Sustainable agricultural intensification practices such as direct seed mulch–based cropping (DMC) systems affects soil physical, chemical and biological properties. Direct seed mulch-based cropping system is conservation Agriculture (CA) practice where emphasis is on no-till or minimum-till, maintenance of permanent plant cover and relevant crop sequence or crop rotation. Direct seeding mulch-based cropping system improves soil health by: (1) controlling erosion, (2) increasing soil fertility, (3) preserving biodiversity, and (4) sequestering soil carbon. Agriculture practices that have negative impact on soil health and crop productivity in Northern Ghana are shown below.

**Introduction**

To evaluate the effects of DMC on soil health using selected soil biological and chemical indicators.

**Objectives**

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

**Materials and Methods**

- Five direct seed mulch based-cropping systems (Main plot factor):
  - Cover crop (CC1): consisted of each row of Braccharia ruziitensis, Stylosanthes guianensis, Crotalaria juncea and Crotalaria retusa
  - Check (CK): Maize
  - DMC1: Maize and Braccharia planted together.
  - DMC2: Maize and Black Dolichos lab lab
  - DMC3: Maize and cowpea (short duration)*
  - Black Dolichos lab lab and cowpea were intercropped into maize 25 days after planting.

- Fertilizer rate (Sub plot factor): Three levels of N-P-K (kg ha⁻¹)
  - F0 = 0-0-0
  - F1 = 30-30-15
  - F2 = 60-60-30

- Soil sampling depths: 0-5 and 5-15 cm

**Treatments**: Five direct seed mulch based-cropping systems (Main plot factor):

- Cover crop (CC1): consisted of each row of Braccharia ruziitensis, Stylosanthes guianensis, Crotalaria juncea and Crotalaria retusa
- Check (CK): Maize
- DMC1: Maize and Braccharia planted together.
- DMC2: Maize and Black Dolichos lab lab
- DMC3: Maize and cowpea (short duration)*
  - Black Dolichos lab lab and cowpea were intercropped into maize 25 days after planting.

- Fertilizer rate (Sub plot factor): Three levels of N-P-K (kg ha⁻¹)
  - F0 = 0-0-0
  - F1 = 30-30-15
  - F2 = 60-60-30

- Soil sampling depths: 0-5 and 5-15 cm

**Analyses**

- Biomass yield (kg/ha): sampled (1m X 1m).
- Soil pH (H₂O 1:1)
- Soil organic C and Total N (SOC and TN)
- Potentially mineralizable nitrogen (PMN)
- Soil microbial respiration (flush of CO₂)
- Microbial biomass C and N (MBC & MBN)

**Statistical Analysis**

- Proc mixed in SAS 9.4 and means separated by LSD at a significance level of 0.05

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**Results and Discussion**

**Figure 1.** Biomass yield affected by interaction of cropping systems and mineral fertilizer (a) 2012 and (b) 2013.

- Biomass yield was significantly affected (P < 0.001) by the interaction of cropping systems and mineral fertilizer in 2012 (Fig. 1a).
- Greater biomass yield due to the interaction effect was observed at 60-60-30 NPK (kg ha⁻¹) (Fig. 1a). Similar trend was observed in 2013 (Fig. 1b).

**Figure 2.** Biomass yield affected by (a) cropping systems and (b) mineral fertilizer in different years.

- Biomass yield was significantly (P < 0.05) greater in DMC systems compared to the check (maize) in 2012 and 2013 (Fig. 2a).
- Biomass yield was also significantly affected by mineral fertilizer application. 60-60-30 NPK (kg ha⁻¹) gave the most increased biomass yield (P < 0.05) in both years (Fig. 2b).

**Figure 3.** Soil organic carbon (SOC) affected by (a) cropping systems and (b) mineral fertilizer at different depths.

- The check (maize) cropping system had the highest (P < 0.05) SOC compared to the other DMC systems at the 0-5 cm depth (Fig. 3a).
- Mineral fertilizer had a positive effect (P < 0.05) on SOC at both 0-5 cm and 5-15 cm depths (Fig. 3b).

**Figure 4.** Soil carbon organic (SOC) affected by interaction of cropping systems and mineral fertilizer at (a) 0-5 cm and (b) 5-15 cm depths.

- Interaction effect of cropping systems and mineral fertilizer on SOC showed an increasing trend at the 0-5 cm depth but a decreasing trend at the 5-15 cm depth (Fig. 4a & b).

**Figure 5.** Potentially mineralizable nitrogen (PMN) affected by (a) cropping systems and (b) mineral fertilizer at different depths.

- Maize and Stylosanthes cropping system (DMC1) had significantly (P < 0.05) lower PMN compared to the other DMC systems in the 0-5 cm depth (Fig. 5a).
- Mineral fertilizer had a significant effect (P < 0.05) on the PMN. Greater PMN was found in 30-30-15 NPK kg ha⁻¹ compared to the other treatments in the 0-5 cm depth (Fig. 5b).

**Figure 6.** Soil pH affected by (a) cropping systems and (b) mineral fertilizer at different depths.

- Check (maize) cropping system had the least (P < 0.05) pH decline than the other cropping systems in the 0-5 cm depth (Fig. 6a).
- Mineral fertilizer application significantly (P < 0.05) decreased soil pH in the 0-5 cm and 5-15 cm depths (Fig. 6b).

**Conclusion**

- All DMC systems yielded greater biomass in both years. Biomass responded to mineral fertilizer application.
- Check (maize) cropping system had the least decline in soil pH and the greatest increase in SOC and PMN.
- Fertilizer application increased SOC and PMN but decreased soil pH.

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