Impact of Integrated Application of Fertilizer and Compost on Soil Quality and Yield in Northern Ghana's Cropping Systems

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Introduction

Low crop productivity and declining soil quality are common characteristics of smallholder cropping systems in sub-Saharan Africa. This can be attributed to the use of unsustainable soil management practices such as residue removal, continuous cropping and low use of organic and inorganic fertilizers.

Adoption of sustainable intensification management practices such as integrating mineral fertilizer with organic inputs (e. g. manure, compost) and maintaining crop residues, cover cropping, and crop rotation can help improve soil quality and enhance water and nutrient use efficiency. Improved soil quality leads to increased soil biodiversity and soil carbon stock resulting in high crop productivity.

Objectives

- To assess the impact of organic and inorganic fertilizers on soil quality, soil microbiome and yield of maize

Materials and Methods

- Location: Nyankapala, Ghana
- Study was initiated in 2013
- Soil Type: Ferric luvisols and Gleyic plinthosols (Nyankpala and Changnayili series), FAO classification
- Experimental Design: Split plot in a Randomized Complete Block Design

Treatments

- Three N-P-K fertilizer rates (kg ha^{-1}) (Main plot factor):
  - Control = 0-0-0
  - Half rate = 30-30-30
  - Full rate = 60-60-60
- Four compost (Fertisoil) application rates (Subplot factor):
  - 0 Mg ha^{-1} (Control)
  - 2 Mg ha^{-1}
  - 4 Mg ha^{-1}
  - 6 Mg ha^{-1}
- Soil Sampling Depths: 0-15 cm
- Test crop: Maize (*Zea mays* var. Obatampa)

Analyses

- Grain yield (kg/ha)
- Bulk density
- Soil organic C
- Soil microbial community structure using Phospholipid Fatty-acid Analysis (PLFA)

Statistical Analysis

- Proc mixed in SAS 9.4 and means separated by LSD at 10% significance level

Results and Discussion

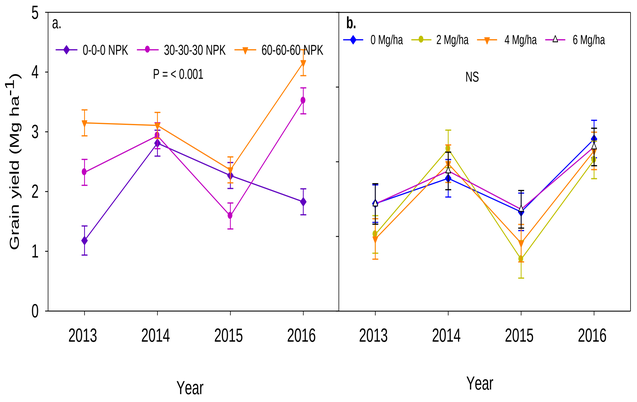

Fig. 1. Maize grain yield affected by (a) mineral fertilizer and (b) compost

- Grain yield responded to higher rate (60-60-60 kg NPK ha^{-1}) of mineral fertilization from 2013 through 2016. However grain yield with no fertilizer started declining linearly from 2014 through 2016 (Fig. 1a.)
- Compost application had no significant effect on grain yield (Fig. 1b.)

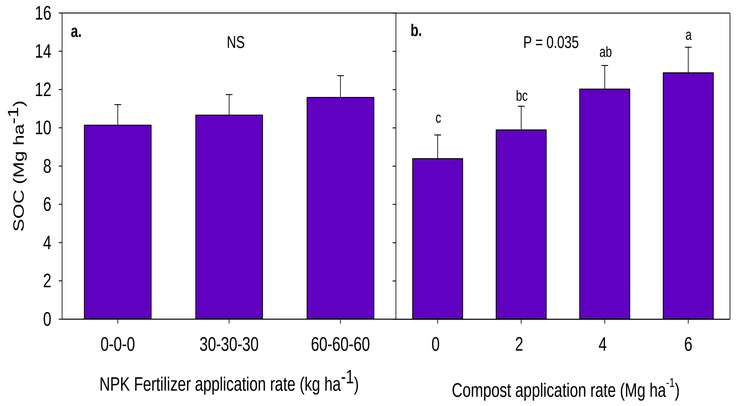

Fig. 2. Soil organic C as affected by (a) mineral fertilizer and (b) compost

- SOC increased linearly with increase in compost application rate. Greater SOC occurred at 6 Mg ha^{-1} compared to 0 Mg ha^{-1} and 2 Mg ha^{-1}, respectively (Fig.2b).
- Mineral fertilizer application had no significant effect on SOC (Fig. 2a).

