Current Journal of Applied Science and Technology

40(9): 63-69, 2021; Article no.CJAST.68511
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Cultivation of Milky Mushroom (*Calocybeindica)* in Greenhouse

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Authors' contributions

This work was carried out in collaboration among all authors. Author MM designed the main concept of the project and supervised the entire research. All authors PI, MM, SS, PRC and SJP were involved in performing the experiments. Author PI and MM took the lead in writing the manuscript. All the authors helped shape the research, analysis and manuscript.

Article Information

DOI: 10.9734/CJAST/2021/v40i931348
Editor(s):
(1) Chen Chin Chang, Hunan Women's University, China.
Reviewers:
(1) M. Natarajan, Annamalai University, India.
(2) Selvakumar R., ICAR-Indian Agricultural Research Institute, India.
(3) Hai Yen, Tan Trao University, Viet Nam.
Complete Peer review History: http://www.sdiarticle4.com/review-history/68511

Original Research Article

Received 02 March 2021
Accepted 09 May 2021
Published 12 May 2021

ABSTRACT

Mushroom cultivation is one of the most important steps in diversification of agriculture. Milky mushroom (*Calocybeindica*) is a tropical edible mushroom, popular because of its good nutritive value and it can be cultivated commercially on large scale. Generally, by creating controlled environment in rooms mushroom cultivation is taken up, In traditional method it is typical to manage the atmospheric temperature and humidity in desired range, which can be maintained easily in greenhouse by automatic control system.Cultivation of milky mushroom in greenhouse was taken up in controlled environment under three different conditions of controlled temperature and relative humidity (RH). The experimental conditions are 28°C and 79% RH, 24°C and 84% RH and 32°C and 72%RH. The yield obtained was found maximum at 24°C temperature and 84% relative humidity when compared with the other two greenhouse environment conditions. The yield from the mushroom cultivation under controlled environmental conditions in greenhouse was found to be high when compared with the conventional practice. It was concluded that, the mushroom cultivation yields high under controlled greenhouse conditions and also economical compared to the conventional method.

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Keywords: Mushroom cultivation; greenhouse; mushroom yield.

1. INTRODUCTION

Milky mushroom, scientifically called as *Calocybeindica,* is a tropical edible fungus and has become the third commercially grown mushroom in India after the popular mushroom varieties, button and oyster [1]. Milky mushroom in particular is a high protein and low fat product. Investigation by Lintzel [2] recommended that 100 to 200 g of mushrooms (dry weight) is required to maintain nutritional balance, in a normal human being weighing 70 kg. Mushroom production can be a lucrative cottage industry for low income rural households in developing countries [3]. The mushroom technologies involving spawn production, while having been proven under controlled laboratory conditions. In small scale commercial activities, no means it is simple. They require training in sterile technique, familiarity with mushroom growing conditions and disease control.

Generally, problems faced in conventional cultivation practice are contamination, slow or stalled growth, oddly shaped fruits, fuzzy feet, stressed substrates and cracked caps. In general practice a controlled environment is created in rooms for cultivation of mushroom. In conventional practice, it is typical to manage the atmospheric temperature and humidity in desired range, where as it can be maintained easily in greenhouse by automatic control of fan and pad cooling system and also the affect of diseases, is minimized in greenhouse cultivation.

Though a small amount of light will not hurt mushrooms, they yield better in darkness. For cultivation of mushrooms in greenhouse a few changes should be made. Steps should be taken to ensure that the temperature stays fairly stable, within the range of 24-35°C. Keeping the greenhouse air moist and certain protection against strong drafts should be taken which can be mortal to developing mushrooms. Adopting this model technique can prolong the production and increase the number of harvests. In addition, this model has many other advantages such as prolonging the period for which the mushroom can be supplied to market, the convenient management and the higher work efficiency. Therefore, it is worth promoting and applying such techniques. Hence a research work was conducted on mushroom cultivation in green house using paddy straw as substrate [4,5] in cylindrical polyethylene bag beds [6] under controlled conditions by comparing the milky mushroom yields with that of conventional and controlled conditions.

