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ScienceDirect
Bioresource Technology 99 (2008) 411–418
BIORESOURCE TECHNOLOGY

Composition variability of spent mushroom compost in Ireland

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Received 10 July 2006; received in revised form 1 December 2006; accepted 1 December 2006
Available online 15 February 2007

Abstract

Spent mushroom compost (SMC) has proven to be an attractive material for improving soil structure in tilled soils and increasing dry matter production in grassland soils, owing to its high organic matter content and availability of essential plant nutrients. Because of this, it is important to identify the variability in composition of SMC in order to evaluate its merit as a fertilizer/soil conditioner. For this reason, a study was carried out involving the analysis of SMC samples obtained from five mushroom growers using compost from each of the 13 mushroom composting yards currently operating in both Northern Ireland (5 yd) and the Republic of Ireland (8 yd). The selected parameters measured include dry matter, organic matter, total N, P and K, C/N ratio; plant-available P and K, pH, EC, total Ca, Mg, Na, Cu, Zn, Fe, Mn, Cd, Cr, Ni, Pb; and cellulose, hemicellulose and lignin constituents. Yield of mushroom data were also collected from the selected growers. There were significant differences ($P < 0.05$) within two compost production yards for some parameters, therefore, for the most part, the uniformity of SMC within each yard is relatively consistent. However, significant differences ($P < 0.05$) were evident when comparing SMC obtained from growers supplied with compost from Northern Ireland and the Republic of Ireland independently, particularly among total and available phosphorus and potassium values. The results obtained show that, while SMC has fertilizer merit, its variability of composition must be taken into ac1count when assessing this value. The variability of composition is also of particular interest in the context of recent emphasis on plant nutrient management in agriculture.

Keywords: Spent mushroom compost; Composition; Variability

1. Introduction

Spent mushroom compost (SMC) is becoming available in increasing quantities with the Irish mushroom production industry producing an estimated 295,000 ton of SMC annually (Anon, 2001) a fact that poses a great environmental challenge in terms of its effective management. It is generally acknowledged that SMC is a valuable material for improving soil structure in tilled soils owing to its highly organic nature (Maher et al., 2000 amongst others) and increasing dry matter production on grassland soils (Mullen and McMahon, 2001). As 72% of all SMC in Ireland is applied to land (Maher et al., 2000) it is therefore imperative that systematic analysis be carried out on its composition, in order to evaluate its merit as a fertilizer, so that it can be applied to land in a rational and informed manner. The main objectives of this study were to identify the differences in nutrient composition of SMC in Ireland, in relation to selected physical and chemical parameters and to evaluate its overall potential when utilized as a fertilizer or soil conditioner.

1.1. Mushroom farming system in Ireland

The manufacture of mushroom compost in Ireland generally involves two stages, the first of which is performed outdoors or under a roof, in large heaps, where the raw materials are moistened and thoroughly mixed for up to 12 days. Raw materials are moistened in order to ensure that the different components are mixed uniformly, and

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doi:10.1016/j.biortech.2006.12.012

more importantly, to encourage microbial activity. However, this system may be susceptible to changes in the ambient temperature, especially outdoors. After this crucial pre-treatment phase, these stacks are placed in long windrows under cover, for 7–8 days and are mechanically aerated. These stacks heat up quickly and sometimes may reach temperatures as high as 80 °C (Maher et al., 1993).

Phase two of this composting process is carried out in purpose built structures, which are generally well-insulated plastic tunnels with slatted floors. The environment is carefully controlled, where the compost temperature is allowed to rise to 57–60 °C for up to 12 h and subsequently reduced by the influx of air from the air plenum below the compost. This pasteurisation stage is essential for the control of diseases and unwanted organisms. This phase is continued until the temperature has dropped to around 30 °C and the ammonium levels are below 10 ppm as at higher concentrations the ammonium would be toxic to the mushroom (Maher et al., 1993).

