Composting Effects on Intensively Cultivated Low Organic Matter Soils in Southeast Idaho

G.E. Woodward[1], J.D. Williams[1], B.D. Willis[1], and B.G. Hopkins[2]
[1]Brigham Young University-Idaho, Rexburg, ID and [2]Brigham Young University, Provo, UT

Introduction

- Long term cultivation of soils reduces the amount of organic matter (OM) resulting in lower soil productivity (Balesdent et al., 2000).
- Studies have shown that compost additions have increased soil OM in cultivated soils (Porter et al., 1999).
- Increased OM improves:
  - Soil structure for rooting and water infiltration (Tester, 1990).
  - Water holding capacity to avoid drought stress (Tester, 1990).
  - Soil fertility from mineralization of composting materials.
  - Yield and quality for all crops in a rotation (Porter et al., 1999).
- **Objectives of this study were:**
  - Compare soil OM, total carbon (C), total nitrogen (N), and fertility of uncultivated (native) soils and intensively cultivated (plot) soils.
  - Compare yields and yield quality of composted and non-composted (control) treatments.

Materials and Methods

- Plot and native soils were a Blackfoot silt loam (BSL; Fine-loamy, mixed, frigid Fluvaquentic Haploxeroll) and a Pocatello variant (PV; Coarse-silty, mixed, frigid Typic Xerothents).
- Soil samples for native and plot soils were taken to a depth of 15 cm in the spring before planting.
- Native soil samples were taken from areas that had never been cultivated.
- Crop rotation for the compost study was a 4 year rotation of wheat-wheat-alfalfa-potatoes.
- Compost treatments consisted of composted steer feedlot manure at a rate of 6.7 Mg ha^{-1} for wheat and alfalfa and 11.2 Mg ha^{-1} for potatoes.
- Soils were tested for OM, total N, total C, organic C (without $CaCO_3$), nitrate (NO_3-N), and phosphorus (P).
- Yields were calculated using standard moisture levels for wheat and alfalfa (135 and 120 g kg^{-1}, respectively) and total weight for potatoes.
- ANOVA was performed using Excel 2007 Analysis Toolpak.

Tables

Table 1. Organic matter (OM), total Carbon (C), organic C, total nitrogen (N), C:N ratio, nitrate ($N0_3$-N), and phosphorus (Olsen-P) for the Blackfoot silt loam (BSL), Pocatello variant (PV), and plots (n = 40).

Soil	OM	Total C	Organic C	Total N	C:N	NO_3-N	Olsen-P
	g kg^{-1}					kg ha^{-1}	
BSL	46.4	26.4	25.0	1.54	16.2:1	63	87
PV	33.9	20.7	12.5	1.02	12.3:1	28	29
BSL-PV†	43.3	25.0	21.9	1.41	15.2:1	54	73
Plots	19.3	9.5	6.4	0.59	11.8:1	35	88

†Calculated as a weighted average based on percent of BSL and PV soils in the plot area (75% BSL and 25% PV).

Table 2. Comparison of wheat, alfalfa, and potato yield data between the control and composted treatments.

Treatment	Wheat‡	Alfalfa	Potatoes
		Mg ha^{-1}	
Control (mean)	4.36	6.71	22.6
Compost (mean)	4.50	6.19	22.7
Control x Compost	NS§	NS	NS

‡Wheat data were combined for both wheat rotations, because it is the first year of the study.
§NS, not significantly different at an alpha = 0.05.

Results and Discussion

Native Soils vs. Plot Soils

- Native soils had 15 - 27 g kg^{-1} more OM than the plot OM average (Table 1) which is a result of 75+ years of cultivation.
- Total C, Organic C, and Total N were higher in the native soils than the plot soils (Table 1) which suggest that the native soils are more productive, fertile, and healthy than the cultivated plot soils.
- Nitrate and P levels where similar among soils except BSL had higher NO_3-N levels and PV had lower P levels. High P levels for the plot soils was expected because of a history of heavy P fertilization (Table 1).
- Native soils had a greater C:N ratio than the cultivated plot soils (Table 1), but the C:N ratios for all soils suggested net N mineralization.

Compost vs. Control Treatments

- No significant yield differences were observed between the control and compost treatments (Table 2).
- Studies have shown that composting may take 3 - 5 years to show yield and yield quality differences (Singer et al., 2004; Porter et al., 1999)
- Yield data were related to preseason NO_3-N samples suggesting residual N and past management may be influencing our results (data not shown).

Conclusion

- Cultivated plot soils have less OM than surrounding native soils.
- Composting cultivated soils has potential to improve soil productivity by increasing soil OM content which will improve soil structure and fertility.

References and Acknowledgements

- Balesdent, J. C. Chenu, and M. Balabane. 2000. Relationship of soil organic matter dynamics to physical properties and tillage. Soil Tillage & Research 53:215-230.
- Porter, G.A., G.B. Opena, W.B. Bradbury, J.C. McBurnie, and J.A. Sisson. 1999. Soil management and supplemental irrigation effects on potato: 1. Soil properties, tuber yield, and quality. Agron. J. 91:416-425.
- Singer, J.W. K.A. Kohler, M. Liebman, T.L. Richard, C.A. Cambadella, and D.D. Buhler. 2004. Tillage and compost affect of corn, soybean, and wheat and soil fertility. Agron. J. 96:531-537.
- Tester, C.F. 1990. Organic amendment effects on physical and chemical properties of a sandy soil. Soil Sci. Soc. Am. J. 54::827-831.
- We thank BYU-Idaho student research fund for funding this research, and Bruce Webb and BYU soil analysis lab staff for their help.