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Pattern of Nitrogen Mineralization from Spent Mushroom Composts and Farm Yard Manure Amended Soil

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Abstract

The cumulative amounts of mineral N in control soil and organic amendments treated soil increased with increase in incubation period. Among organic amendments, WB-SMC accumulated higher amounts of mineral N in soil followed by FYM and Dhingari-SMC. The lower accumulation of mineral N under Dhingari-SMC treatment as compared to WB-SMC or FYM was presumably due to immobilization of native mineral N by increased soil micro-organism activity.
Key words : Nitrogen mineralization, Organic amendments, Soil, Spend mushroom composts, Farm yard manure.

Mineralization of nitrogen from organic amendment varies with N content and C : N ratio (1—3). Unlike mineral fertilizer, organic amendments undergo mineralization before N become available to growing crop. Variations in chemical composition of organic amendment affect the mineralization and N release pattern. Organic amendment consists of many complex compound and it is expected that no single characteristic will control N mineralization through out. Several other factors like organic-N content of amendment, temperature, soil composition, level of other nutrients also affect the mineralization rate of N from added organic substance. The amount of N mineralized was significantly positively correlated to total N content and negatively with C : N ratio (2, 4).

Mushroom compost/mushroom substrate for growing mushroom is an organic material made from a blend of natural products that can include straw bedded horse manure, poultry manure, wheat straw, paddy straw, brassica straw, field hay, crushed corn cobs, cotton seed hulls, cocoa bean hulls, gypsum and water. In addition to these bulk ingredients, composters add a variety of protein concentrates e.g. cotton seed meal, soybean meal to enhance the nitrogen content of the finished compost. It is formulated by adding N, P and K containing fertilizers and then composted under controlled conditions. The fungal mycelia derive their nutrition from this medium and produce the fruiting bodies. Three to four week later, the initial harvest (first break) occurs followed by two or three weekly breaks (flushes) of mushrooms that are harvested. When a farmer decides that input costs exceed the potential value of additional harvests or when an economical crop is no longer being produced, the mushroom compost/mushroom substrate become waste and declared "spent." Thus, spent mushroom compost is a waste product of the mushroom industry, which has traditionally been discarded as useless wastes, creating an environmental nuisance. In recent years, the world production of mushroom has increased dramatically (5). The annual production of mushrooms is estimated to be over 4.1 million tons world wide (6). Indian mushroom growers generate approximately 1.50 lakh tons of spent mushroom compost (SMC) each year. However, with the coming up of many new export-oriented high-tech farms in the next couple of years, these farms are likely to produce about 6.0 lakh tons of SMC annually as a waste product and of which Haryana alone would contribute about 35%. Mushroom growers all over the world are facing increasing pressure of environmental legislation, giving rise to the need for a more

Table 1. Physico-chemical properties of soil used in the study.

Properties	Value	Properties	Value
Sand	64.3	pH (1 : 2)	7.7
Silt	17.3	EC, dS/m (1 : 2)	1.2
Clay	18.4	Organic carbon (%)	0.6
Textural class	Sandy loam	CEC [Cmole (P^+)/ kg]	11.6
Taxonomy	Typic camborthids	Available-N (kg/ha)	116.00
Saturation (%)	39.0	Available-P (kg/ha)	15.50
Field capacity (%)	17.0	Available-K (kg/ha)	192.50

Table 2. Chemical composition of organic amendments used in the study.

Nutrients	WB-SMC	Dhingari-SMC	FYM
OC (%)	32.00	38.00	22.00
N (%)	1.84	0.78	1.20
P (%)	0.90	0.19	0.88
K (%)	2.19	1.24	1.92
Ca (%)	5.10	1.21	1.48
Mg (%)	2.38	1.26	1.48
Zn (mg/kg)	215.00	108.00	203.00
Cu (mg/kg)	179.00	118.00	153.00
Fe (mg/kg)	2200.00	1508.00	1800.00
Mn (mg/kg)	1439.00	1153.00	1226.00

viable solution for the disposal of SMC. At the same time, there is an increasing demand for organic residues and composts, which could provide a great potential outlet for spent mushroom compost generating more income for the mushroom growers (7) as it has the role of increasing the fertility of soils and productivity of crops (8).

Spent mushroom compost has been found to be a good reserve of plant nutrients with a C : N ratio of 16 : 1. These nutrients are made available in a phased manner contributing to substantial yields increase and nutrients uptake (9). The nutrient value varies with different sources of SMC. As spent mushroom compost contains considerable amounts of nutrients and is generally not phytotoxic. Thus, the utilization of this waste seems to be a promising way to improve soil physical, chemical and biological properties and increase nutrient resources for crop production (8). The suitability of organic amendments as source of N depends to a great extent on its mineralization of N in relation to crop demand. In SMC, most of the N is found in a stable organic form that must be mineralized by soil microbes before it is available for plant growth. Therefore, the present investigation is planned to study the nitrogen mineralization of SMCs and FYM in soil.

