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Effect of Spent Mushroom Substrates (*Hypsozygous ulmarius*) on Growth of Finger Millet (*Eleusine coracana*)

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Paddy straw, ragi husk, ragi straw, groundnut shell, lawn grass and shredded paper were used as substrates for the cultivation of *Hypsozygous ulmarius* mushroom. After the cultivation of mushroom, the spent substrates application with NPK was used to know the effect on growth of finger millet. The green house experiment showed significantly higher microbial population *viz*., bacteria, fungi, actinomycetes, *Azotobacter*, phosphate solubilizers and Arbascular mycorrhiza spores. Use of *Hypsozygous ulmarius* mushroom spent ragi husk exhibited significantly higher growth in finger millet, which recorded significantly higher plant height (90.25 cm), total fresh weight (97.33 g/ plant), root dry weight (7.75 g/ plant), shoot dry weight (23.75 g/ plant) and total dry weight (31.25 g/ plant) followed by in *Hypsozygous ulmarius* mushroom spent paddy straw. Application of spent mushroom substrates to soil with recommended NPK enhances the growth of finger millet.

Key words: Paddy straw, mushroom, finger millet, spent substrates.

Mushrooms are the fruiting bodies of fungi belonging to basidiomycetes and ascomycetes. Spent mushroom substrate is the material remaining after a crop of mushroom which serves as source of nutrients to plants in the soil, helps to neutralize acidic soils, facilitates plant growth in barren areas and in some cases, adds organic matter (Yadav *et al*., 2001). The recomposted spent mushroom substrate has been found to be a good growing medium for majority of the vegetables and field crops and it has shown multifacet utilities in improving the yield and quality of the crop and management of the diseases. The other utilities of spent mushroom substrate are in vermicomposting, bioremediation and as organic-mineral fertilizer (Tewari, 2007).

Eleusine coracana (Linn.) Gaertn., called as Finger millet. Bird's foot, Nagli, Mandua in different regions, is one of the important millet crops of India. It belongs to the family Poaceae (Chalam and Venkateshwaralu, 1965). Finger millet commonly referred as ragi in Karnataka is one of the important millet crops of India. It is a staple food of many farming communities of southern Karnataka. In south India apart from grains for human consumption, straw is used to feed the cattle, the malted grains used as food for infants and it is recommended for diabetic patients. Now a day's finger millet is used to prepare some value added products like biscuits etc. The grain is nutritionally rich in protein, iron and calcium.

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MATERIALS AND METHODS

The glass house experiment was conducted in the Department of Agricultural Microbiology, University of Agricultural Sciences, GKVK, Bengaluru-65. The polythene cover with size (25 x 15 cm) were filled with *Hypsozygous ulmarius* mushroom spent paddy straw, lawn grass, ragi husk, ragi straw, groundnut shell and shredded paper in combination with Soil (3.0kg) + NPK (0.42g **:** 0.075g **:** 0.075g), for the growth of finger millet (GPU-28). In the treatments instead of compost mushroom spent substrates alone was used. Following treatment combinations were used.

a) T_1 – Soil (3.0 kg) + NPK (0.42g + 0.075g + 0.075g) + Compost (15g)
b) T_2 – Soil + NPK + *Hypsozygous ulmarius* mushroom spent paddy straw
c) T_3 - Soil + NPK + *Hypsozygous ulmarius* mushroom spent lawn grass
d) T_4 - Soil + NPK + *Hypsozygous ulmarius* mushroom spent ragi husk
e) T_5 - Soil + NPK + *Hypsozygous ulmarius* mushroom spent ragi straw
f) T_6 - Soil + NPK + *Hypsozygous ulmarius* mushroom spent groundnut shell
g) T_7 - Soil + NPK + *Hypsozygous ulmarius* mushroom spent shredded paper

Polythene covers were kept in green house, watering was done at regular intervals. Recommended fertilizers were added at the time of sowing.

