Spent mushroom compost effect on aggregate stability and percent organic carbon on low organic matter tillage soils

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Introduction

Irish mushroom production has an estimated produce value of €130 m per annum (Anon., 2002). Consequently, 295,000 tonnes of its by-product known as 'spent mushroom compost' (SMC) is generated annually and its safe utilisation presents environmental problems. Substances high in organic matter such as SMC potentially improve the physical structure of the soil. Soil aggregate stability is widely used to measure changes in soil structure. The aim of this study was to assess the effect of various application rates of SMC on soil aggregate stability and organic carbon (%) of ten tillage soils in Ireland.

Materials and Methods

The Irish Sugar Company identified ten problematic soils and using these, together with a well-structured soil and structureless subsoil a pot trial was initiated. Approximately 1kg of each soil was put in each pot. There were a total of 480 pots in the experiment as follows: there were 2 compost types, (fresh and composted SMC) by 4 application rates (0, 50, 100 and 200t/ha) by 5 replications by 12 soils. Composted SMC was produced by placing fresh SMC in an in-vessel composting system for a period of 40 days. The material recovered was dark in appearance, had a light crumbly structure and was odourless. Following incorporation of the composts into the soils the pots were placed on a heated glasshouse bench from October 2001 to February 2002.

Aggregate stability, organic carbon % (OC) and a number of other parameters were determined. Aggregate stability was measured on 4.75-2.36 mm aggregates (method of Le Bissonnais, 1996). This method distinguished between various breakdown mechanisms such as slaking due to fast wetting (treatment I, fast), microcracking due to slow wetting (treatment II, slow) and mechanical breakdown of wet aggregates (treatment III, stir). The stability for each breakdown mechanism was expressed using the mean weight diameter (MWD), which is the sum of the mass fraction of soil remaining on each sieve after sieving multiplied by the mean aperture of the adjacent meshes. OC% was estimated by the Walkey-Black dichromate method. Results were analysed by one-way ANOVA and related t-tests. Simple correlation analyses were also employed.

Results and Discussion

Aggregate stability varied greatly amongst soils and treatments. The higher the MWD value the greater the aggregate stability of the tested soil (Le Bissonnais, 1996). From the mean of the three breakdown mechanism treatments, soils 6 and 7 had the lowest aggregate stability, soil 11 had the greatest and the remaining soils had varying intermediate levels of aggregation. The MWD values indicated that aggregate stability decreased in the order of slow wetting > stirring after pre-wetting > fast wetting treatment ($P<0.05$). Results for treatment I fast, showed control soils ranged from 0.31 to 1.71 mm for soils 7 and 11 respectively, which suggest that different soil properties affect breakdown process. The fragments resulting from slaking are mainly micro-aggregates, and they increase in size with increasing clay content as described by Le Bissonnais (1996). The effect of application rate on treatment I fast, was significantly higher ($P<0.05$) for all application rates of SMC than the control. Likewise, in treatments II slow and III stir, values were significantly higher ($P<0.05$) in amended soils than control soils. The effect of type of SMC (fresh vs composted) application was analysed by related t-tests. Higher ($P<0.05$) aggregate stability values for treatments I fast and III stir were obtained in soils amended with fresh SMC than composted. It suggests that some components of the organic carbon pool are more actively involved in stabilizing aggregates than others, as also noted by Perfect and Kay (1990).

The effect of SMC on mean soil OC% was statistically significant ($P<0.05$) for all application rates with values of 1.68, 1.81, 1.94 and 2.17 recorded for the control, 50, 100 and 200t/ha. Employing related t-tests, the type of SMC had no significant effect on OC% measured.

Significant correlations between MWD and organic carbon exist for all breakdown mechanisms, treatment I fast, $r^2=0.62$: $P<0.05$, treatment II slow, $r^2=0.54$: $P<0.05$, and treatment III stir $r^2=0.46$: $P<0.05$. The fast wetting treatment had the highest correlation coefficient (Fig. 1).

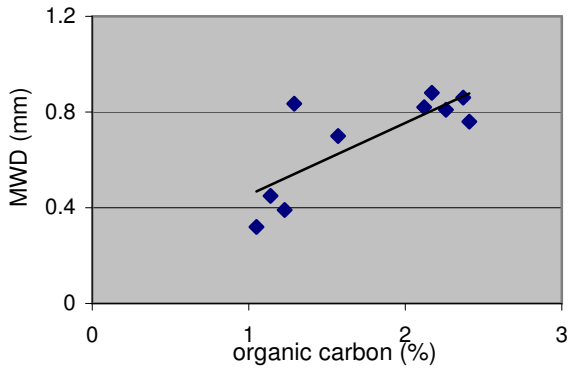

Fig 1. Effect of organic carbon on aggregate stability, fast wetting ($r^2=0.62$; $P<0.05$).

Conclusion

Spent mushroom compost, both fresh and composted, increased the aggregate stability of the twelve soils over the three breakdown mechanism treatment due to a positive interaction between aggregate stability and organic matter status.

References

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