Methods

The bulk surface soil sample (0—15 cm) of sandy loam (Typic camborthids) was collected from the experimental area of the Department of Soil Science, CCS Haryana Agricultural University, Hisar. The physico-chemical properties of the soil are shown in Table 1. Organic amendments used in this study included white button spent mushroom compost (WB-SMC), Dhingari spent mushroom compost (Dhingari-SMC) and farm yard manure (FYM). WB-SMC refers to the compost previously used for cultivation of *Agaricus bisporus* and Dhingari-SMC refers to the compost previously used for cultivation of *Pleurotus* spp. The SMCs and FYM used in this study were collected from Mushroom Technology Laboratory and Live Stock Farm, CCS Haryana Agricultural University, Hisar, respectively. The SMCs and FYM were oven dried and ground to pass through 2 mm sieve and mixed thoroughly. The chemical analysis of the organic amendments used in this study is given in Table 2. Spent mushroom compost formulations given by CCS Haryana Agriculture University, Hisar are also presented in Table 3.

The experiment was conducted in a completely randomized design with three replications. The required amounts of organic amendments at 0.75% were added in 500 g sandy loam soil. After thorough mixing the soil and organic amendments, triplicate samples of (20 g) for each treatment and each incubation period were transferred to 125 ml wide mouth plastic bottles. The required amount of double distilled water was added to maintain moisture content at field capacity. A control treatment which received no organic amendments was also run. The plastic containers were covered with perforated para film to prevent any appreciable loss of moisture due to evaporation. The containers were incubated at 25 ±

Table 3. Spent mushroom compost formulations. *Formula given by CCS Haryana Agriculture University, Hisar).

	Components	Amount (kg)
1.	Wheat straw	300
	Wheat bran	30
	Gypsum	2.5
	Calcium ammonium nitrate	9
	Urea	3.5
	Murate of Potash	3
	Single super phosphate	3
	Molasses	5
2.	Wheat straw	300
	Chicken manure	60
	Wheat bran	7.5
	Gypsum	20
	Calcium ammonium nitrate	6
	Urea	2
	Murate of potash	2

1 C in a BOD incubator for 12 weeks and moisture content at field capacity was maintained throughout the incubation period with double distilled water by weighing the containers on alternate days. After each incubation period i.e. 1, 2, 3, 4, 5, 6, 7, 8, 10 and 12 weeks triplicate samples of each treatment were removed from the incubator and then extracted immediately with 2 M KCI solution for determination of mineral-N. The extracts were analyzed for mineral-N (NH^+_4-N and NO^-_3-N) by steam distillation (10).

Results and Discussion

The cumulative amounts of mineral-N in control and organic amendments treated soil increased with the increase in incubation period (Table 4). Among the organic amendments, WB-SMC accumulated higher amounts of mineral N in soil followed by FYM and Dhinghari-SMC with their respective values of 79.9, 76.5 and 50.8 mg/kg in soil after 12 weeks incubation. Higher accumulation of mineral N by WB-SMC than FYM may be attributed to its higher total N content. The lower accumulation of mineral N under Dhangari-SMC treatment (having wider C : N ratio value) compared to WB-SMC or FYM was presumably due to immobilization of N by increased soil micro-organism activity during decomposition (11, 12). Shields et al. (13) and Toor and Beri (14) found upto 98% immobilization of nitrogen into microbial biomass under wide C : N ratio treatment

Table 4. Cumulative amounts of mineral-N in soil treated with different organic amendments (mg/kg soil).

Incubation period (weeks)	Control soil	Organic amendments WB-SMC	Dhingari-SMC	FYM
1	30.4	44.0	24.6	43.2
2	34.6	53.2	30.4	52.0
3	37.7	60.4	33.4	58.9
4	40.7	66.1	37.2	64.3
5	43.6	69.0	39.0	67.0
6	46.4	71.8	42.8	69.5
7	48.8	74.1	44.2	71.4
8	50.4	76.2	47.1	73.2
10	51.6	78.1	49.0	74.9
12	52.5	79.9	50.8	76.5

Relatively large amounts of mineral N were obtained during first four weeks of incubation in control and organic amendments treated soil. In general the cumulative amounts of mineralized N increased in all the treatments but the magnitude of increase with successive incubation period decreased. Higher mineralizations during early period of incubation and gradually decreasing rates with time have also been reported by other investigators (15—19). Stanford (20) reported the existence of two general pools of organic-N. The flush of mineral N and corresponding high mineralization rates during the initial period of incubation were attributed to the decomposition of labile organic N. As the first pool (more labile organic N) disappears, the second pool of organic N predominates which is somewhat resistant to further rapid decomposition and contributes a small proportion of N-mineralization during short term incubation studies.

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