Observations on crop growth

Growth attributes

Plant height (cm)

The plant height was measured in centimeters from the base of the plant to tip of the fully emerged leaves. It was recorded at 30, 60, 90 days after sowing (DAS).

Tillers per hill

The numbers of tillers per hill were counted at 30, 60 and 90 days after sowing and expressed as average number of tillers per hill.

Total fresh weight production

The plant samples were collected at 90 days after sowing then it was weighed and expressed in gram.

Total dry matter production

The plant samples were collected at 90 days after sowing were dried under shade for few days followed by oven drying at 70^0 C untill a constant weight was obtained. Then it was weighed and expressed in gram.

Shoot dry weight

The shoots were dried in shade and then oven dried at 70^0 C till a constant weight was obtained and expressed in gram.

Root dry weight

The roots were dried in shade and then oven dried at 70^0 C till a constant weight was obtained and expressed in gram.

Enumeration of microbial populations

The enumeration of total bacteria, fungi, actinomycetes, *Azotobacter* and P-solubilizers and AM fungal spores in the rhizosphere soil samples were carried out at sowing, tillering and ear head emergence stages of finger millet, by following the standard dilution plate count technique (Skinner, *et al*., 1952). Wet sieving methods for AM fungal spores were used for enumeration. The Petri plates were incubated at 30^0 C for three to six days and population was counted and expressed per unit dry weight of substrate.

RESULTS AND DISCUSSION

Significantly higher growth parameters (plant height, number of tillers per hill, total fresh weight, total dry weight, shoot dry weight, root dry weight) and microbial populations were found in T_4 (Soil:NPK:*HuSRH*) followed by T_2 (Soil:NPK:*HuSPS*). The lowest growth parameters and microbial population were found in T_7 (Soil:NPK:*HuSSP*) (Table 1, 2 and Table 3, 4).

The maximum growth parameters and microbial populations were recorded in the combination of spent ragi husk + NPK followed by spent paddy straw + NPK. This could be due to spent mushroom substrates contributing to higher organic matter and nutrients to the soil, which in turn, improved the growth parameters and microbial populations of finger millet.

Similar results were reported by Yadav *et al*. (2001) in maize by using *Agaricus bisporus* spent mushroom compost, Ahlawat *et al*. (2007) by using recomposted button mushroom spent substrate with wheat crop and Mallesha (2008) with *P. florida* spent substrate on tomato crop.

Table 1. Effect of *Hypsozygous ulmarius* spent substrates on plant height and number of tillers of finger millet

Substrates	Plant height (cm)			No. of tillers per hill	
	30 DAS	60 DAS	90 DAS	60 DAS	90 DAS
T_1 (Soil: NPK: Co)	33.75^{bc}	2.25^{bc}	3.00^{c}	51.50^{c}	81.00^{c}
T_2 (Soil: NPK: *HuSPS*)	35.25^{b}	3.50^{ab}	4.00^{b}	56.50^{ab}	87.50^{ab}
T_3 (Soil: NPK: *HuSLG*)	35.00^{b}	3.00^{b}	3.50^{bc}	55.25^{b}	86.25^{b}
T_4 (Soil: NPK: *HuSRH*)	37.00^{a}	4.00^{a}	5.00^{a}	59.00^{a}	90.25^{a}
T_5 (Soil: NPK: *HuSRS*)	34.75^{b}	2.75^{bc}	3.75^{bc}	54.75^{b}	85.75^{b}
T_6 (Soil: NPK: *HuSGS*)	34.25^{bc}	2.50^{bc}	3.25^{bc}	54.00^{bc}	84.25^{bc}
T_7 (Soil: NPK: *HuSSP*)	33.00^{c}	2.00^{c}	2.75^{c}	49.75^{c}	78.75^{c}
SEm ±	0.59	0.27	0.33	0.99	1.14
CD at 5 %	1.73	0.80	0.97	2.90	3.35

DAS: days after sowing, Co: Compost, *HuSPS*: *Hypsozygous ulmarius* spent paddy straw, *HuSLG*: *Hypsozygous ulmarius* spent lawn grass, *HuSRH*: *Hypsozygous ulmarius* spent ragi husk, *HuSRS*: *Hypsozygous ulmarius* spent ragi straw, *HuSGS*: *Hypsozygous ulmarius* spent groundnut shell, *HuSSP*: *Hypsozygous ulmarius* spent shredded paper.

