

ABSTRACT

A Soil Tool Kit to Evaluate Soil Properties and Monitor Soil Health Changes in Smallholder Farming Contexts

Blessing Nyamasoka-Magonziwa, Steven J. Vanek, John O. Ojiem and Steven J. Fonte

Smallholder farmers often face challenges in managing soil fertility due to limited inputs and high spatial variability on their farms. While improved knowledge of soil constraints could help them manage limited resources more effectively, formal soil analyses are typically out of reach due to high costs of testing and transport associated with regional analytical laboratories. To address these challenges, we assembled a tool kit that uses minimal reagents and low-cost equipment to provide in-field quantitative data that are comparable to formal laboratory methods. We validated our tool kit measurements against standard analyses conducted at national laboratories on soils collected from 36 smallholder farms in Kenya and 115 farms in Peru. Additionally, in Kenya, we evaluated two legume treatments, involving the incorporation of residues from: 1) *Lablab purpureus* (lablab), versus 2) *Phaseolus vulgaris* (common bean). The tool kit measurements that were considered include important indicators of soil health (such as permanganate oxidizable carbon (POXC), available P, pH, particulate organic matter (POM), and aggregate stability) that can influence crop yields and multiple soil functions. POXC and pH measured with the tool kit from Kenyan soils were highly correlated to those measured by a standard laboratory ($R^2 = 0.77$; $R^2 = 0.56$; respectively). The tool kit and standard laboratory available P were less well correlated, but also showed a highly significant positive relationship ($R^2 = 0.30$). Similar patterns were noted for POXC, pH and available P measured in Peruvian soils ($R^2 = 0.75$; $R^2 = 0.75$; $R^2 = 0.35$; respectively). Importantly, the tool kit and standard lab analyses also displayed similar abilities to predict maize grain yield in Kenya. When used to detect soil impacts of incorporating *P. vulgaris* versus *L. purpureus*, only POM differed significantly between the two legume treatments, although *L. purpureus* was slightly higher for most of the beneficial soil health properties. Our findings suggest that the tool kit methods proposed here have broad applicability to smallholder farms for explaining variability in crop yields, assessing soil contexts, and quantifying management-induced changes in soil health.

Keywords: Available phosphorus, Kenya, Particulate organic matter, Permanganate oxidizable carbon, Peru, Soil fertility assessment