# **Effect of Maize Cob Biochar, Vermicompost and Inorganic N-P nutrients on Soil Properties and Yield of Maize (*Zea mays* L.) Northwestern Ethiopia**

**Habtamu Tadele Belay1, 3\***, **Tesfaye Feyisa Beyene2, LewoyeTsegaye Ayalew3, Sintayehu Musie Mulugeta4**

1Department of Natural Resource Management, Debre Markos University, Ethiopia

2Soil and Water Research Directorate, Amhara Agricultural Research Institute, Ethiopia

3Department of Natural Resource Management, Bahir Dar University, Ethiopia

4Department of Horticulture, Debre Markos University, Debre Markos, Ethiopia

**\*Correspondence:**

Email: [Habtamu\_Tadele@dmu.edu.et](mailto:Habtamu_Tadele@dmu.edu.et)

**Abstract**

**Background:** Soil fertility and maize productivity are highly influenced by fertilizer type and rate. Maize cob biochar (BC) and vermicompost (VC), applied on a nitrogen-equivalent basis, can improve soil properties and crop yield. However, their combined effects with inorganic fertilizers from urea (N) and P₂O₅ from NPSB (N, P, S, B) on acidic Nitisols in Northwestern Ethiopia remain unclear.

**Methods:** A field experiment was conducted in 2023 and 2024 using BC (0, 4, 8 t ha⁻¹), VC (0, 5.02, 10.04 t ha⁻¹), and N/P₂O₅ (0, 120/69, 240/138 kg ha⁻¹). Twenty-seven treatments were arranged in RCBD factorial design with three replications.

**Results:** Application of 8 t BC + 10.04 t VC ha⁻¹ reduced soil bulk density (12.1%) and exchangeable Al (66%) while increasing porosity (11.8%), soil moisture (36.3%), and volumetric moisture (29%) over control. Combined 4 t BC + 5.02 t VC + 120/69 kg N/P₂O₅ ha⁻¹ improved TN, SOC, SOM, porosity, moisture content, leaf traits, harvest index, and grain yield (GY) by 38–64% compared with control. Bulk density, exchangeable H and Al decreased, while soil pH increased (27%). Grain yield correlated positively with LAI (r=0.726), SOC (r=0.693), TN (r=0.687), HI (r=0.656), AvP (r=0.648), and pH (r=0.549), but negatively with exchangeable acidity (r=-0.404), Al (r=-0.400), and BD (r=-0.396). The highest GY (12.13 t ha⁻¹) occurred in T24 (8 t BC + 10.04 t VC + 120/69 N/P₂O₅), followed by T14 (4 t BC + 5.02 t VC + 120/69 N/P₂O₅) at 12.09 t ha⁻¹, compared to 4.40 t ha⁻¹ in the control. Overall, integrated use of BC, VC, and N/P₂O₅ increased GY by 64% over control. PCA showed bulk density explained 52% of variation, followed by porosity (24%) and soil moisture (11%); the first two components accounted for 87% of variation in soil and crop traits.

**Conclusion:** Combined application of BC, VC, and N/P₂O₅ (T24 and T14) significantly improved soil chemical and physical properties, enhancing maize growth and yield. Maize cob biochar with vermicompost plus moderate inorganic fertilizer rates can be recommended as cost-effective alternatives to high inorganic fertilizer use in Northwestern Ethiopia.

**Keywords:** Soil amendment; exchangeable acidity; soil porosity; limiting nutrients, bulk density; harvest index; yield, maize cob biochar.

# **Graphical Abstract**

