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Effect of different spawning bag techniques on various yield and growth parameters of white button mushroom (*Agaricus bisporus*)

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Abstract

In the present diet conscious era, mushrooms are increasingly considered as a future vegetable, thus to sustain the productivity and enhance the yield, the experiment was conducted at Mushroom Production Technology unit at Bihar Agricultural University, Sabour, Bhagalpur during November 2019- February 2020.

White button mushrooms, *Agaricus bisporus* (Lange) Sing. were cultivated using different techniques of spawning bag. Among various techniques employed, closed mouth bag with perforated PVC pipe and without pores gave best result with minimum days for spawn run (14 days), case run (11.8 days) and gave maximum total yield (1.32 kg/bag) and biological efficiency 33.06% followed by closed mouth bags with perforated PVC pipes and 16-18 pores and closed mouth bags with 16-18 pores with total yield of 1.13 and 0.97 kg/bag respectively.

Keywords: *Agaricus bisporus*, spawning, PVC pipe, yield

1. Introduction

Agriculture has remained to be the major force of Indian economy but a fight is still on to meet the ever increasing demand of nutritional security following secondary agricultural vocation. To meet such challenges, diversification in the agricultural activities which include mushroom production is important to address the problems of quality food, health and environmental sustainability (Singh *et al.* 2017) [4, 5]. In the present diet conscious era, mushrooms are increasingly considered as a future vegetable and their consumer demand has markedly expanded owing to its nutritional and medicinal properties (Netam *et al.* 2018) [2]. Mushroom is an excellent source of vitamin- D, minerals such as iron, potassium, copper and are low in calories, carbohydrates, fat, sodium and almost cholesterol-free (Sharma *et al.* 2017) [4]. World's total production of mushroom is about 10.37 million tons with China contributing highest share (Pandey *et al.* 2018) [3]. In India, mushroom production is about 1.3 lakh metric tons which is 3 per cent of world production. From 2010- 2017, the mushroom industry in India has registered an average growth rate of 4.3% per annum. (Sharma *et al.* 2017) [4]. Out of the total mushroom produced, white button mushroom share is 73% followed by oyster mushroom (16%), paddy straw mushroom (7%) and milky mushroom (3%) (Sharma *et al.* 2017) [4].

The white button mushroom (*Agaricus bisporus*) is very popular throughout the world and is the most important mushroom of commercial significance in India (Maheswari 2013) [1]. It belongs to phylum Basidiomycota, class Agaricomycetes, order Agaricales and family Agaricaceae.

Keeping in mind the demand of button mushroom, the most popular variety still dominating the Indian and International market, we have to think for the production of white button mushroom so that we can meet the requirement of this mushroom but for meeting the requirement we have to focus on technology or we can say low-cost technology for its cultivation and develop a modified technique for enhancing and sustaining its production. Based on these facts the present study has been undertaken to study the effect of different spawning bag techniques on various growth and yield parameters of white button mushroom (*Agaricus bisporus*) in the mushroom production technology unit of Bihar Agricultural University, Sabour, Bhagalpur.

2. Material and Methods

2.1 Inoculation and Spawn Production

2.1.1 Preparation of Pure culture

Pure culture of *Agaricus bisporus* was prepared using tissue culture method. For tissue culture, the basidiocarp after alcohol sterilization was cut longitudinally into 2 halves and bits from collar region was transferred to pre-sterilized Potato Dextrose Agar (PDA) culture medium. The PDA medium was used for isolation, purification and maintenance of *Agaricus bisporus* cultures. The ingredients of Potato dextrose agar (PDA) medium used in present investigation are given below:

- Potato (peeled and sliced): 200 g
- Dextrose: 20 g
- Agar-agar: 20 g
- Distilled water: 1000 ml

The Petri-plates were incubated at $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ in BOD incubator for one week. Mycelium from growing edges were carefully transferred to PDA slants and again incubated for 2-3 weeks to obtain pure cultures.

Wheat grains were used as support media for spawn production.

