Official publication of Pakistan Phytopathological Society
Pakistan Journal of Phytopathology
ISSN: 1019-763X (Print), 2305-0284 (Online)
http://www.pakps.com

EVALUATION OF VARIOUS CASING MATERIALS FOR ENHANCING GROWTH AND YIELD OF BUTTON MUSHROOM (*AGARICUS BISPORUS* LANGE)

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A B S T R A C T

Fruiting of Button mushroom (*Agaricus bisporus*) requires a casing layer that possesses specific physicochemical characteristics and hence, encourages the initiation of fruiting bodies. The experiment was conducted in order to investigate the agronomic performance of different casing materials including Swat peat, Abbottabad peat, spent mushroom compost, common soil and 45cm deep soil. Maximum pH, moisture and nitrogen contents were observed in Abbottabad peat-1. Besides this, time for appearance of fruiting bodies and accomplishment of oncoming harvesting stage was also lowest in peat-I. Yield attributes specifically number of mature fruiting bodies and their weight were also found significant in Abbottabad peat- 2. This research will be supportive for mushroom growers to choose the appropriate casing material for improving growth and yield of button mushroom.

Keywords: Button mushroom, casing materials, growth, yield.

INTRODUCTION

Mushroom cultivation exhibits an important biotechnological industry that has been notably extended all over the world in the last few decades (Ram and Kumar, 2010). Button mushroom (*Agaricus bisporus* L.) is most extensively cultivated and consumed mushroom throughout the world and includes about 40% of total world mushroom production (Giri and Prasad, 2007). Mushroom cultivation generally depends on the agricultural crop residues (Banik and Nandi, 2004). These crop resides are available in our country in abundance; principally used in cattle feeding and the remains are burnt or spread in the field. Consequently, mushrooms cultivation can keep pollution away from environment by recycling of agricultural wastes as they are well known for conversion of crop residues to protein food. For commercial production of mushrooms, casing soil is employed as top layer on spawn nourishing compost. This layer is essential for rapid transformation of mushroom mycelium from the vegetative stage to the reproductive stage; in which growing mycelium thickens to produce pinheads, which later develop into mushrooms (Sharma *et al.,* 1999). Substrates after treatment with water, chelating agents and pasteurization have potential as a casing material for mushroom production. For instance, use of farmyard manure (FYM) as a casing material for mushroom cultivation has been in vogue in Indian subcontinent because of its easy availability (De Gier, 2000). Peat is generally used and recommended as a good casing layer. It has unique water holding and structural properties (Colak, 2004). Most *Agaricus bisporus* strains have a requirement of separate casing layer that has specific physical, chemical and micro biological properties. Current composting formulations used for mushroom cultivation provide sufficient level of nutrients to obtain optimum yield potentials (Weil, 2003). A large number of agro-industrial wastes are used as casing material in *Agaricus bisporus* cultivation and attention has been given to the importance of biological properties of the casing layer (Fermor *et al*., 2000). Physico-chemical properties of casing materials were evaluated and casing sample farmyard manure (FYM) + spent mushroom substrate (SMS) had minimum bulk density while the casing sample FYM + vermiculite (VC) showed relatively

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higher bulk density (Choudhary *et al.,* 2009). Polat and coworkers (2008) investigated the effect of vegetable material on yield and production of button mushroom. He used seven vegetable materials. Neemazal-T and green neem oil gave better growth than other materials. He also concluded that these materials had a significant effect on Button mushroom yield. Addition of waste paper in various mixtures as casing soil did not completely replace peat material for mushroom production (Sassine *et al*., 2007). Use of plastic pots, wooden boxes, iron racks and plastic bags was assessed to ensure the colonization of mushroom compost. As a consequence, colonization of mushroom compost usually took 10-14 days in completion through using growing medium (Wood, 2005).Therefore this project has been designed to evaluate various casing materials for improving growth and yield of button mushroom.

MATERIAL AND METHODS

The experiment was carried out in Mushroom Laboratory, Institute of Horticultural Sciences, University of Agriculture, Faisalabad during 2010-2011.

Preparation of compost: The compost used in this study, was prepared in green house of University of Agriculture Faisalabad.

