International Journal of Plant Protection | Volume 5 | Issue 1 | April, 2012 | 136-140

IJPP

Research Article

Evaluation of different casing materials and cacing in *Agaricus bisporus* cultivation

R.S. RATNOO* AND ANILA DOSHI

Department of Plant Pathology, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, UDAIPUR (RAJASTHAN) INDIA

ARITCLE INFO

Article Chronicle :
Received : *27.12.2011*
Revised : *20.01.2012*
Accepted : *11.03.2012*

Key words :
Casing,
Compost,
Button mushroom,
Fruit bodies

*Corresponding author: rs_ratnoo@yahoo.co.in

ABSTRACT

Five different casing materials prepared by making their ingredients in a definite proportions such as FYM -2 years old, spent mushroom compost (SMC) -2 years old, vermicompost, FYM with burnt rice husk and FYM soil + sand with spent compost in different combinations were tested in present investigation with a view to identify the suitable casing media for use in button mushroom cultivation. The different casing materials were analyzed for physico-chemical properties and evaluated in relation to mushroom yield/quality. Medium porosity, water holding capacity and pH 6.5 to 7.6 were found to promote good yield during the early phase of cropping. Casing mixture of FYM+spent compost + sand + soil (1:1:1:1) was found to be the best for getting higher yield (305.00 g/2 kg of compost) and number of fruit bodies (28.25) produced as compared to other casing mixture tried. CAC'ing with spawn run compost at the rate of 1.5 per cent was found to be the best by giving significantly higher yield (275.00 g/2 kg of compost) and number of fruit bodies (24.25) in comparison with 0.5, 1.0 and 2.0 per cent CAC'ing.

How to view point the article : Ratnoo, R.S. and Doshi, Anila (2012). Evaluation of different casing materials and cacing in *Agaricus bisporus* cultivation, India. *Internat. J. Plant Protec.*, **5**(1) : 136-140.

INTRODUCTION

After completion of spawn run mushroom bags/beds needs casing, however, it does not matter how well the mycelium has established in the compost. It will not produce any fruit bodies unless the compost surface is covered with casing layer. The process of applying casing layer on the surface of compost bag/bed is called casing. The casing layer promotes factors responsible for fruit body initiation.

An application of casing layer over spawn run compost is prerequisite to induce pinning in case for *A. bisporus* and *A. bitorquis*. The casing layer stimulates pinhead formation per unit air exchange between compost and air, prevents drying of compost and supports the growing mushroom on compost bed. Nevertheless, the choice of casing materials in any region mainly depends upon ready availability and cost of the materials.

Different materials are being used in different parts of the world (Garcha and Khanna, 1993; Wust and Beyer, 1996). In Europe, for example peat mass (low in pH) is used, after it is neutralized with chalk or limestone, as the casing medium. However, in several other countries, where peat is not available or too costly to import, then locally available organic material continues to be the popular casing material after steam pasteurized or chemically treated.

In India, several materials like spent compost + slaked lime+ sand, 4:1:1 v/v are used. Farm yard manure + loam soil, 1:1 v/v (Hayes and Shandilya, 1977) farm yard manure + 25 years old spent mushroom compost, 1:1 (Garcha, 1980), paper mulch + 2 years old spent compost, 3:1 v/v (Garcha and Sekhon, 1981) and burnt rice husk+ clay loam 3:1 v/v (Khanna *et al.,* 1995) have been reported to be used for casing in *A. bisporus* cultivation. Besides physical, chemical and biological factors determining the suitability of particular casing medium, cost and availability of materials are other important factors in acceptability by the mushroom growers in a region.

In Rajasthan, there are several material available which qualifies as the casing materials needs to be evaluated for better yields. The materials after extensive research has been developed into a material that matches the performance of peat.

MATERIALS AND METHODS

Five different casing mixtures were prepared by making their ingredients in a definite proportion *viz.*, (a) FYM (cowdung), (b) two years old spent compost of *A. bisporus* (c) Vermicompost +loam soil (1:1), (d) FYM+burnt rice husk (1:1) and (e) FYM +soil+sand+spent compost (1:1:1:1). Physical and chemical characteristics of all these casing materials were analysed and are given in the experimental results.

The physico-chemical properties were carried out such as bulk density, apparent density (Page *et al*., 1986) water holding capacity (Kneen Raczkowski method; Piper, 1950), pH (Richards, 1954), electrical conductivity by solubridge (Richards, 1954).