Table 2. Effect of *Hypsozygous ulmarius* spent substrate on biomass of finger millet

Substrates	Total fresh weight (g/plant)	Total dry weight (g/plant)	Shoot dry weight (g) / plant	Root dry weight (g) / plant
T_1 (Soil: NPK: Co)	82.08^{c}	23.25^{cd}	18.75^{c}	4.50^{bc}
T_2 (Soil: NPK: *HuSPS*)	94.98^{ab}	29.00^{ab}	22.25^{ab}	6.75^{ab}
T_3 (Soil: NPK: *HuSLG*)	91.63^{b}	27.50^{b}	21.25^{b}	6.25^{ab}
T_4 (Soil: NPK: *HuSRH*)	97.33^{a}	31.25^{a}	23.75^{a}	7.75^{a}
T_5 (Soil: NPK: *HuSRS*)	88.75^{bc}	26.50^{bc}	20.50^{bc}	6.00^{b}
T_6 (Soil: NPK: *HuSGS*)	84.97^{c}	25.00^{c}	19.25^{c}	5.25^{bc}
T_7 (Soil: NPK: *HuSSP*)	78.23^{c}	21.50^{d}	16.75^{d}	3.75^{c}
SEm ±	1.49	0.77	0.65	0.54
CD at 5 %	4.39	2.27	1.92	1.60

Co: Compost, *HuSPS*: *Hypsozygous ulmarius* spent paddy straw, *HuSLG*: *Hypsozygous ulmarius* spent lawn grass, *HuSRH*: *Hypsozygous ulmarius* spent ragi husk, *HuSRS*: *Hypsozygous ulmarius* spent ragi straw, *HuSGS*: *Hypsozygous ulmarius* spent groundnut shell, *HuSSP*: *Hypsozygous ulmarius* spent shredded paper.

Table 3. Effect of *Hypsozygous ulmarius* spent substrates on bacteria, fungi, actinomycetes population during growth of finger millet

Treatments	At sowing			Tillering stage			Ear head emergence		
	Bacteria (10^5)	Fungi (10^3)	Actino-mycetes (10^4)	Bacteria (10^5)	Fungi (10^3)	Actino-mycetes (10^4)	Bacteria (10^5)	Fungi (10^3)	Actino-mycetes (10^4)
T_1 (Co)	7.00^{bc}	6.75^{bc}	4.50^{bc}	11.25^{c}	9.00^{bc}	5.75^{c}	17.25^{bc}	12.00^{c}	7.50^{b}
T_2 (*HuSPS*)	9.25^{ab}	8.50^{ab}	6.00^{ab}	13.75^{ab}	11.25^{ab}	8.25^{ab}	19.75^{ab}	14.50^{b}	9.00^{ab}
T_3 (*HuSLG*)	8.50^{ab}	8.00^{ab}	5.75^{ab}	13.00^{b}	11.00^{ab}	7.75^{ab}	19.00^{b}	13.75^{bc}	8.75^{b}
T_4 (*HuSRH*)	10.00^{a}	9.75^{a}	6.50^{a}	15.25^{a}	12.25^{a}	8.75^{a}	21.25^{a}	17.25^{a}	10.75^{a}
T_5 (*HuSRS*)	8.25^{ab}	7.75^{b}	5.25^{b}	12.50^{bc}	10.25^{b}	7.25^{b}	18.50^{b}	13.25^{bc}	8.25^{b}
T_6 (*HuSGS*)	7.75^{b}	7.00^{bc}	5.00^{bc}	12.00^{bc}	10.00^{bc}	6.75^{bc}	18.00^{bc}	13.00^{bc}	8.00^{b}
T_7 (*HuSSP*)	5.50^{c}	5.50^{c}	4.00^{c}	10.00^{c}	8.50^{c}	5.50^{c}	16.00^{c}	11.25^{c}	7.00^{b}
SEm ±	0.63	0.65	0.37	0.52	0.57	0.46	0.74	0.75	0.61
CD at 5 %	1.84	1.90	1.09	1.53	1.67	1.35	2.17	2.21	1.79

