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THE USE OF SPENT MUSHROOM SUBSTRATE OF *L. SUBNUDUS* BERK AS A SOIL CONDITIONER FOR VEGETABLES

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ABSTRACT
The effects of spent mushroom substrate on the vegetative growth and yields of cowpea and tomato were determined. Autoclaved and unautoclaved spent mushroom substrates, mixed with loamy soil in ratio 1:9 were utilized with both composted and uncomposted spent mushroom substrates. Composted spent mushroom substrate mixed with loamy soil produced greater vegetative growth and yields of cowpea and tomato than uncomposted spent mushroom substrate, which in turn gave better results than loamy soil controls. Autoclaving was found to be unnecessary in sterilizing the spent substrate; loamy soil mixture as autoclaving caused biodegradation of some of the component nutrients, thus resulting in lower vegetative growth and yields of cowpea and tomato. Oven-drying only of the spent substrate; loamy soil mixture was found to confer enough sterilization.

Key words: Spent mushroom substrate, Lentinus subnudus, loamy soil, cowpea, tomato

INTRODUCTION

Mushrooms have created interest in man from early civilization. The Romans identified mushrooms as "food of the gods" and the Greeks believed that mushrooms provided strength for warriors in battles. The Pharaohs of Ancient Egypt prized mushrooms as a delicacy and plant of immortality and because of their delicious flavour, the Pharaohs of ancient Egypt decreed that no commoner could ever touch them (Daba, 2006).

Mushrooms have a unique texture and flavour that are not found in other food items and for hundred of years, mushrooms have been used medicinally, mainly in Latin America, Africa, Asia, Australia and Papua New Guinea (Kadiri *et al.,* 2003; Kadiri, 2005; Kadiri and Adegboye, 2006; Kadiri *et al.,* 2007). The Chinese have used dried mushrooms as diuretics and some mushroom species are currently being utilized as carcinostatic substances (Chihara et al., 1970; Chihara, 1989; Mizuno, et al., 1995; Daba, 1998; Wasser and Weis, 1999; Daba and Ezeronye, 2003).

Total mushroom production worldwide has increased more than 18 fold in 32 years, from about 350,000 metric tons in 1965 to about 6,160,800 metric tons in 1997 (Chang, 1999).

Bacteria and fungi are the key decomposers of earth's organic materials into organic matter or humus and without these powerful decomposers, the earth would have been completely covered with organic materials. Spent compost is the substrate left after harvesting mushroom fruit bodies and is also known as spent mushroom substrate (SMS) or spent mushroom compost (SMC). It contains lignocellulosic materials, hemicellulose, lignin, mushroom mycelial and products liberated into the compost by metabolic activities of the mycelia.

Addition of spent compost to agricultural or garden soil has been found to be an effective soil manure and conditioner and has been found to increase considerably the yield of some vegetable crops. Chang and Yau (1981) and Iwase et al. (2000) observed that spent compost of *Volvariella volvacea* on addition to soil increased the yield of tomatoes 7 fold and the yields of soybean lettuce and radish 2 fold each. Furthermore, they observed that addition of *Agaricus* spent compost to the soil produced greater yields of cabbage, cauliflower, beans and celery compared to addition of poultry manure to soil. Spent compost is believed to be a source of humus formation and humus is known to provide plants with micronutrients, improve soil aeration, soil – water holding capacity and contributes to maintenance of soil structure. The present study was carried out to evaluate the effect of spent compost of *Lentinus subnudus* Berk on yields of some vegetables, tomato and cowpea.

MATERIALS AND METHODS

Preparation of *L. subnudus* spent mushroom substrate. Moistened rice straw, rice bran and ground cassava peels were mixed in a ratio of 86:10:4 (W/W/W) and piled up. It was fermented for one week with watering and turning at intervals to avoid over-heating and to achieve equal watering. The compost was then packed in polypropylene bags, autoclaved at $121^{o}C$ for 30mins and inoculated with *L. subnudus* grain mother spawn under a sterile condition. The substrate was incubated at $27 \pm 2^{o}C$ and relative humidity of 60 – 70% until the substrate was fully colonized by the *L. subnudus* mycelium. This took about six weeks, and there were five replicates.

Uncomposted substrate in five replicates was prepared in a similar manner as above, with the exception that there was no one week fermentation in it. At six weeks of incubation, both the composted and uncomposted substrates were transferred to a fruiting chamber at 28 ± 2^{o}C and relative humidity of 80 ± 5%. Watering was done when necessary and 2 weeks later, the ensuing mushroom fruitbodies were harvested and the spent mushroom substrates were processed further for use as soil conditioner.

Utilization of spent mushroom substrate as soil conditioner. The composted and uncomposted spent mushroom substrates collected above were covered with polythene nylon and further fermented for five weeks. Thereafter, the fermented spent composted and uncomposted substrates were oven dried and used in the experiment below.

Field planting trial: portions of the spent oven-dried composted and uncomposted substrates were incorporated into treatment plots by missing them with loamy soil in ratio 1:9 and autoclaved. Other portions were also mixed with loamy soil in ration 1:9 but not autoclaved. These constituted the treatments while the controls consisted of autoclaved and unautoclaved oven-dried loamy soil. The treatment and control soils were thereafter packed separately into polythene bags and tomato and bean seeds planted into them singly.

