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In this study six different combinations of casing materials were evaluated for their effect on yield of button mushrooms. Among the six combinations, FYM + garden soil was found to be the best followed by FYM and FYM+GS+VC in terms of duration of pinhead initiation, number of pinheads produced and total yield

Key words: *Agaricus bisporus*, casing, growth, yield

INTRODUCTION

The button mushroom *Agaricus bisporus* **(**Lange) is an most important mushroom of commercial significance in India which accounts for the 40% of the global share. Button mushroom is cultivated in North India during winter seasons due to the favorable conditions. The optimum temperature for mycelium growth is 22° - 25°C and 14^{O}-18^{O} C that for fruiting body formation 14^{O} -18^{O} C with increased relative humidity. Casing layer, aids in the transition of the mushroom from the vegetative stage to the reproductive one which is due to the presence of microorganism (Colauto *et al*. 2011). It protects the compost against desiccation and supports the mushroom against pests and diseases and provide physical support for the developing sporophores and exchange of gases for development and growth of mushrooms. (Colauto *et al.* 2011). The composition of casing mixture determines the quality in terms of texture, structure, high porosity, water holding capacity, C: N ratio, pH (7.2–8.2), free of disease and pests etc., which directly affect the mycelial growth and initiation of fruiting bodies (Kumar *et al*. 2012). Therefore, the present study was designed to assess the effects of casing materials for pinhead formation, number of fruiting bodies and the total yield of button mushroom.

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MATERIALS AND METHODS

Mushroom culture and spawn preparation

Pure culture of *A. biosporus* was obtained from Mushroom Research and Training Center, G. B. Pant University of Agri. & Tech., Pantnagar, Uttarakhnad. This was subcultured and maintained on PDA medium in a BOD incubator at 22 ± 2ºC. Experiments were conducted in the Mushroom Laboratory of Department of Plant Pathology, BAU. Sabour, Bihar during the year 2013-2014. Spawn of *A. bisporus* was prepared on wheat grains, *Triticum aestivum* (Linn.), according to the standard procedure given by Tandon *et al*. (2004). The grains were filled up to 2/3rd of 500 ml capacity wide mouthed glass bottles. The bottles were plugged with non absorbent cotton and covered with butter paper. These bottles were then sterilized at 121^{0}C (15 lbs pressure) for 60 minutes on two consecutive days and inoculated with 5 mm disc of a vigorously grown 7 days old culture of *A. bisporus*. Inoculated bottles were incubated at 28 ± 1^{O} C and shaking was done after 7 days. Entire grains were covered with fine mycelial growth after 15 days.

Compost preparations

The compost was prepared by long method of composting, first suggested by Mental *et al*. (1972). Composting was done on a cement floor

in the open condition. Raw materials used for composting were; wheat straw-1000 kg, urea-18 kg, wheat bran-150 kg, molasses-5 kg, potassium-4 kg, phosphorus- 6 kg and gypsum-35 kg. The raw materials used were thoroughly mixed and periodically turned eight times, turning at four days interval, after which the compost turned dark brown without the smell of ammonia and with 68-70% of moisture content.

Spawning

The spawn was mixed with compost @ 500 gm./ 100 kg of compost, filled in formalin sterilized wooden boxes (60 x 90 x 15 – 23 cm, accommodating 6 kg compost) and covered with formalin sterilized newspaper. These mushroom boxes were placed in a growing chamber, maintained at 22-28^{0} C with 90-95% RH. The paper over the beds, the floor and the walls were sprayed regularly with water to prevent drying and to maintain humidity up to 90-95%.

Preparation of casing materials and casing

Garden soil (G.S.) containing 12 - 18% organic C, decomposed farm yard manure (FYM) containing C:N ration 20:1, vermi compost (V.C.) containing 1.5% nitrogen, 1.0% phosphorus, 0.60% potash and 12 % organic carbon, vermi compost + garden soil (1:1), FYM + garden soil (1:1), FYM + garden soil + vermi compost (1:1:1) were used as casing materials and were sterilized in a horizontal autoclave at a temperature of 121°C for 20 minutes. Sterilized casing materials were spread over a well cleaned cemented floor, till it reached at room temperature.

After complete colonization of compost by the mushroom mycelium, the newspaper sheets spread over the compost were removed and the surface of compost was uniformly layered to a thickness of 3.5 cm by different casing materials used in the present study. Three replications were maintained for each treatment. Pin heads appeared between 16.81 - 21.04 days after casing and were ready for harvest after 8 to 9 d after pinhead initiation. Observations pertaining to the parameters including. i. time taken (in day) for pin head initiation, ii. number of pin heads at I, II, III and IV flushes, iii. number of fruiting bodies at I, II, III and IV flushes and iv. yield (in gm.) during the I, II, III and IV flushes.

Statistical method

All experimental data were statistically analyzed by using Factorial Completely Randomized Block Design. Significance of each data was analyzed by calculating critical difference at1% level.