Crop raising:

The crops of *A. bisporus* were raised on compost prepared by long method of composting using wheat straw 1000 kg, urea- 18 kg, wheat bran- 150 kg and gypsum – 35 kg. The ready 2kg of compost was filled in polypropylene bags having size of 12" x 12". The spawning of strain MS-39 (S-11) of *A. bisporus* was done at the rate of 1.0 per cent, which was completed within 15 days. The casing materials were wetted before sterilization and then uniformly applied to a thickness of 4 cm on fully spawn run compost. After application of casing mixture the bags were kept in a cropping room for case run and subsequent cropping following a RBD design in tiers. The growing parameters maintained during spawn run and case run were 25^0C temperature, 95 per cent RH and high CO_2 concentration. The case run got completed within 10 days. The data were recorded for the total mushroom and average fruit body weight.

Application of casing layer :

The use of casing is important and prerequisite for pinhead formation. The layers of casing soil forms the environment in which the mycelium changes from vegetative phase to the reproductive phase, casing layer of 1.5 inch was applied on fully spawn run compost after pressing it and light irrigation with water and then casing was applied and immediate after application of casing layer water was sprayed over casing medium to maintain the moisture in the casing soil.

CAC'ing means addition of a certain amount of spawn to fully grown compost directly into the casing soil at the time of casing. CAC'ing is an additional practice to increase the yield of white button mushroom. Spawn run compost of MS-39 was added at different rates to casing *viz.,* 0.5, 1.0, 1.5 and 2.0 per cent of the weight of casing material along with control (without any addition of spawn run compost to casing).

RESULTS AND DISCUSSION

All the five materials were analyzed for pH, water holding capacity, electrical conductivity and bulk density. In chemical properties (Table 1) the FYM + burnt rice husk had lowest pH 7.2 and FYM alone had pH 7.3, whereas spent compost had pH 7.4 and FYM + soil sand + spent compost had pH 7.5 and vermicompost + loam soil had pH 8.1.

The electrical conductivity was lowest in spent compost (45 mmhos/cm) and 82 mmhos/cm in vermicompost + loam soil, 89 mmhos /cm in FYM + brunt rice husk, whereas, 115 mmhos/cm in the FYM and 122 mmhos/cm in the FYM + soil + sand + spent compost.

The bulk density was found lowest in case of FYM + burnt rice husk (0.52) and 0.59 in the FRM only. Whereas, 0.63 in vermicompost + loam soil and 0.72 was found in spent compost. Highest in the FYM + soil + sand+ spent compost (0.78).

The water holding capacity was found maximum (98.91) in vermicompost + loam soil followed by 73.1 FYM + brunt rice husk and 68.46 in the FYM + soil + sand +spent compost spent compost (66.86) whereas, lowest WHC was found in FYM only 63.41.

The casing plays an important role in the fruit bodies production. The yield potential of any compost largely depends on the type of casing material used. It is obvious that physical properties such as WHC, porosity, bulk density

Table 1 : Analysis of physical and chemical properties in casing materials

Sr. No.	Casing materials	pH	WHC (%)	EC (mmhos/cm)	Bulk density (g/cm^2)	Spawn run (days)	Case run (days)	First harvest (days)	Last harvest (days)
1.	FYM (a)	7.3	63.41	115	0.59	15	15	44	66
2.	Spent compost (2 years old) (b)	7.4	66.86	45	0.72	15	18	42	65
3.	Vermicompost + loam soil (1:1)(c)	8.1	98.91	82	0..63	15	17	39	71
4.	FYM+Burnt rice husk (1:1) (d)	7.2	73.10	89	0.52	15	14	41	67
5.	FYM+Soil+Sand+ Spent compost (1:1:1:1) (e)	7.5	68.46	122	0.78	20	13	42	66

and chemical properties such as pH and EC are considered important characteristics of casing material. Keeping this in view, these characteristics were analysed for different casing mixtures *viz.*, (a) FYM, (b) spent compost, (c) vermicompost + loam soil (1:1), (d) FYM+burnt rice husk (1:1), (e) FYM+soil+ sand+spent compost (1:1:1:1).

It is apparent from the data in the Table that casing mixtures a, b, c, d and e have their pH, WHC, porosity, bulk density and EC values near to acceptable level. The casing mixture 'c' has the highest WHC (98.91%) and pH (8.1). While casing mixture 'e' has the highest EC (122) and bulk density (0.78), followed by casing mixture in pH value e, b and a. The minimum pH is in 'd' casing mixture. Whereas, WHC followed as d, e and b. While EC followed as a, d and c and minimum in 'b' casing mixture. The bulk density followed as e, c, and minimum in 'd' (Table 1).