2.1.2 Preparation of Mother Spawn

- Step 1 Select healthy and clean cereal grains
- ↓
- Step 2 Boil grains in water (15-20 min.)
- ↓
- Step 3 Remove excess water on sieve
- ↓
- Step 4 Dry grains in shade (4 h)
- ↓
- Step 5 Mix CaCO_3 (0.5%) and CaSO_4 (2%) on dry wt. basis
- ↓
- Step 6 Fill 300 g grains in glucose/milk bottle
- ↓
- Step 7 Plug and autoclave at 22 p.s.i. for 1.5 to 2 h
- ↓
- Step 8 Inoculate growing mycelium of desired strain using laminar flow
- ↓
- Step 9 Incubate in BOD at $23 \pm 20^{\circ}\text{C}$ for 20-25 days (shake bottles after 10 days)
- ↓
- Step 10 Master spawn is ready

2.1.3 Preparation of Commercial Spawn

- Step 1 Use polypropylene bags instead of bottle
- ↓
- Step 2 Upto autoclaving (Step 1 to 7) is same as of mother spawn
- ↓
- Step 8 Inoculate with 10-15 grams of mother spawn per PP bags
- ↓
- Step 9 Incubate at $23 \pm 20^{\circ}\text{C}$ in incubation room (Shake bags after 7-8 days)
- ↓
- Step 10 Commercial spawn is ready in 2-3 weeks



Fig 1: Isolation and purification of pure culture

2.2 Compost preparation

Compost was prepared using zero-energy polytunnel method according to Wakchaure and Singh, (2013) [6].

The trapezoidal compost pile was formed by inserting the perforated HDPE pipes in parallel zigzag arrangement from the properly mixed pre-wetted compost ingredients. The compost ingredients included wheat straw (300 kg), wheat bran (30 kg), gypsum (25 kg), benoula khali (30 kg), chicken manure (100 kg), DAP (10 kg), Urea (5 kg), MOP (5 kg), Phephronil (1 kg), Furadan (3 kg) and Carbendazim (1 kg) respectively. For making compost, 300 kg of dry wheat straw was wetted with water properly for 1-2 days upto moisture level 75-80% and all other ingredients was added to it at once. The standard process involved, the mixing of pre-wetted compost ingredients including gypsum, natural pasteurization by covering of compost pile with polythene sheet for three days at $66-70^{\circ}\text{C}$ and conditioning of compost at $50-60^{\circ}\text{C}$ for another two days. The first turning of compost pile was done on sixth day. Again, second natural pasteurization of compost was done after two days at $60-65^{\circ}\text{C}$ and conditioned the compost for next two days at $50-54^{\circ}\text{C}$. The pile was turned secondly on 11th day and covered with polythene cover for next three days and conditioned at $48-52^{\circ}\text{C}$. The desirable quality of matured compost (moisture content 62-66%, pH 7-7.7, ammonia < 7-10 ppm) was obtained after 14-16 days. Mature compost was broken, spread for cooling and after sterilization left overnight before spawning.

2.3 Spawning and Filling of bags

For spawning, mixed spawning method was used. Mixing of wheat grain based spawn was done @ 2 kg per 100 kg compost of *Agaricus bisporus* under clean conditions (i.e., with clean hands and pre-sterilized area). Good quality compost with temperature of 25 °C was used. Then filling of spawned compost into polythene bags (size 16" x 22") to a depth of 10-12". Little compressing and levelling of spawned compost was done and 5 bags of 4 kg weight each will be made per treatment.

For testing different techniques of spawning bag, five bags of 4 kg weight each were made per treatment. Bags with open mouth served as check (treatment 1). Bags with closed mouth and 16 to 18 pores were treatment 2. Open mouth bags inserted with perforated PVC pipes (8" x 1" x 0.06" dimensions and 4 holes of 0.1" each on two opposite sides) vertically served as treatment 3. Perforated PVC pipe (same as above) were inserted in spawned bags and the mouth of the bags were closed. This was treatment 4. Bags with perforated PVC pipes and closed mouth along with 16-18 pores served as treatment 5.