At nine weeks after sowing, the ensuing plants were harvested in five replicates per treatment or control and growth and yield parameters of plant height, stem girth, number of leaves, total leaf area, fresh weight of pods/fruits, fresh weight of seeds and dry weight of whole plant determined.

Statistical analysis

Significant differences between means of treatment and control plants were determined using Least Significant Differences (LSD) at 5% probability.

RESULTS AND DISCUSSION

In general, spent mushroom substrate mixed with loamy soil produced significantly greater plant height, stem girth, no of leaves and total leaf area than only loamy soil for both cowpea and tomato (Table 1). Similar results of significantly increased fresh weight of pods or fruits or seeds and dry weight of whole plants were obtained for a mixture of spent mushroom substrate and loamy soil compared to loamy soil only used for the cultivation of cowpea and tomato (Tables 2 and 3).

Autoclaving of the spent mushroom substrate and loamy soil resulted in lower plant height, stem girth, no of leaves, total leaf area, fresh weight of pods, seeds or fruits and dry weight of whole plant for both cowpea and tomato (Tables 1, 2 and 3). This means that autoclaving of the spent mushroom substrate and loamy soil mixture resulted in biodegradation of some nutrients in the mixture. The implication of this is that autoclaving of the spent mushroom substrate and loamy soil mixture and the loamy soil control is not necessary. Oven-drying only of spent mushroom substrate and loamy soil mixture and the loamy soil control is enough in order to ensure sterility of the material.

Moreover, composted spent mushroom substrate tended to produce better results than uncomposted mushroom substrate (Tables 1, 2 and 3). This could be due to the fact that during the process of composting, nutrients are released into the compost (Kadiri, 2002a and 2002b). Harris (1992) had earlier reported that soil mushroom substrate application to a potato crop soil improved the moisture holding capacity of the soil and this resulted in increased plant uptake of nutrients. Maynards (1994) and Wang *et al.* (1994) similarly showed that vegetable production could be sustained using spent mushroom compost. The present findings are in line with those of Steward (1995) and Steward et al. (1997), who observed that spent mushroom substrate application to the soil resulted in increased yield of potato. In conclusion, spent mushroom substrate, which presently has no economic value, is strongly recommended for use as a soil conditioner in order to enhance the yield of vegetables.

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Table 1: Mean plant height (cm), stem girth (cm), number of leaves and total leaf area (cm^2) of *Vigna unguiculata* and *Lycopersicom esculentum* at 9 weeks after sowing

Treatment type	*Vigna unguiculata*				*Lycopersicon esculentum*			
	Plant height	Stem girth	No. of leaves	Total leaf area	Plant height	Stem girth	No. of leaves	Total leaf area
Spent unautoclaved oven-dried composted substrate & loamy soil (1:9)	66.10	2.56	41.40	1566.80	65.38	3.20	264.80	578.0
Spent autoclaved oven-dried composted substrate & loamy soil (1:9)	53.50	2.28	36.80	1506.50	58.86	2.54	244.40	480.0
Spent unautoclaved oven-dried uncomposted substrate & loamy soil (1:9)	56.76	2.52	38.40	1565.80	63.06	2.66	248.40	515.60
Spent autoclaved oven-dried uncomposted substrate & loamy soil (1:9)	47.64	2.34	33.80	1274.20	39.50	2.10	194.80	480.60
Autoclaved oven-dried loamy soil (control)	34.40	2.27	30.86	1058.00	36.14	1.86	96.00	314.68
Unautoclaved oven-dried loamy soil (control)	43.14	2.24	31.40	1190.20	38.40	1.98	98.40	351.00
Least significant difference (5%)	6.7	0.26	4.1	157.1	6.6	0.31	27.1	58.6

Table 2: Mean fresh weight of pods (g), fresh weight of seeds (g) and dry weight of whole plant (g) for *Vigna unguiculata* at 9 weeks after sowing

Treatment type	Fresh weight of pods per plant	Mean fresh weight of seeds per plant	Mean dry weight of whole plant
Spent unautoclaved oven-dried composted substrate & loamy soil (1:9)	17.30	16.26	12.31
Spent autoclaved oven-dried composted substrate & loamy soil (1:9)	13.60	12.86	10.04
Spent unautoclaved oven-dried uncomposted substrate & loamy soil (1:9)	13.90	14.84	11.88
Spent autoclaved oven-dried uncomposted substrate & loamy soil (1:9)	13.32	12.26	8.46
Autoclaved oven-dried loamy soil (control)	8.32	7.60	7.46
Unautoclaved oven-dried loamy soil (control)	10.18	9.48	8.32
Least significant difference (5%)	1.4	1.5	1.2

Table 3: Mean fresh weight of fruit (g) and dry weight of whole plant (g) for *L. esculentum* at 9 weeks after sowing

Treatment type	Mean fresh weight of fruits per plant	Mean dry weight of whole plant
Spent unautoclaved oven-dried composted substrate & loamy soil (1:9)	77.88	39.12
Spent autoclaved oven-dried composted substrate & loamy soil (1:9)	46.10	23.76
Spent unautoclaved oven-dried uncomposted substrate & loamy soil (1:9)	52.60	28.94
Spent autoclaved oven-dried uncomposted substrate & loamy soil (1:9)	38.52	19.90
Autoclaved oven-dried loamy soil (control)	25.80	12.04
Unautoclaved oven-dried loamy soil (control)	28.24	18.20
Least significant difference (5%)	7.8	4.1