Mixing ingredients: The compost was prepared by using wheat straw, chicken manure, gypsum and urea with the concentrations as given in table 1., for this purpose wheat straw was spread over the ground and water was sprinkled for 3-4 days in order to remove waxy coating of the straw. All ingredients except gypsum mixed in wet wheat straw then stacked into pile about one meter height. After 3rd day, turning was given to compost. Turning procedure involves shuffling of bottom material with top material. Gypsum was added after 3rd and 4th turning in two equal doses. After 10-11th turning, the specific ammonia smell comes out and this is the sign of compost preparation. Compost should carry optimum moisture and nutrients availability that should support the mushroom growth for a longer period.

Table 1. Weightage of different ingredients used for compost formulation.

No.	Ingredients	Quantity (kg)
1	Wheat Straw	1000
2	Chicken Manure	400
3	Gypsum	28
4	Urea	07

Pasteurization: Pasteurization is considered as key step in mushroom cultivation. For this purpose, compost material was filled in white plastic bags and their mouth was tied with rubber band. After adding the water, these loosely tied bags were kept in iron drum on a stand of iron. After closing the drum heating of the drum was started up to a Temperature 58-60 °C and maintained for one hour. Then gas supply was stopped and lid of drum was opened to lower down the temperature. After cooling the bags, they were taken out of drum and material was filled in the plastic trays for the spawning.

Spawning: After pasteurization of compost, spawn was applied to the trays having size (3×7) inches length and 4 inches depth. Spawning was done at rate 0.5-0.75% according to the fresh weight of the compost. After spawning, it took two weeks to appear the mycelial growth. Casing was carried out as mycelial growth completed.

Casing treatment: Six different types of casing materials were used which were applied in 3-4 cm thickness over the compost. It is recommended it should not press firmly to avoid oxygen supply which is necessary for pinheads initiation. Then these trays were maintained at 22-25°C and 80-90% relative humidity to promote mycelial colonization under the casing layer. The mycelial growth in casing layer was established after 8-10 days, depending upon treatments applied. Casing materials used in this experiment include T_1 = Common soil, T_2 = Abbottabad peat 1, T_3 = Abbottabad peat 2, T_4 = Swat peat, T_5 = Spent mushroom compost (SMS), T_6 = 45cm deep soil.

Statistical Analysis: The experiment was laid out according to completely randomized design (CRD). Data of the experiment was subjected to statistical analysis of variance using the computer software MSTAT- C (Russel and Eisensmith, 1983). Treatment means were compared with the help of least significant difference (LSD) test at 5% probability level (Steel *et al*., 1997).

RESULTS AND DISCUSSION

Physical and chemical characteristics of casing materials

pH: pH is an important parameter for mushroom growth and yield. pH can contribute to maximum utilization of raw material and indeed results in greater biomass production of mushroom. Maximum pH was recorded with Abbottabad peat-1 (5) while Swat peat had been found to have lowest pH (3.50) (Fig.1).

Moisture contents: Highest moisture contents were recorded in Abbottabad peat-1 (55%), followed by Abbottabad peat-2 (50%), Swat peat (47%) and spent mushroom compost (46%). In contrast, common soil carried the lowest moisture contents (53%) (Fig. 2).

Nitrogen contents: High nitrogen contents significantly affect the mushroom growth and yield. To cope with its requirement, it was essential to add some additive nitrogen sources e.g. urea mostly used in compost preparation. Abbottabad peat-1 (1.47%) had the maximum nitrogen percentage which stood at par with Abbottabad peat-2 (1.35%). At the same time, lowest nitrogen percentage was found in 45 cm deep soil (0.75%) (Fig .3).

