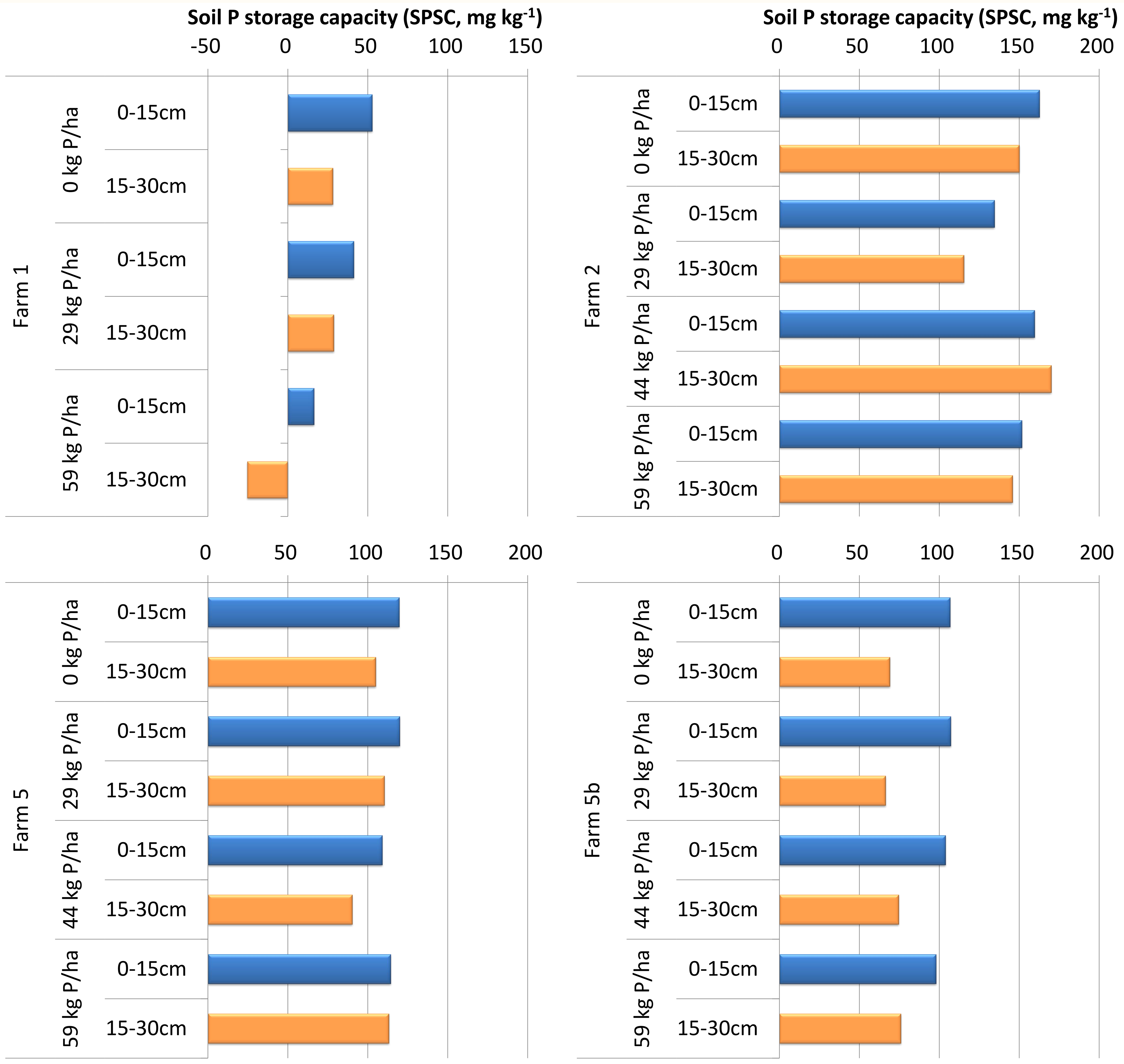


Fig. 3. Soil P storage capacity of top (0-15 cm) and bottom (15-30 cm)depths with 4 different P application rates

SUMMARY

- 32% of the total number of soil samples in Farms 1 showed PSR > 0.15 (threshold level, Fig. 1), thus negative SPSC values (Fig. 2), indicating saturated P sorbing capacity that could result in an environmental risk with further addition of P.
- Based on the regression equation between M1P and PSR (Fig. 1), soils in Farm 1 with M1P > 160 mg kg^{-1} at pre-plant may exhibit negative SPSC values, thus environmental risk.
- 9% of the total number of soil samples in Farm 2 showed PSR > 0.15 (Fig. 1), thus negative SPSC values (Fig. 2), corresponding to M1P ranging from 313 to 607 mg kg^{-1}.
- Soils in Farm 2 did not yield a good correlation between M1P and PSR (Fig. 1), indicating a need to evaluate other soil P test methods than Mehlich 1 for improved correlation.
- Soils in Farm 2 had higher SPSC relative to PSR than soils in other farms based on the slope of the regression equation (Fig. 2) because of higher M1Ca and M1Al for greater adsorption capacity.
- Soils in Farms 5 and 5b (except for 2 samples) did not show PSR > 0.15, thus showed positive SPSC values, indicating possibility of no environmental risk.
- ☺ Soils in Farm 1 had low or negative (only 15-30 cm with 59 kg P ha^{-1} added) SPSC values (Fig. 3).
- ☺ Soils in Farm 2 had the highest SPSC among soils in other farms regardless of soil depths and P application rates (Fig. 3).
- ☺ Soils in Farms 5 and 5b showed a tendency of lower SPSC values at 15-30 cm depth than those at 0-15 cm depth regardless of P application rates (Fig. 3).