2.4 Casing

A mixture of FYM (one year old) + Soil (1:1 wt / wt) was prepared, sterilized with 2% formalin solution. It was added upto 3 cm on top of spawn run compost. Sterilization was done by making a heap of casing material (FYM + Soil) on a cemented platform and wetted upto 50-60% water holding capacity. The wet casing was drenched with formalin @ 0.2% by mixing with shovel. It was then covered with polythene sheet and the outer periphery was sealed with bricks. The material was kept for 24-48 hrs in sun for fumigation effect. The cover was removed after 48 hrs and the material was exposed to open air and sunlight by spreading over with clean tools and permitting the formalin fumes to escape in to air for 2-3 days before it was used as casing (formalin treatment effect decreases at low temperature due to inadequate fumigation). After application of casing materials water sprays were given in installments immediately.

2.5 Cropping

Under favourable environmental conditions *viz.* temperature initially 23 ± 2 °C for about a week and then 16 ± 2 °C, moisture (2-3 light sprays per day for moistening the casing

layer), humidity (above 85%), proper ventilation and CO₂ concentration (0.08-0.15%) the fruit body initials which appeared in the form of pin heads started growing and gradually developed into button stage. Mushrooms were harvested by gentle twisting and soil end parts were cut off. After harvesting was complete, the gaps in the beds were filled with fresh sterilized casing material and then watered. Yield data for average weight and total yield of fruiting bodies per bag was recorded and biological efficiency was calculated as

$$\text{Biological efficiency (in percentage), B.E.} = \frac{\text{Total weight of fresh mushroom}}{\text{Total dry weight of compost}} \times 100$$

3. Results and Discussion

3.1. Effect of different techniques of spawning bags on various growth and yield parameters of white button mushroom

The effect of different techniques of spawning bag was observed on various growth parameters like spawn run, case run, pinhead emergence, date of first and last harvest and on yield parameters like total yield relation with mean temperature and mean relative humidity in the cropping room was established. The observations are tabulated in Table 1 and table 2 and illustrated graphically in Fig 2.

3.1.1 Effect of different spawning bag techniques on growth parameters of white button mushroom

The results of the effect of different spawning bag techniques were presented in Table 1.

Among different spawning bag techniques employed, the days required for colonization of substrate after spawning were comparatively less in closed mouth bags with perforated PVC pipes without pores and in closed mouth bag with 16-18 pores (14 days in each) followed by open mouth bags with perforated PVC pipe (15.20 days after spawning). For case run, pinhead emergence, first harvest and last harvest, minimum days (11.80 days, 24.60 days, 31.20 days and 69 days after casing were observed in closed mouth bags with perforated PVC pipes and without pores followed by closed mouth bags with 16-18 pores and closed mouth bags with perforated PVC pipes and 16-18 pores.

The longest time period for pinhead emergence (26.8 days), first harvest (33.6 days) and last harvest (71.40 days) after casing was observed in open mouth bags (check)

Table 1: Effect of different spawning bag techniques on various growth parameters of white button mushroom

Treatments	Parameters*				
	Spawn run (days)	Case run (days)	Days for pinhead emergence	Date of first harvest	Date of last harvest
T ₁ (Check-Open mouth bag)	16.00	14.60	26.80	33.60	71.40
T ₂ (Closed mouth bag +16-18 pores)	14.00	12.20	24.60	31.80	69.20
T ₃ (Perforated PVC Pipe + open mouth bag)	15.20	13.40	26.20	32.20	70.00
T ₄ (Perforated PVC Pipe + Closed mouth bag (without pores)	14.00	11.80	24.80	31.20	69.00
T ₅ (Perforated PVC pipe + Closed mouth bag +16-18 pores)	16.40	15.40	24.60	31.80	69.00
SE(m) ±	0.30	0.41	0.39	0.45	0.46
CD (P = 0.05)	0.90	1.23	1.17	1.34	1.39
CV (%)	4.3930	6.88	3.52	3.14	1.50

* Denotes Mean value of five replications

3.2.2 Effect of different spawning bag techniques on various yield parameters of white button mushroom

From Table 4, we can see that for various yield parameters, the maximum average weight of fruiting bodies (12.78 g /bag)

was found in closed mouth bags with perforated PVC pipe and without pores followed by Closed mouth bags with perforated PVC pipes and 16-18 pores (11.38 g /bag) while the least weight was recorded in check- open mouth bags

(10.94 g /bag). Similarly, highest yield of fruiting bodies (1.32 kg /bag) and highest biological efficiency (33.06%) was found in closed mouth bags with perforated PVC pipe and without pores followed by closed mouth bag with perforated PVC pipe and with 16-18 pores (1.13 kg /bag and 28.46% B.E.) and closed mouth bags with 16-18 pores (0.97 kg /bag and 24.26% B.E.). This may be possible due to sufficient

amount of aeration provided through perforated PVC pipes to accelerate the mycelial colonization by enhancing the decomposition of substrate. The perforated PVC pipes in different spawning bags mainly altered the temperature pattern of substrate in comparison to other methods.