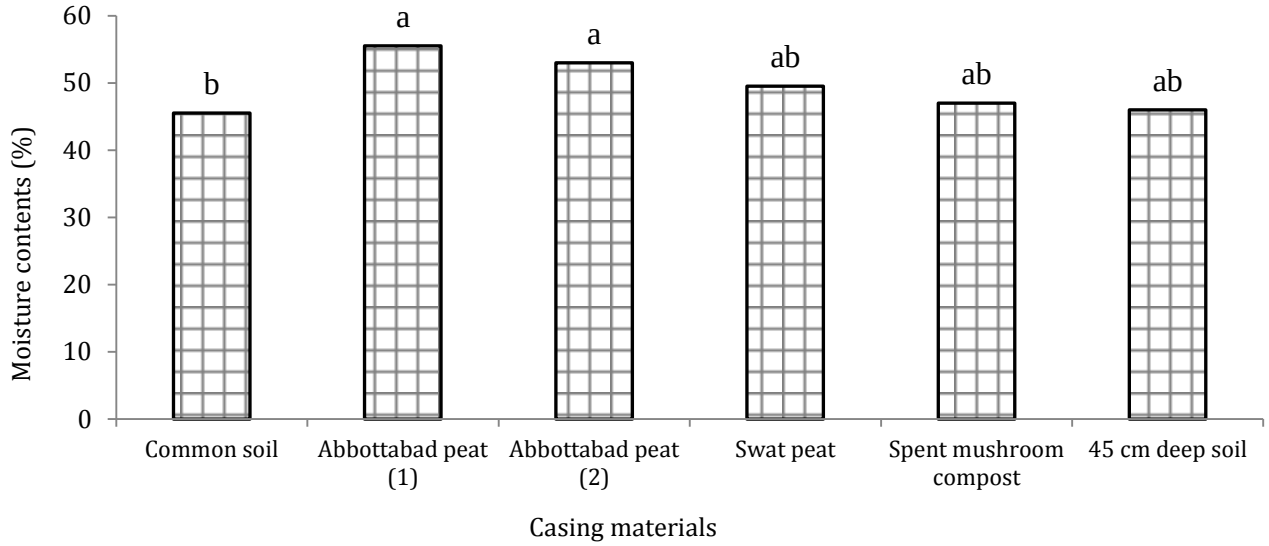

Figure 1. Determination of pH of casing materials to evaluate the growth of *A. Bisporus*. Treatments sharing same letter(s) do not differ significantly.

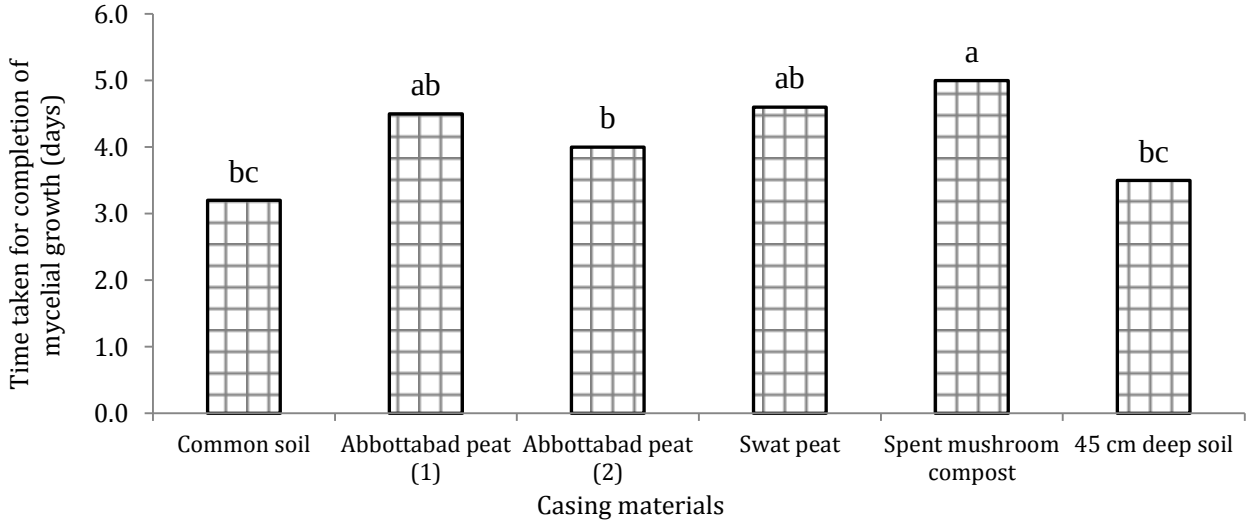

Figure 2. Determination of moisture contents of casing materials to evaluate the growth of *A. bisporus*. Treatments sharing same letter(s) do not differ significantly.