The compost is then mixed with spawn, which is a monoculture of mushroom mycelium on cooked and sterilised grain and then placed into plastic bags, or more economically on Dutch shelves which are then distributed to mushroom farms around the area. After about two weeks the compost is completely colonized by the mycelium and the final step in the preparation of the compost involves covering the mycelium with a layer of casing. This layer generally consists of peat and calcium carbonate, which initiates the formation of pinheads in a vertical direction. Three weeks after casing, the first mushrooms can be harvested. The used compost is sometimes sterilised for 12 h at 70 °C or disinfected. This sterilised mixture of compost and casing soil is further available for beneficial use in agriculture and horticulture and is known as spent mushroom compost (Maher et al., 1993).

2. Methods

Spent mushroom compost was collected from mushroom production units supplied with compost from each of the thirteen composting yards in Northern Ireland (5 yd) and the Republic of Ireland (8 yd), where the compost was initially manufactured from the raw materials wheaten straw, gypsum, poultry litter and/or horse manure, with cottonseed meal and mushroom spawn also supplemented. One bag of SMC was chosen randomly from each of five production units (growers) supplied by each yard and all of these bags originated from the same compost cycle and had produced three flushes of mushrooms. The total number of bags of SMC collected and analysed was 63 as only four SMC samples could be obtained from each of two production units.

Bags were cylindrical in shape and measured approximately 60 cm in diameter and 45 cm in height, about 22 kg in weight and included the casing layer. Segments of compost, 20 cm wide, extending from the surface to the bottom of the bag were cut along the diameter of each bag so as to achieve a representative sub-sample as illustrated in Fig. 1 and these were subsequently removed for analysis. These were mixed thoroughly by hand and the dry matter (DM) content determined on duplicate sub-samples by drying in a forced draught oven at 105 °C. The remainder of each segment was air dried for one week and shredded using a JCB SS2400 shredder (Argos, Ireland). Representative sub-samples of the shredded material were then finely pulverized using a coffee grinder, which allowed the material to pass through small-aperture sieves as required by some of the analytical procedures.

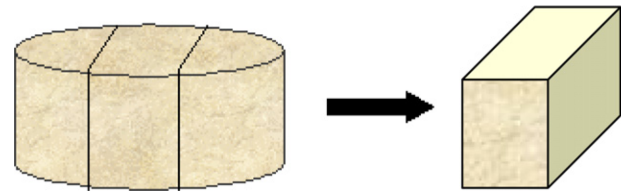

Fig. 1. Sub sample of SMC module.

Despite the fact that no standard analytical methods of compost or SMC analysis exist, methodologies chosen for this study were similar to those employed for analysis of SMC and dry plant material. No comparisons were made where different extraction methods were employed or where incomparable units were reported.

2.1. Plant nutrient and physical analysis

Twenty-five parameters were measured on the 63 samples and, in addition, associated mushroom yield data were obtained from each grower. Organic matter (OM) content was determined following overnight ashing at 500 °C (Gallenkamp muffle furnace). pH values were obtained in a 2:1 ratio with distilled water, using a Jenway 3010 pH meter in accordance with Hendershot et al. (1993) while the electrical conductivity (EC) of the composts was determined using a 5:1 ratio with deionised water, as per Bower and Wilcox (1965) using a Jenway 4200 portable conductivity meter.

Total phosphorus was measured colorimetrically by UV spectrophotometry (UV Spect 2000) while total potassium, calcium, magnesium and sodium levels were analysed by atomic absorption spectrophotometry (AAS) (Varian, 1989) using an air-acetylene flame. Filtrates for both phosphorus and total cations were obtained as per Rowell (1994). Plant-available soil phosphorus and potassium levels were also determined using AA spectrophotometry, following extraction with Morgan's solution (Byrne, 1979), which is routinely used for agricultural analysis in Ireland.

Total nitrogen was determined using the Kjeldahl method (AOAC, 1995) and the C/N ratio was calculated from this value along with the associated organic matter value, on the hypothesis that organic matter contains 58% carbon (Haug, 1993). The acid detergent fibre