Co: Compost, *HuSPS*: *Hypsozygous ulmarius* spent paddy straw, *HuSLG*: *Hypsozygous ulmarius* spent lawn grass, *HuSRH*: *Hypsozygous ulmarius* spent ragi husk, *HuSRS*: *Hypsozygous ulmarius* spent ragi straw, *HuSGS*: *Hypsozygous ulmarius* spent groundnut shell, *HuSSP*: *Hypsozygous ulmarius* spent shredded paper.

Table 4. Effect of *Hypsozygous ulmarius* spent substrates on azotobacter, phosphate solibilizer, AM fungal spores population during growth of finger millet

Treatments	At sowing			Tillering stage			Ear head emergence		
	Azotobacter (10^4)	P.Solibilizer (10^4)	AM spores (No./50g of soil)	Azotobacter (10^4)	P.Solibilizer (10^4)	AM spores (No./50g of soil)	Azotobacter (10^4)	P.Solibilizer (10^4)	AM spores (No./50g of soil)
T_1 (Co)	7.00^{bc}	6.75^{bc}	4.50^{bc}	11.25^{c}	9.00^{bc}	5.75^{c}	17.25^{bc}	12.00^{c}	7.50^{b}
T_2 (*HuSPS*)	9.25^{ab}	8.50^{ab}	6.00^{ab}	13.75^{ab}	11.25^{ab}	8.25^{ab}	19.75^{ab}	14.50^{b}	9.00^{ab}
T_3 (*HuSLG*)	8.50^{ab}	8.00^{ab}	5.75^{ab}	13.00^{b}	11.00^{ab}	7.75^{ab}	19.00^{b}	13.75^{bc}	8.75^{b}
T_4 (*HuSRH*)	10.00^{a}	9.75^{a}	6.50^{a}	15.25^{a}	12.25^{a}	8.75^{a}	21.25^{a}	17.25^{a}	10.75^{a}
T_5 (*HuSRS*)	8.25^{ab}	7.75^{b}	5.25^{b}	12.50^{bc}	10.25^{b}	7.25^{b}	18.50^{b}	13.25^{bc}	8.25^{b}
T_6 (*HuSGS*)	7.75^{b}	7.00^{bc}	5.00^{bc}	12.00^{bc}	10.00^{bc}	6.75^{bc}	18.00^{bc}	13.00^{bc}	8.00^{b}
T_7 (*HuSSP*)	5.50^{c}	5.50^{c}	4.00^{c}	10.00^{c}	8.50^{c}	5.50^{c}	16.00^{c}	11.25^{c}	7.00^{b}
SEm ±	0.63	0.65	0.37	0.52	0.57	0.46	0.74	0.75	0.61
CD at 5 %	1.84	1.90	1.09	1.53	1.67	1.35	2.17	2.21	1.79

Co: Compost, *HuSPS*: *Hypsozygous ulmarius* spent paddy straw, *HuSLG*: *Hypsozygous ulmarius* spent lawn grass, *HuSRH*: *Hypsozygous ulmarius* spent ragi husk, *HuSRS*: *Hypsozygous ulmarius* spent ragi straw, *HuSGS*: *Hypsozygous ulmarius* spent groundnut shell, *HuSSP*: *Hypsozygous ulmarius* spent shredded paper.

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