Time taken for completion of mycelial growth: Time for completion of mycelial growth was calculated after casing of substrates. Minimum time (3 days) was recorded in common soil and 45 cm deep soil followed by Abbottabad peat-1 and Swat peat. Whereas, maximum time (5 days) was taken by spent mushroom compost to complete *Agaricus bisporus* mycelial growth (Fig. 4).

Time taken after casing for appearance of fruiting bodies: Abbottabad peat-1, Abbotabad peat II and 45 cm deap soil are significantly at par in time taken for appearance of fruiting body in *Agaricus bisporus* followed by swat peat and common soil. Whereas spent mushroom compost used as casing material take maximum 5.25 days for appearance of fruiting bodies (Fig. 5).

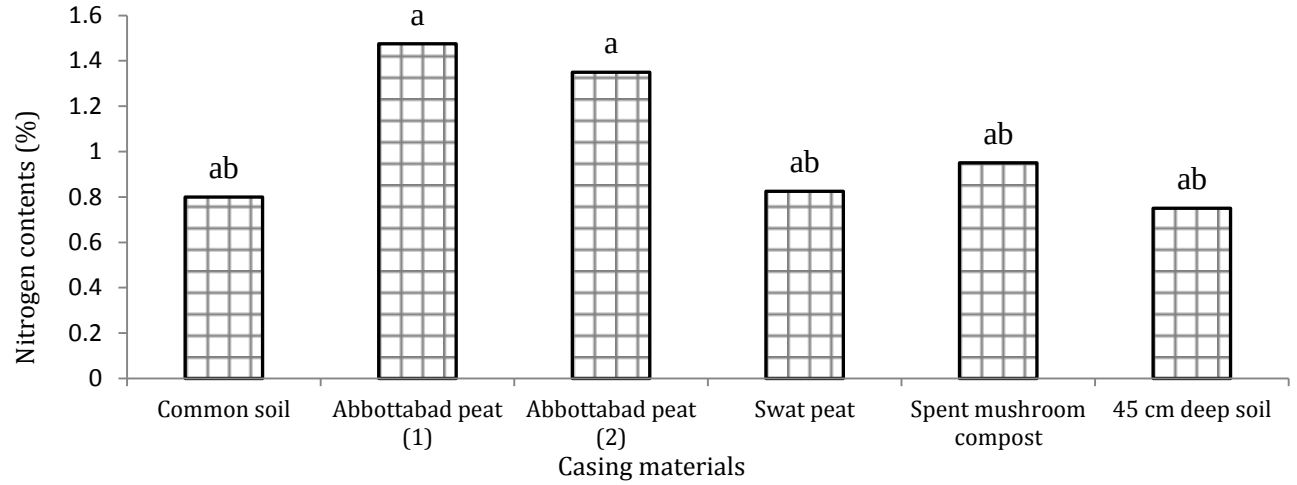

Figure 3. Determination of nitrogen contents of casing materials for evaluation of growth of *A. bisporus*. Treatments sharing same letter(s) do not differ significantly.