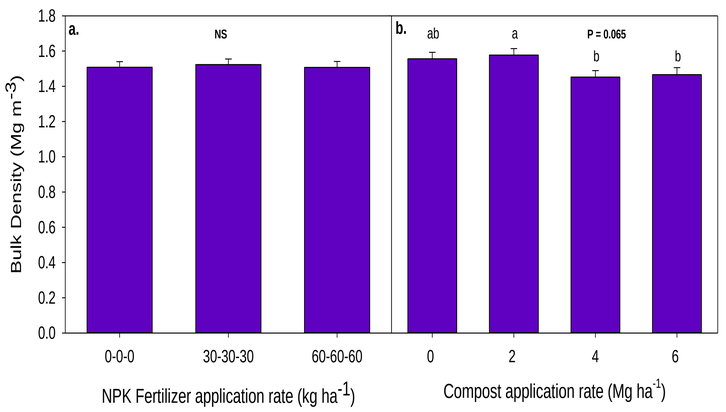

Fig. 3. Soil bulk density as affected by (a) mineral fertilizer and (b) compost

- Application of higher rates (4 & 6 Mg ha^{-1}) of compost significantly decreased soil bulk density (Fig.3b).
- Bulk density was not affected by mineral fertilizer application (Fig.3a)

Results and Discussion (cont.)

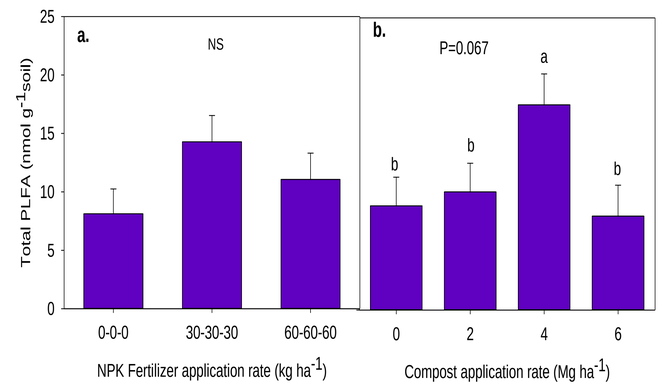

Fig. 4. Microbial biomass (Total PLFA) as affected by (a) mineral fertilizer and (b) compost

- Microbial biomass (Total PLFA) was affected by different compost application rates (Fig 4b). Application of 4 Mg ha^{-1} of compost resulted in a higher microbial biomass (Total PLFA) than the other treatments.
- Mineral fertilizer application had no effect on microbial biomass (Total PLFA) (Fig.4a).

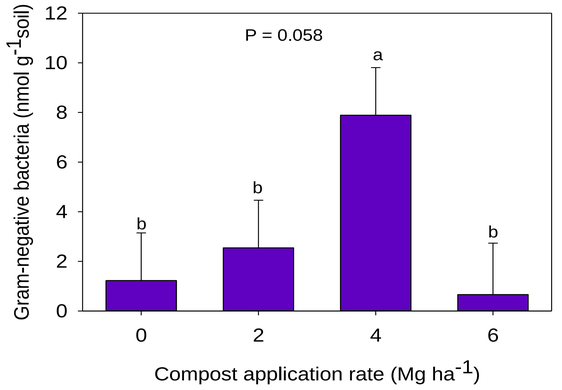

Fig 5. Gram-negative bacteria abundance as affected by compost application

- Gram-negative bacteria abundance was increased by compost only at 4 Mg ha^{-1} application rate (Fig.5a).

Conclusion

- Grain yield was enhanced by mineral fertilization, hence mineral fertilizer is needed to sustain higher crop productivity
- Compost enhanced SOC with subsequent decrease in soil bulk density, indicating improvement in soil quality
- Compost application also affected on microbial biomass. Application of 4 Mg ha^{-1} yielded in higher microbial biomass

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