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Compost Effects on Soil Health and Yields of Organic Winter Wheat in Semi-Arid Environments

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Abstract

Organic dryland wheat (*Triticum aestivum* L.) is an important crop in Utah and the Intermountain Western United States. Yields are often severely constrained by lack of rainfall and, to mitigate crop failure, a wheat-fallow system is typically used. Organic dryland wheat-fallow systems risk major soil loss due to dependency on tillage and a lack of economically viable organic inputs to improve yield and return residue to the soil. The objective of this study was to assess the effects of a one-time compost application on soil health and organic carbon (OC) content of soil fractions in surface- and sub-soils. Three compost rates (0, 25, and 50 Mg dry weight ha^{-1}) were applied once at three organic dryland sites, Snowville (SN), Blue Creek (BC), and Historical (HT) after 3 yr (SN and BC) and 24 yr (HT). Soil samples were collected at four depths, 0-10, 10-30, 30-60, and 60-90 cm and OC in bulk soils, particulate organic matter (POM), sand associated organic matter (SMA), silt + clay mineral associated organic matter (MAOM) and dissolved organic carbon (DOC) were measured. Active carbon, microbial biomass and enzyme activities were measured on the 0-10 cm depths and grain yield was collected across all treatments. Water infiltration was measured in 2022 and 2023. After 3 yr, OC content of POM and MAOM fractions was greater in surface- and sub-soils at all sites. Additionally, POM and MAOM were positively correlated with bulk soil OC. Compost increased soil water infiltration and reduced runoff. Yields of winter wheat increased by 30 to 250 percent depending on site and have persisted consistently at least sixteen years. Our findings indicate that a one-time compost application (25-50 dry weight ha^{-1}) resulted in gains in wheat yield, OC in SOM fractions and bulk soil, and should be considered for OC restoration and the long-term sustainable management of organic dryland agroecosystems. A lack of yield response to conventional fertilizer at the BC site suggests that non-nutritive benefits of improved soil health were responsible for improved yields at the high compost rate.

Keywords: Compost carryover, soil health, organic wheat

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