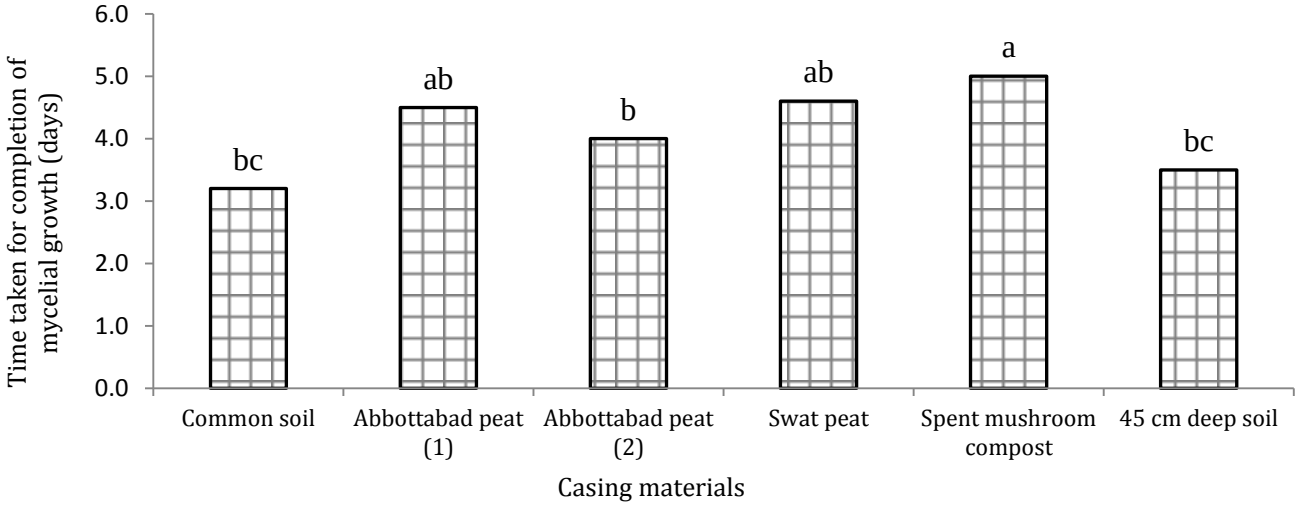

Figure 4. Effect of casing treatments on time required for completion of mycelial growth in *A. bisporus*. Treatments sharing same letter(s) do not differ significantly.

Time taken to reach harvesting stage after casing: Minimum time (4.25 days) to reach harvesting stage was recorded in Abbottabad Peat-1. While spent mushroom compost took maximum time (6.25 days) for reaching harvesting stage (Fig. 6).

Number of pin heads after casing: More number of pin heads lead to the maximum mushroom yield. Maximum numbers (2.25) were noted in Abbottabad peat-2 and 45 cm deep soil, whereas fewer numbers were noted in spent mushroom compost (0.50). Only one pinhead was maintained by Swat peat and common soil. (Fig. 7).

Number of mature fruiting bodies after casing: The performance of casing materials on number of mature fruiting bodies was also studied. The maximum number of fruiting bodies (2.25) were obtained by treatment of Abbottabad peat- 2 (2.25) as casing material, whereas spent mushroom compost gave the lowest number (0.50) of mature fruiting bodies (Fig. 8).

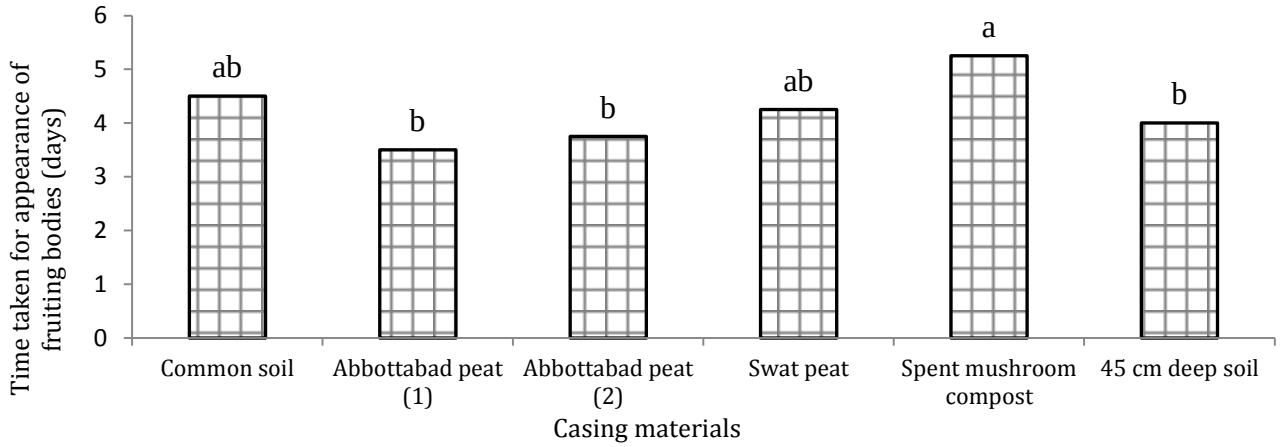

Figure 5. Effect of casing treatments on time required for appearance of fruiting bodies in *A. bisporus*. Treatments sharing same letter(s) do not differ significantly.

