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The effects of conservation-agriculture practices on soil greenhouse gas emissions in maize production systems in buea, cameroon

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Abstract

With a specific focus on reduced tillage and organic fertilisation, this study examines the effects of conservation-agriculture practices on soil greenhouse gas (GHGs—CO_2, N_2O, and CH_4) emissions, global warming potential (GWP), maize productivity and greenhouse gas intensity (GHGI) over two growing seasons (2020 minor and 2021 main season) in Buea, Cameroon. Two tillage practices–i.e., zero-tillage and conventional tillage and three fertiliser treatments—i.e., no fertiliser, synthetic fertiliser (urea), and organic fertiliser (composted municipal solid waste), were factorially combined in a split-plot design with three replications. GHG emissions were measured using the static flux chamber method, and flux rates were calculated with the HMR package in R software. Results showed that tillage and fertiliser types significantly ($p < 0.05$) influenced seasonal cumulative CO_2, N_2O, and CH_4 emissions. Synthetic fertiliser treatments produced the highest cumulative N O emissions, particularly under zero-tillage in 2020 and conventional tillage in 2021. Conventional tillage paired with organic fertiliser yielded the highest CO emissions across both seasons, while methane fluxes were predominantly negative across treatments, indicating that the volcanic upland soils acted as CH sinks. Application of synthetic fertiliser increased GWP by 20 % and 322 % under no-tillage in the 2020 and 2021 seasons, respectively. Under conventional tillage, GWP decreased by 15 % in 2020 but sharply increased by 295 % in 2021, highlighting season-specific and management-dependent effects. Although treatment effects were not significant ($p > 0.05$) on maize yields in 2020, the highest yield (3.06 t/ha) occurred under conventional tillage without fertilisation. Fertiliser type and its interaction with tillage significantly ($p < 0.05$) influenced yields in 2021, with the highest yield under conventional tillage with synthetic fertilisation (6.15 tons/ha). While conventional tillage treatment without fertilisation generated the highest yield (3.06 t/ha) in 2020, its GHGI was lowest GHGI (12.04 kg CO -eq t ^{1} ha ^{1} season ^{1}). In 2021, zero tillage treatment without fertilisation achieved a high yield (5.56 t/ha) with the lowest GHGI (2.15 kg CO -eq t ^{1} ha ^{1} season ^{1}). The results suggest that in Buea's minor growing season, conventional tillage with or without organic fertilisation reduced GHG emissions without compromising yields, while in main seasons, zero tillage without fertilisation offered the best yield-emission balance.

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