RESULTS AND DISCUSSION

Influence of different casing materials on growth of A. bisporus

Complete colonization by mushroom mycelium took an average of 21.33 days. Pinhead initiation was found to be influenced by the casing materials used. Significant differences in pinhead initiation was observed in different combinations of casing materials used and ranged between 16.81 to 21.04 days. Out of the six combinations of casing materials used, minimum number of days for pinhead initiation was found in FYM+GS combination while maximum was observed in GS (Table 1). Tandon *et al.* (2006) reported same observation that, out of the 5 casing materials evaluated for yield in *C. indica*, FYM + loam soil (3:1 v/v) proved to be the best, followed by spent compost and loam soil.

Effect of different casing materials on the number of pinheads

Total number of pinhead initiation ranged from 176.25 to 141.26 per box (Table 1). Maximum number of pinheads (176.25/box) was observed in FYM + garden soil combination, followed by 157 pinheads/box in beds cased with FYM alone, and the number of pinheads in the garden soil was found to be the least (141.6). The maximum number of pinhead initiation of 43.81/box was produced in the beds cased with FYM + garden soil followed by FYM (40.59/box alone during first flush of cropping. Similarly, the maximum pinheads of 52.33/ box was recorded during the II flush in the beds cased with FYM + garden soil followed by FYM (46.56/box) alone. Rest of the casing materials were not found effective.

Effect of different casing materials on fruiting body and yield

The results indicate (Table 2) that casing material comprising FYM + garden soil produced maximum number of fruiting bodies (60.71/box) with a mean of fruit yield (708.85/unit), followed by casing the beds with FYM, producing a mean number of 54.44 fruiting bodies/ box with the mean yield of 615.95/

Table 1: Effect of casing materials on growth of pin head initiation of button mushroom (*Agaricus bisporus*)

Casing Materials	Days taken for pinhead initiations	No. of pinheads at different flushes				Total pinhead initiations
		Ist	IInd	IIIrd	IVth	
G.S.	21.04	33.56	41.26	43.48	22.96	141.26
FYM	18.33	40.59	46.56	45.15	25.00	157.3
V.C.	20.30	39.56	41.81	40.63	22.96	144.96
V.C. + G.S.	19.26	40.48	43.81	42.30	23.37	149.96
FYM + G.S.	16.81	43.81	52.33	53.30	26.81	176.25
FYM + G.S.+V.C.	19.11	42.85	43.44	43.81	23.22	153.32
CD(1%)	0.350	0.670	0.749	0.687	0.506	
SEm(±)	0.177	0.239	0.267	0.245	0.180	

G.S.= Garden soil, FYM = farm yard manure V.C.= vermi compost

Table 2: Effect of casing materials on growth of fruiting body of button mushroom (*Agaricus bisporus*)

Casing Materials	No. of fruiting body per box at different flushes				Total fruiting body	yield of mushroom (gm./box) at different flushes				Total yield
	Ist	IInd	IIIrd	IVth		Ist	IInd	IIIrd	IVth	
G.S.	13.89	14.93	11.81	6.85	47.48	179.56	173.51	142.94	64.48	560.49
FYM	15.19	16.74	14.70	7.81	54.44	181.89	190.53	163.43	80.11	615.96
V.C.	14.07	16.00	12.41	7.04	49.52	165.74	187.72	150.26	70.97	574.69
V.C. + G.S.	15.15	16.30	13.63	7.22	52.3	187.59	179.31	159.80	69.25	595.95
FYM + G.S.	17.85	18.78	16.04	8.04	60.71	210.37	221.69	196.34	80.45	708.85
FYM+G.S.+VC	15.56	16.30	13.70	7.48	53.04	190.98	188.04	157.05	71.52	607.59
CD(1%)	0.503	0.466	0.492	0.460		1.570	1.577	1.533	1.999	
SEm(±)	0.179	0.166	0.175	0.164		0.560	0.563	0.547	0.713	

box. However the minimum number of fruiting bodies and fruit yield was obtained from garden soil - 47.48/box and 560.49/box respectively. The cursory glance over the data indicates that, at the second flush we get maximum number of fruiting bodies (18.78/box) and highest fruit yield (221.69 g/box) with FYM + garden soil followed by Farm Yard Manure gave (16.74/box and 190.73 g/box respectively.

This finding is in conformity with the result of Singh and Shukla (2002), for *Agaricus bisporus* in which the highest yield was recorded with FYM + loam soil as the casing material. Highest fruiting body yield obtained in this experiment is in agreement with previous reports by Ram and Kumar (2010). Similar observation was also made by different workers who studied the suitability of various materials as casing substrates for the production of button mushrooms (Pandey *et al*. 2004; Dhar *et al*. 2006; Doshi *et al*. 2012; Taherzadeh and Jafarpour, 2013).

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