Therefore, all these casing mixtures were tested to know the effect on yield.

Results recorded in Table 2 clearly indicate that significantly maximum mushroom yield (305.00 g/2 kg compost) with 28.25 maximum average number of fruit bodies were obtained when casing mixture 'e' was used as casing medium. It was followed by mushroom yields 280.00, 267.50, 207.75 and 193.50 g/2kg compost when casing mixture d, c, b and a used as casing medium, respectively. These results are highly significant at 5 and 1 per cent levels of significance.

Maximum average number of fruit bodies were recorded in casing mixture 'e' (28.25) followed by c, d, b and a. Average individual fruit body weight was highest in 'b' (13.85g) followed by a (13.57g), d (11.08g), e (10.79g) and minimum in c (10.30g).

Thus, it can be concluded that the average biological efficiency was found highest in e (15.25%) followed by d (14.00), c (13.37), b (10.38) and minimum in a (9.67).

In *A. bisporus* fruit bodies appear only when mycelium impregnates the casing soil. It takes about one week. This period can be shortened by addition of a certain amount of spawn run compost directly into the casing soil at the time of casing, thus increasing the foci for spread of the mushroom mycelium and this technique is known as CAC'ing.

Keeping this in view, an experiment was conducted to know the effect of CAC'ing on mushroom yield and number of fruit bodies in which the compost run spawn is added to casing soil at four different concentrations *i.e.*, 0.5, 1.0, 1.5 and 2.0 per cent w/w.

It is evident from Table 1 that CAC'ing with spawn run compost showed significant increase in mushroom yield and number of fruit bodies in *A. bisporus*. In treatments with CAC'ing the fruit bodies started appearing 4-5 days earlier as compard to control where CAC'ing was not done. With increase in CAC'ing rate, the number of fruit bodies as well as total yield of *A. bisporus* also increased significantly. The maximum yield as well as number of fruit bodies were noticed in 1.5 per cent rate of CAC'ing, followed by 2.0, 1.0 and 0.5 per cent CAC'ing rate.

Thus, it can be concluded that all the treatments of CAC'ing were found superior to control. The highest mushroom yield (275.0 g/2kg compost) and average number of fruit bodies (24.25) were obtained from the treatment with 1.5 per cent spawn run compost which was significantly superior in comparison with the treatment with 2.0, 1.0 and 0.5 per cent with mushroom yield of 265.25, 223.75 and 210.00 g/ 2kg of compost (Table 3). These results are highly significant at 5 and 1 per cent levels of significance.

Maximum number of fruit bodies were produced in 2.0 per cent (25.00) followed by 1.5 per cent (24.25), 1.0 and 0.5 per cent (21.5)per 2 kg of compost (Table 3).

The average individual fruit body weight was observed to be significantly highest in case of treatment of CAC'ing 1.5 per cent with an average individual fruit body weight of 11.34g followed by 2.0 per cent (10.61g), 1.0 per cent (10.40g) and 0.5 per cent (9.76g).

The average biological efficiency was found highest in 1.5 per cent CAC'ing treatment with 13.75 per cent followed

Table 2 : Mushroom yield obtained with different casing materials and average number of fruit bodies and individual fruit body weight (g)

Sr. No.	Casing materials	Avg. mushroom yield*(g/2kg of compost)	Avg. No. of fruit bodies/ 2 kg of compost	Avg. individual fruit body wt.* (g)	Avg. biological efficiency (%)
1.	FYM (a)	193.50	14.25	13.57	9.67
2.	Spent compost (2 years old) (b)	207.75	15.00	13.85	10.38
3.	Vermicompost + loam soil (1:1)(c)	267.50	25.75	10.30	13.37
4.	FYM+Burnt rice husk (1:1) (d)	280.00	25.25	11.08	14.00
5.	FYM+Soil+Sand+ Spent compost (1:1:1:1) (e)	305.00	28.25	10.79	15.25
	S.E.±	11.58	1.54		
	C.D. (P=0.05)	34.90	465		
	C.D. (P=0.01)	48.26	6.44		
	CV (%)	9.24	14.23		

Table 3 : Effect of CAC'ing# on yield and number of fruit bodies of *A. bisporus*