The minimum total yield was given by check- open mouth bags 0.85 kg /bag and 21.71% B.E.

Table 2: Effect of different spawning bag techniques on various yield parameters of white button mushroom

Treatments	Yield Parameters*		
	Av. Wt. of fruiting bodies (g per bag)	Total yield of fruiting bodies (kg per bag)	B.E. (%)
T ₁ (Check-Open mouth bag)	10.94	0.85	21.37
T ₂ (Closed mouth bag +16-18 pores)	12.56	0.97	24.26
T ₃ (Perforated PVC Pipe + open mouth bag)	11.16	0.86	21.71
T ₄ (Perforated PVC Pipe + Closed mouth bag (without pores))	12.78	1.32	33.06
T ₅ (Perforated PVC pipe + Closed mouth bag +16-18 pores)	11.38	1.13	28.46
SE(m) ±	0.38	0.02	0.95
CD (P = 0.05)	1.14	0.08	2.83
CV (%)	7.35	5.84	8.41

* Denotes Mean value of five replications

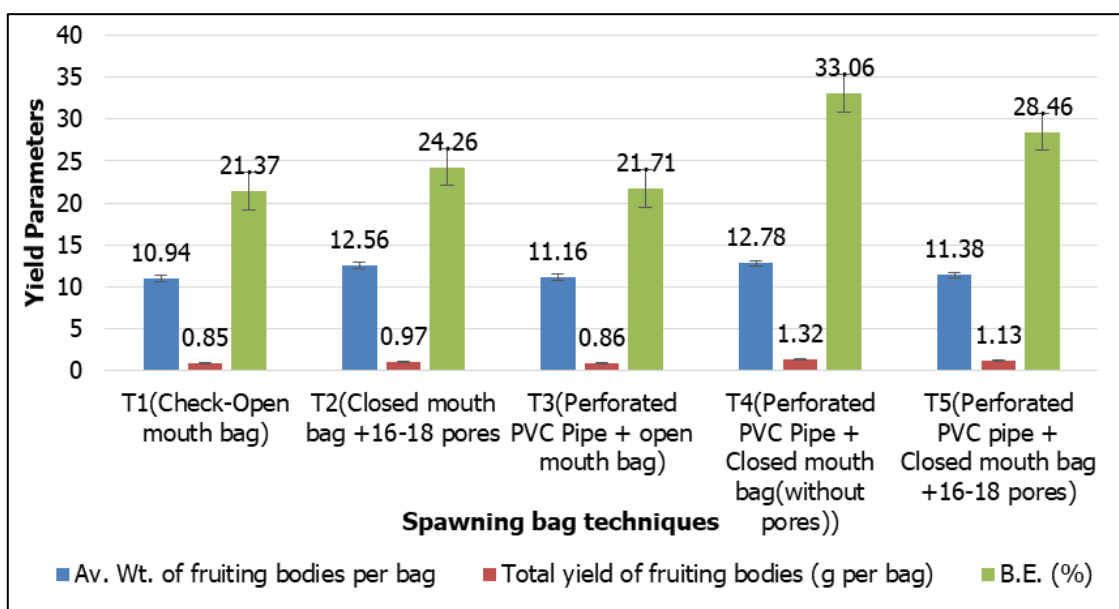


Fig 2: Effect of different date of spawning on various yield parameters of white button

4. Conclusion

It can be concluded that the most suitable spawning bag technique was found to be closed mouth bag with perforated PVC Pipe and without pores followed by closed mouth bag with PVC Pipe & 16-18 pores and Closed mouth bag with 16-18 pores in terms of maximum yield, being 1.32, 1.13 and 0.97 kg per bag respectively in minimum time i.e., 31.2 and 31.8 days after casing. With these methods, productivity could be sustained for a longer time, and the production was enhanced with more return in less input.

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