Effects of a one-time compost addition on soil health in a rainfed dryland organic wheat system

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Introduction

Wheat is the foremost dryland crop across the world. About 41, 834 acres is used for organic winter-wheat production in Utah, located in the intermountain region (USDA NASS, 2015). However, the economic and environmental sustainability of organic wheat production in rainfed drylands is threatened by poor soil health.

Compost amendments can improve soil health, however farmers avoid the use due to the inability to recoup the application cost in the short-term. Recent studies, however, have shown that the one-time application had beneficial effects on soil microbial activities, organic carbon contents and wheat yields 16 years later (Reeve et al., 2012).

Soil enzyme activities, microbial biomass carbon, total organic carbon content, and total nitrogen are indicators of soil quality used in showing soil responses to management practices. Improved soil quality is well correlated with enhanced crop production.

The long-term goals of this research are to understand the soil mechanisms that help explain how a single organic amendment application can explain 16+ years of increased yields in a dryland, rainfed, organic winter-wheat system.

Aim

The aim of this study is to explore the contribution of compost application rates and type of organic amendment on microbial activities, total soil carbon and total soil nitrogen in a dryland organic winter-wheat system.

Methods

- Field plot experiments were established in 2015 in a semiarid, dryland, organic wheat field in Snowville, Utah.
- The soil at the study location is a Thiokol silt loam.
- Compost was applied in a randomized complete block design at the rates of:

ID	Treatment	ID	Treatment
C	0 Mg/ha compost	CM3	50 Mg/ha compost
CM1	10 Mg/ha compost	CMU	2 Mg/ha chicken manure
CM2	25 Mg/ha compost	PC	25 Mg/ha compost + 40 lb N feather meal

- Soil samples were collected from the 0-10 cm depth in May 2016.
- Soil cores were collected from each plot, pooled, stored at 4° C and the dehydrogenase and microbial respiration assays were done within two weeks.
- Total organic carbon, total nitrogen and phosphatase activities were measured on air-dried soils.

Results

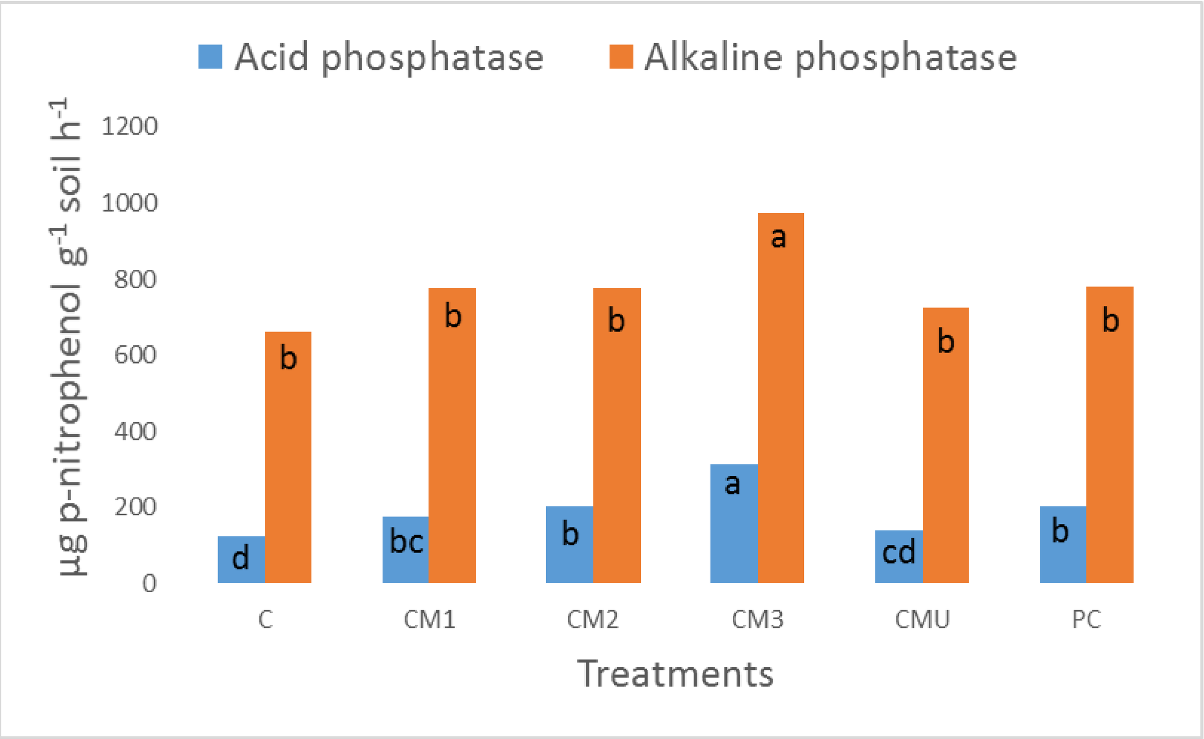

Figure 1. Acid phosphatase activities were significantly higher than the control at all compost rates except CMU. Alkaline phosphatase was only significantly higher than the control at the 50 Mg/ha compost rate