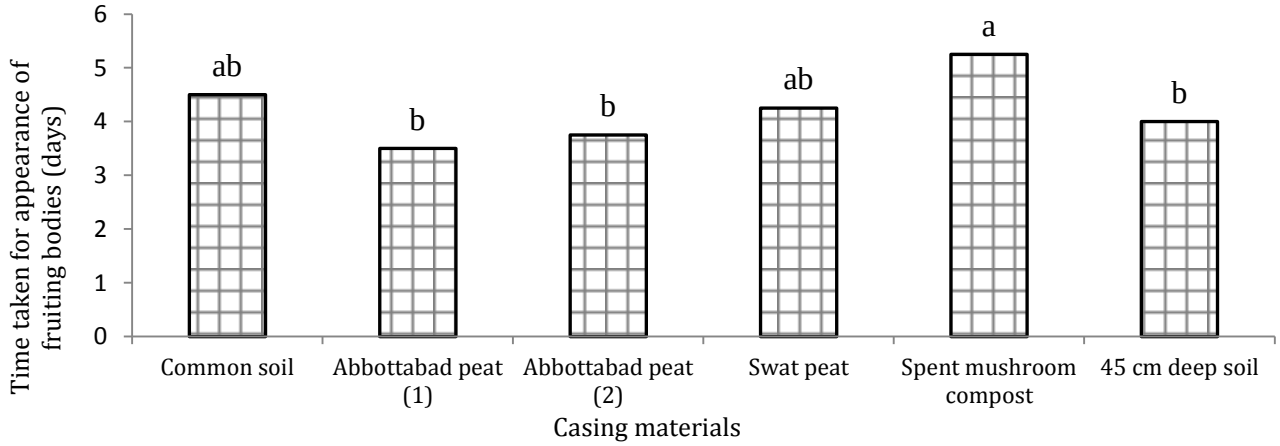

Figure 6. Effect of casing treatments on time taken to reach harvesting stage after casing in *A. bisporus*. Treatments sharing same letter(s) do not differ significantly.

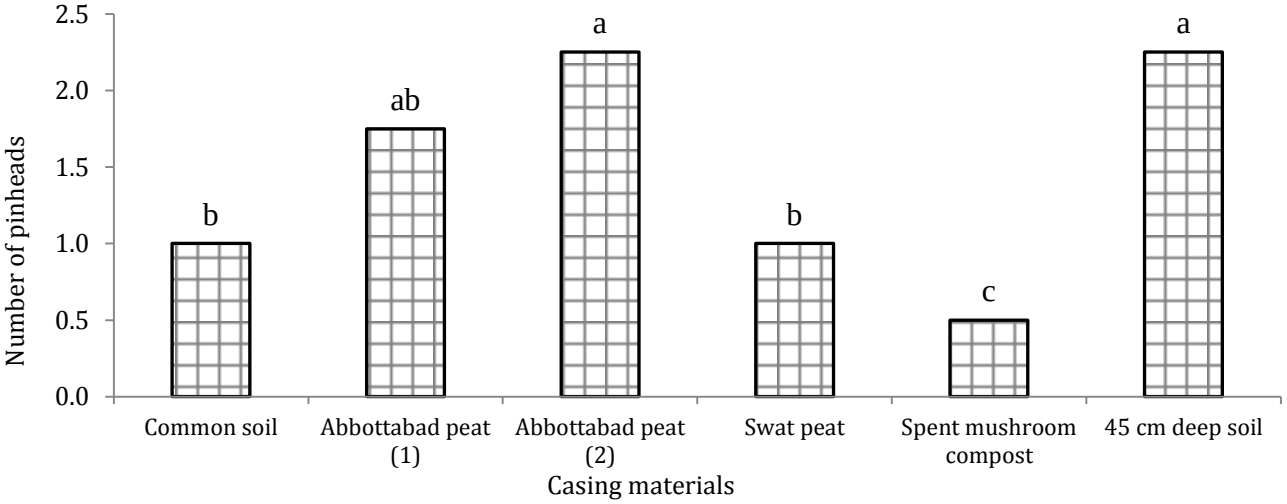

Figure 7. Effect of casing treatments on formation of pinheads in *A. bisporus*. Treatments sharing same letter(s) do not differ significantly.