Sr. No.	CAC'ing rate w/w basis (%	Avg. mushroom yield*(g/2kg of compost)	Avg. no. of fruit bodies/ 2 kg of compost	Avg. individual fruit body wt.* (g)	Avg. biological efficiency (%)
1.	0.5	210.00	21.50	9.76	10.50
2.	1.0	223.75	21.50	10.40	11.18
3.	1.5	275.00	24.25	11.34	13.75
4.	2.0	265.25	25.00	10.61	13.26
5.	Control (without CAC'ing)	196.25	19.75	9.93	9.81
	S.E.$\pm$	9.95	1.56		
	C.D. (P=0.05)	29.98	NS		
	C.D. (P=0.01)	41.46	NS		
	CV (%)	8.50	13.90		

* Average of four replications NS=Non-significant

by 2.0 per cent (13.26%), 1.0 per cent (11.18%) and in 0.5 per cent (10.50%) (Table 3).

The casing plays an important role in the fruit bodies production. The yield potential of any strain largely depends upon the type of casing material used. In the present investigation different kinds of casing mixtures *viz.,* (a) FYM, (b) Spent compost, (c) Vermicompost+loam soil, (d) FYM+burnt rice husk (1:1), (e) FYM+soil+sand+spent compost (1:1:1:1) were tried. The physical and chemical properties of these mixtures were also studied to explain the variation in their performance. It is an established fact that the bulk density of soil affects porosity and that porosity proportionately affects the water holding capacity, pH, electrical conducvitity and organic matter of casing soil. All these factors together determine the quality and utility of casing soils. Results of physio-chemical properties demonstrated that the higher the bulk density of casing material the lower lower the porosity. The FYM which has higher WHC, when added to spent compost in the ratio of 1:1 v/v improved the WHC while in reduction in ratio of FYM content in spent compost reduced the WHC of casing material.

Similar observations have been recorded in case of pH. It decreased when the ratio of spent compost was increased.

A significant correlation between the number of sporophores that were produced and the free pore space in the casing mixture was documented earlier by Flegg (1953). Similarly, space in the casing facilitates better air exchange and has a relation to moisture and also affects microbial build up particularly that of *Pseudomonads* (Nair and Hayes, 1974; Rainey *et al.,* 1986; Stainer *et al.,* 1966).

It was suggested that casing material must have a high water holding capacity (Flegg, 1953a). In the present investigation the casing material FYM alone and in combination had a better WHC, which resulted in good crop yield.

The acidity and alkalinity of the casing soil also affect the mushroom production. In present study pH ranged from 6.8 to 8.1. This pH range has also been reported by several workers (Atkins, 1972; Singh *et al.,* 2000). Thus, it is clear that a slight alkaline pH of FYM had a positive impact in enhancing the yield of mushroom in both crops.

Decrease in number of pinheads is almost proportional to increase in conductivity (Shandilya and Hayes, 1987). EC plays an important role in the production of *A. bisporus* but it is not the sole controlling factor. Productivity of *A. bisporus* is determined by the additive effect of various factors.

The physio-chemical properties of the casing mixtures and the average weight of mushrooms have a significant relationship with higher porosity and WHC as observed in FYM, FYM+spent compost.

The number and weight of fruit bodies was higher. In contrast, when porosity and bulk density were reduced as observed in spent compost alone, a higher number of fruit bodies with lower weight was recorded. These findings are in agreement with the results of various workers (Tschierpe and Sinden, 1964; Rainey *et al.,* 1986 and Singh *et al.,* 2000) who have reported the importance of air pores in the casing layer. They have also suggested that the number of mushrooms was larger with higher pore spares and that this has a positive effect on both, the yield and mean mushroom weight.

Maximum mushroom yield of 305.00 g/2 kg of compost with 28.25 fruit bodies were obtained when casing mixture, FYM+soil+sand+spent compost (1:1:1:1) was used as casing medium which was significantly superior to all other casing mixtures. The casing mixture 'c' has the highest WHC (98.91%) and pH (8.1) while casing mixture 'e' has the highest EC (122) and bulk density (0.78). Singh *et al.* (2000) found increase in yield with use of 2-3 years old spent compost.

CAC'ing or addition of spawn run compost in casing material is an improved technique to increase the yield and number of fruit bodies of mushrooms. In the present investigations, spawn run compost was added to casing material at different rates (0.50, 1.0, 1.5 and 2.0% w/w).