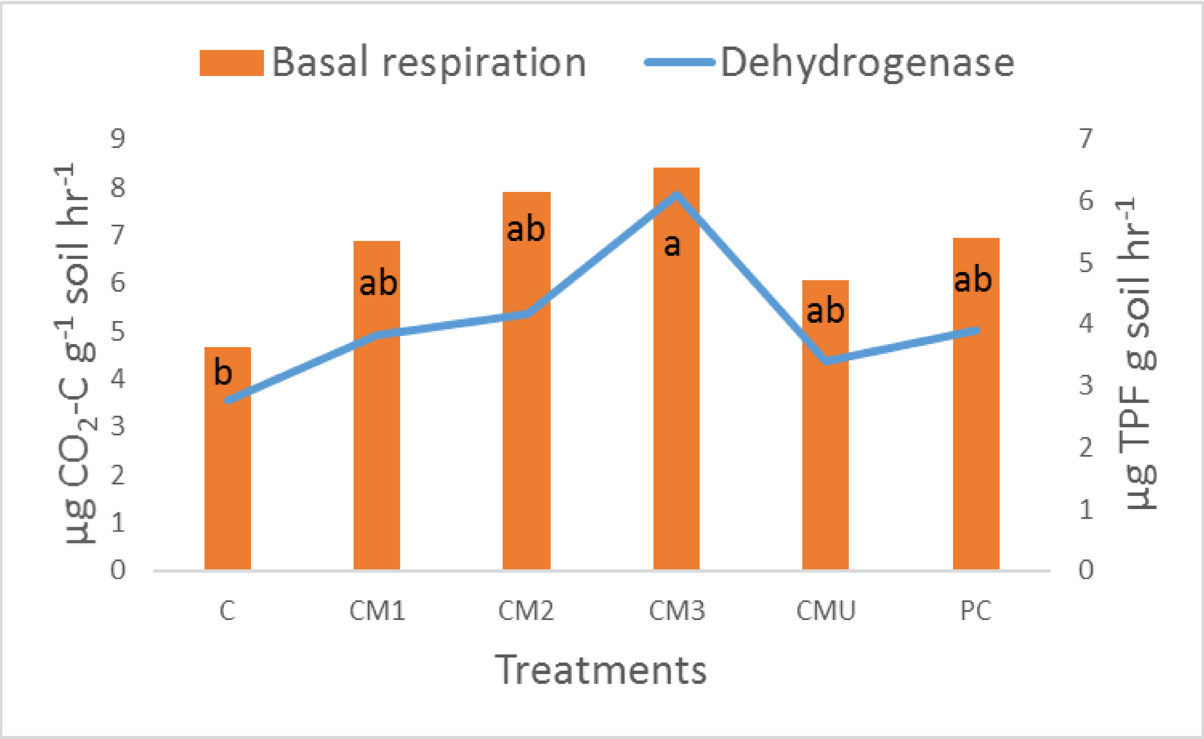

Figure 2. Basal respiration and dehydrogenase activity was only significantly different from the control at the 50 Mg/ha compost application rate.