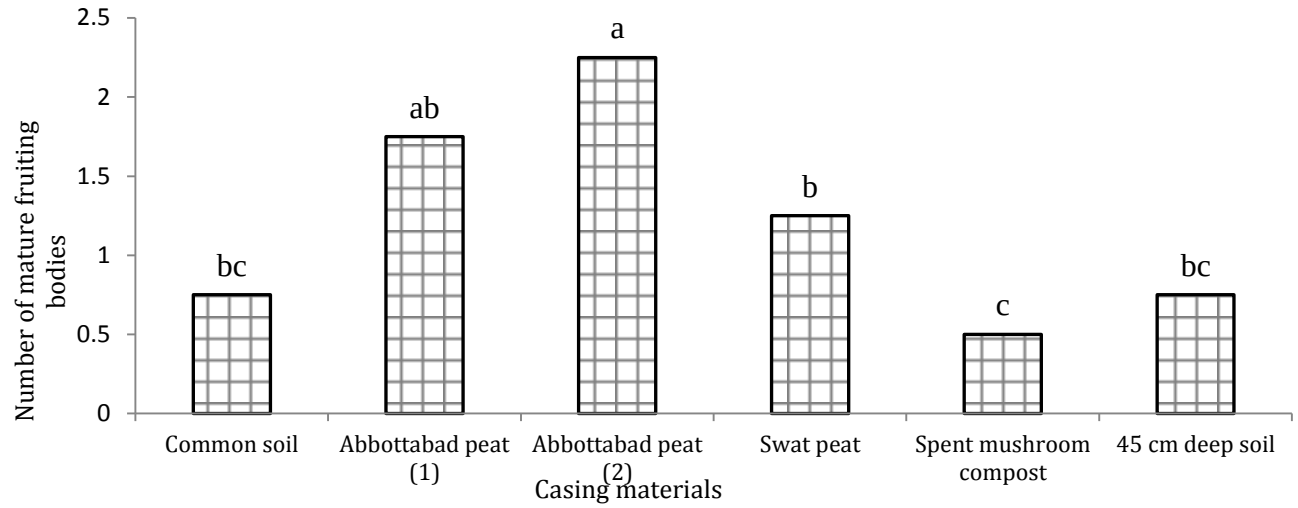

Figure 8. Effect of casing treatments on number of mature fruiting bodies in *A. bisporus*. Treatments sharing same letter(s) do not differ significantly.

Weight of fruiting bodies after casing: Maximum biomass was observed with casing of Abbottabad peat 2 (87.5 g) whereas lowest yield was recorded with casing treatment of 45 cm deep soil (43.75 g). This might be due to the less retention of nutrients and moisture contents throughout the growing period of crop (Fig. 9).