Significant increase in yield and number of fruit bodies were found in CAC'ing treatments as compared to control ones. Maximum yield was obtained when 1.5 per cent spawn run compost was added to the casing.

There was a significant increase in yield with the increase in the rate of CAC'ing. This practice resulted in early and uniform colonization of mushroom mycelium, early pinning and appearance of evenly distributed synchronized flushes. These results are in agreement of Gupta *et al.* (1989) who reported maximum mushroom yield of *A. bisporus* with 0.1 per cent CAC'ing rate. They further observed that this technique is responsible for uniform distribution of inoculum in casing which ensures that all mycelium on the bed surface is at the same stage of development and has an equal access to nutrients in compost.

Jadhav *et al.* (1997) studied the effect of spawned casing (CAC'ing) on yield of *A. bisporus* and the spawned casing treatment with grain spawn @ 100 g/m^2 recorded the highest mushroom yield.

REFERENCES

Atkins, F.C. (1972). *Mushroom growing today*. 6th Revised Edn. Republished by the Mushroom Growers Association.

Flegg, P.B. (1953). Pore space and related properties of casing materials. *Mush. Sci.,* **2:**149-161.

Flegg, P.B. (1953a). Casing soil. Report of Mushroom Research Station, 1952, pp. 10-19.

Garcha, H.S. (1980). Mushroom growing. Punjab Agricultural University, Ludhiana.

Garcha, H.S. and Sekhon, A. (1981). Evaluating casing materials for mushroom culture in Punjab. *Indian Mush. Sci.,* **11** : 411-417.

Garcha, H.S. and Khanna, P.K. (1993). In: Proceeding of biogas slurry utilization (Tarak Kote Ed.), Paragon Enterprises, New Delhi, India, pp. 131-134.

Gupta, Y., Vijay, B. and Sohi, H.S. (1989). Spawned casing : Effect on yield of *A. bisporus* (Lange) Sing. *Indian J. Mycol. Pl. Pathol.,* **19**:225-226.

Hayes, W.A. and Shandilya, T.R. (1977). Casing soil and compost substrates used in the artificial culture of *Agaricus bisporus* the cultivated mushroom. *Indian J. Mycol. Pl. Pathol.,* **7**:5-10.

Jadhav, S.W., Nevase, A.G., Pawar, N.B. and Patil, B.D. (1997). Effect of spawned casing (cacing) on yield of *Agaricus bisporus*. Abstract of paper presented in Indian Mushroom Conference, 10-12 Sept. 1997, Solan, 36.

Khanna, P.R., Phutela, Kapoor, S. and Garcha, H.S. (1995). Evaluation of casing materials for *Agaricus bisporus* cultivation. *Mushroom Res.*, **4**:65-68.

Nair, N.G. and Hayes, W.A. (1974). Suggested role of carbondioxide and oxygen in casing soil. pp.27-36. In : *The casing layer*. Ed. W.A. Hayes. Mushroom Growers Association, LONDON.

Page, A.L., Miller, R.H. and Keeney, D.R. (1986). *Methods of soil analysis*. Part-II. Agronomy No.9. Publication Amer. Sco. Agron. Soil Sci. Soc. amer. Wisconsin, USA.

Piper, C.S. (1950). *Soil and plant analysis*. Hans Publication, BOMBAY.

Rainey, P.B., Cole, A.L.J. and Sanderson, F.R. (1986). Air filled pores : An important component of the mushroom casing layer. p.501-514. In : Cultivating Edible Fungi. Ed. P.J. Wnest, D.J. Royse and R.B. Beelman, Elsevier, Amsterdam.

Richards, C.A. (1954). *Diagnosis and improvement of saline and alkali soils*. USDA Hand Book No.60.

Shandilya, T.R. and Hayes, W.A. (1987). *Indian Mush. Sci.,* **2**:10-15.

Singh, M., Singh, R.P. and Chanbe, H.S. (2000). Impact of physico-chemical properties of casing on yield of *A. bisporus* (Lange) Imbach. MRC, G.B. Pant Univ. of Agric. and Tech. Pantnagar, India.

Stainer, R.Y., Palleroni, N.J. and Doudoroff, M. (1966). *J. Gen. Microbiol.* **43**:159-271.

Tschierpe, R.J. and Sinden, J.W. (1964). Archiv for Mikrobiologie. 49:405-425.

Wust, J.P. and Beyer, M.P. (1996). In : *Mushroom biology and mushroom products* (DJ Royse Eds.), pp. 241-250.

****