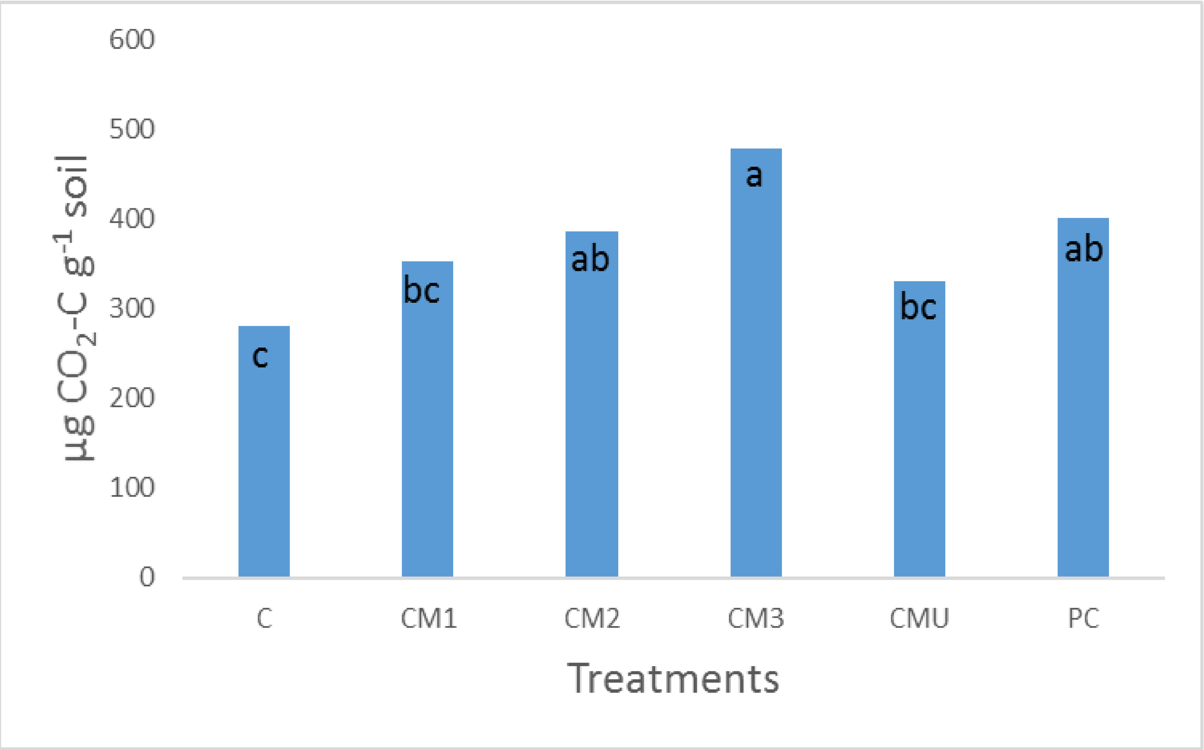

Figure 3. Only compost additions at 25 Mg/ha or higher significantly increased the soil microbial biomass carbon. Adding feather meal with the compost did not significantly increase microbial biomass C relative to the compost amendment.

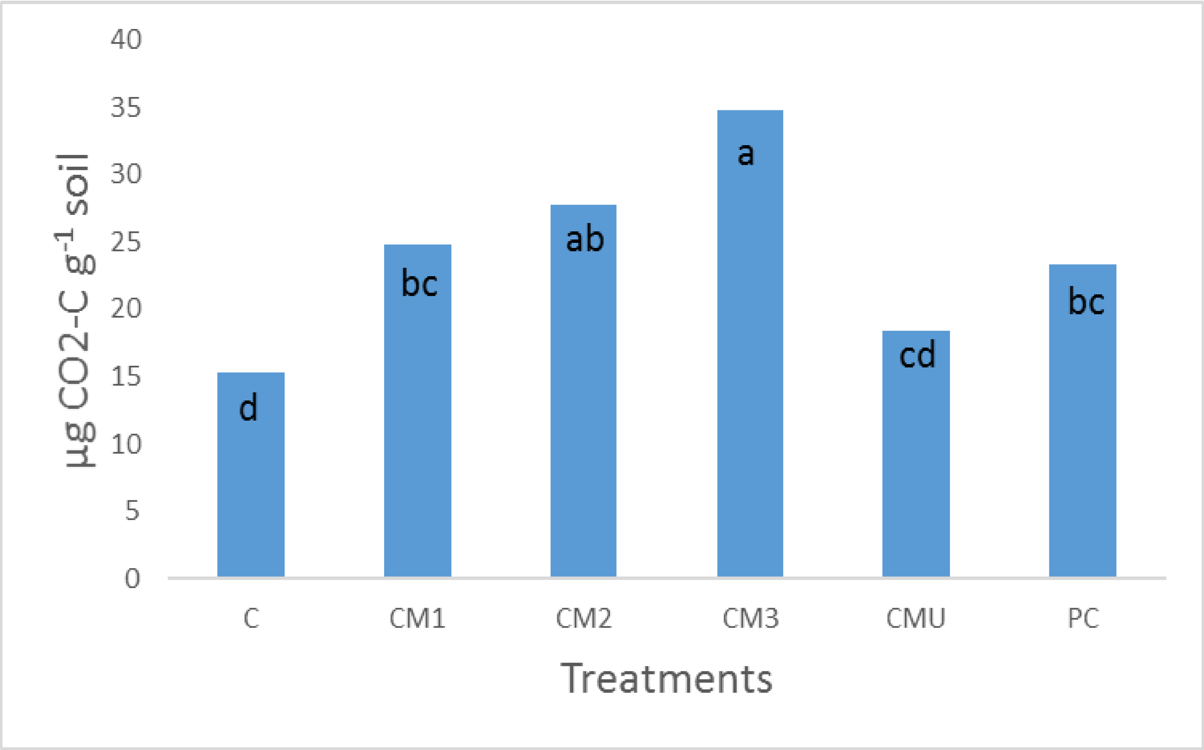

Figure 4. The amount of mineralizable organic carbon increased with the rate of compost applied. It was not significantly affected by the addition of chicken manure or feather meal.