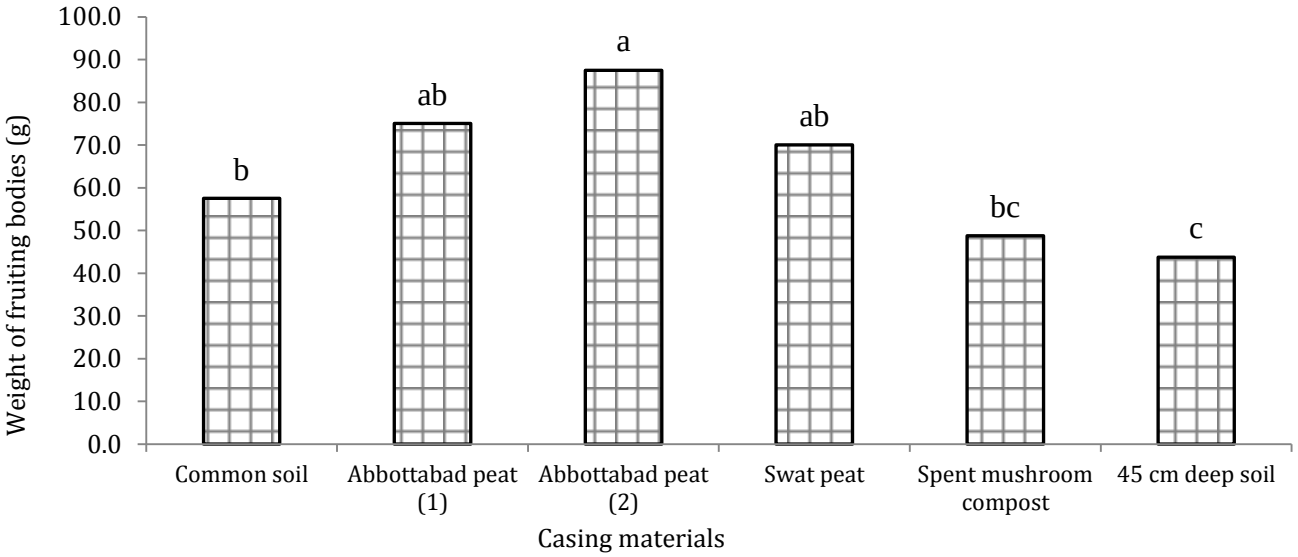

Figure 9. Effect of casing treatments on weight of fruiting bodies in *A. bisporus*. Treatments sharing same letter(s) do not differ significantly.

DISCUSSION

Agaricus bisporus is the most widely cultivated mushroom around the globe, accounting for 40% of the world production of cultivated mushrooms (Giri and Prasad, 2007). It is considerably rich source of riboflavin and minerals i.e. potassium, selenium, and copper along with equivalent sources of protein and vitamins, thiamin, niacin and folate. Moreover, some measurable amounts of anti-cancerous substances also found in button mushrooms such as tyrosinase, aromatase inhibitors and other anti-tumour polysaccharides (Ying *et al*., 1987).

Mushroom cultivation requires less space, care, equipment and cost compared to many other horticultural crops. It only requires good quality spawn, substrate and casing material. The casing layer is an essential component for the artificial cultivation of *Agaricus Bisporus*. According to Sassine *et al.,* (2005) the casing layer must be very loose; otherwise, the primordia cannot penetrate from the bottom to

the top of the casing layer. The use of aerobically fermented substrate as casing material gives a boost in mushroom yield, with peat based casing material with an additional advantage of less bacterial blotch (*Pseudomonas tolaasii*) infection on fruiting bodies than those from peat-based casing material (Ahlawat *et al*., 2004). Optimum pH is precondition for better growth, fructification and yield of Button mushroom. Previous investigation revealed a negative correlation between mycelial growth rate and substrate salinity (Badham, 1989). Our results also signified that rise in acidity (low pH) in all substrates is probably a requirement for primodia formation (Kalberer, 1995).

Han *et al*. (1981) reported that colonization rate of mushrooms declined drastically when the moisture content of substrate increased over 60%. Additionally, a linear negative relationship between water content and growth rate was found by Badham (1989). This might be fairly attributed to the inhibition of oxidative nature of lignin degradation by O_2 unavailability (Burla *et al*. 1992). The results recorded on all substrates were almost similar to the findings of Shah *et al*. (2004). He reported that *Pleurotus ostreatus* took 16 days on an average from inoculation to mycelial growth completion.

Previous reports estimated that lower nitrogen could be a growth-limiting factor in mushroom cultivation (Kalberer, 2000).

These results are in agreement with laboratory studies of investigators, who explained that bacteria association in casing material resulted significant effects on the growth and basidiocarp initiation of the mushroom (Reddy and Patrick, 1990). Jarial and Shandilya (2005) also proved that casing material like vermi-compost considerably affected crop period of *A. Bisporus*. Our results correlated with those of previous experiment (Sassine *et al.*, 2005). He found an immense difference between the numbers of pin heads of *A. Bisporus* treated with various casing materials. These results also confirm the findings of Pardo (2004); who evaluated different casing materials for the cultivation of button mushroom.

Our findings accorded with Shah *et al.* (2004), who made experiment on oyster mushroom using various substrates. Bhatti *et al.* (2007) also found similar results in oyster mushroom.

CONCLUSION

Button mushroom showed positive correlation with application of casing material. It had a positive effect on vegetative and reproductive growth of button mushroom. The use of Abbottabad peat-2 is moderately effective to improve growth and yield of button mushroom.

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