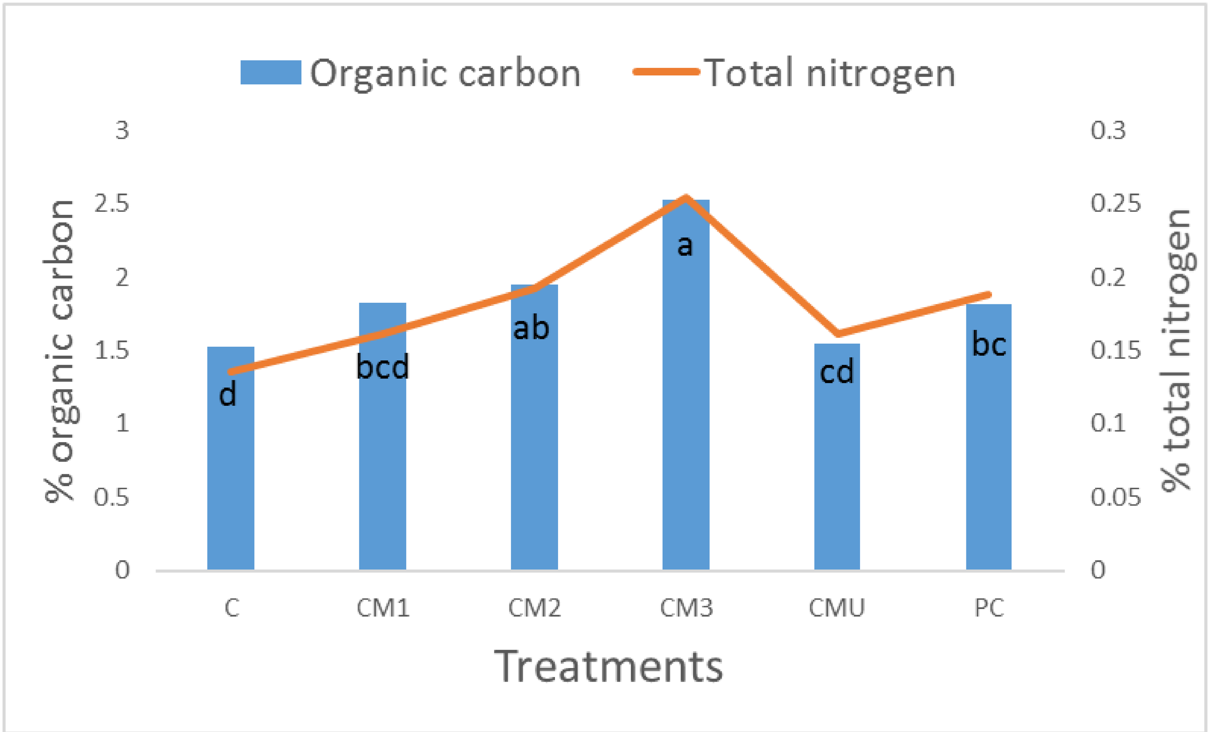

Figure 5. As the amount of soil organic carbon increased with the rate of compost addition, the soil total nitrogen also increased.

Figure 6: Field site in Snowville, Utah during the 2015/2016 growing season.

Discussion

- The activity of acid phosphatase was enhanced by the addition of organic amendment. It was highest when 50 Mg/ha of compost was used and least in the control plots.
- Alkaline phosphatase activity was enhanced when 50 Mg/ha of compost was applied but no difference was found among other treatments.
- Microbial biomass carbon increased relative to the control at 25 Mg/ha and 50 Mg/ha compost and 25 Mg/ha compost + 40 lb N/ha feather meal.
- The readily mineralizable carbon at 50 Mg/ha was significantly higher than in chicken manure and feather meal treated plots. Although no difference was observed between the chicken manure and feather meal plots and the other levels of compost addition.
- No difference was found for the dehydrogenase enzyme activity among the treatments except between the control and 50 Mg/ha compost.
- The total organic carbon and total nitrogen were all highest at 50 Mg/ha compost.

Conclusions

- The increase in enzyme activities suggest that compost addition stimulated soil microbial activities, soil organic carbon and nitrogen in the 0-10 cm depth.
- The addition of 40 lb N in feather meal to the compost did not significantly affect any of the soil properties that were analysed.
- The greatest compost effect was observed at the 50 Mg/ha application rate.

References

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