2. MATERIALS AND METHODS

Experimental investigations on milky mushrooms were carried out at College of Agricultural Engineering, Bapatla, Andhra Pradesh. Greenhouse is constructed of UV resistant 6 mm thick clear poly carbonate sheet provided with fan and pad cooling system, fog system and automated control system to control temperature and relative humidity having acrylic sensors. Thermostat was used to get desired temperature and is located at near the center of the greenhouse where they are not influenced by drafts or sidewall cooling and the 'Mextech' make digital hygrometer was used to measure relative air humidity and temperature with an accuracy of ±1%. In the automated control system, the required experimental conditions of temperature and relative humidity were set prior to the experiment and were maintained.To ensure protection of mushrooms from higher temperatures,a shade net with 50% shade factor was provided (Fig. 1). In addition to sunlight and temperature control, it also reduces the loss of moisture and creates an environment that best suited the mushroom growth.

2.1 Spawn Preparation

Good quality sorghum grains which are free from pest and moulds were selected & boiled in submerged clean water for 20-30 min. As the grain softens, the water is strained using cotton cloth and dried in shade. Grains were mixed with 3% chalk powder (30 g/ kg of grain) for adjusting the pH and to keep the grains loose and then filled in empty milk or glucose bottles and autoclaved at 15 lb/sq inch for about one hour, on two consecutive days [4]. Inoculated bottles were incubated at 26-28°C for 3-4 weeks. The grains were thoroughly shaken after 6^{th}, 9^{th} and 12^{th} days to avoid clumping of grains. To this the mother spawn was added.

2.2 Selection and Preparation of Substrate

Milky mushroom can be grown on wide range of substrates containing lignin, cellulose and hemicelluloses. However, cereal straw (paddy/wheat) can be used as a best substrate

to get a good yield of *C. indica* [7]. Fresh and dry paddy straw substrate was selected for growing mushrooms. The paddy straw was chopped into 2-3inch pieces and soaked in fresh water for 8-16 hours. This period can be reduced when pasteurization is to be done by steam. Main purpose of soaking was to saturate the substrate with water. After that, the substrate was taken out from the solution and excess water was drained out for 2-3 hours. A moisture content of about 60% was maintained in the wet substrate prior to spawning.

2.3 Mushroom Bed Preparation

Beds were made with each bed containing 0.5 kg of paddy straw (dry weight basis). Polyethylene bags of 60 × 30 cm size and 100-gauge thickness were used and cylindrical mushroom beds were prepared following layer methods of spawning. The rate of spawning was 5% of wet weight of the substrate. Spawn running period was allowed under semi dark conditions with temperature range of 25-35°C and relative humidity above 80%. After 20 days substrate is fully colonized and bags are ready for casing. After spawn running the mushroom beds were shifted to greenhouse and then casing was done.

2.4 Casing and Cropping

The top surface of mushroom beds after spawn run, was covered with about 2-3 cm thick pasteurized casing material, clay loam soil with pH adjusted to 8.0- 8.5 (Fig. 2).

Fig. 1. Interior view of greenhouse

Regular spraying of water on the surface of the casing soil was done to maintain approximately 60% moisture on the bed surface. It took about 10 days for mycelium to reach on top of casing layer by introducing fresh air and maintaining temperature and RH. Cropping period was allowed to run in greenhouse at three different conditions viz., 28°C,79% RH; 24°C, 84% RH and 32°C, 72% RH.

Fig. 2. Casing on mushroom beds

2.5 Harvesting Mushrooms

It took about 10-15 days for mycelium to reach on top of casing layer. The controlled environment, resulted in the initiation of fruiting bodies within 3-5 days in the form of needle shape which matured in about a week. Mushrooms of 7-8 cm diameter were harvested by twisting. The harvested mushrooms were cleaned and packed. After harvesting, mushrooms were weighed by physical balance.

3. RESULTS AND DISCUSSION

The yield obtained from mushroom beds which were placed in greenhouse after spawn running period at different conditions set prior to experiment was recorded and comparison were drawn.

3.1 Mushroom Yield at 24°C Greenhouse Temperature

This experiment was conducted at the conditions set to a temperature of 24°C and 84% relative humidity. Here the pin head formation occurred in 12 days due to favourable temperature and humidity which are maintained in the greenhouse. Yield obtained from the beds was found comparatively decreasing from first harvest to last harvest, i.e., about 1325 g, 1065 g and 785 g at first, second and third harvest respectively.

The average yield per bed per harvest is 221 g, 177 g and 131 g respectively for first, second and third harvests. The total yield obtained from the beds is about 3175 g. The yield of mushrooms at 24°C and 84% RH is graphically represented in the Fig. 3.

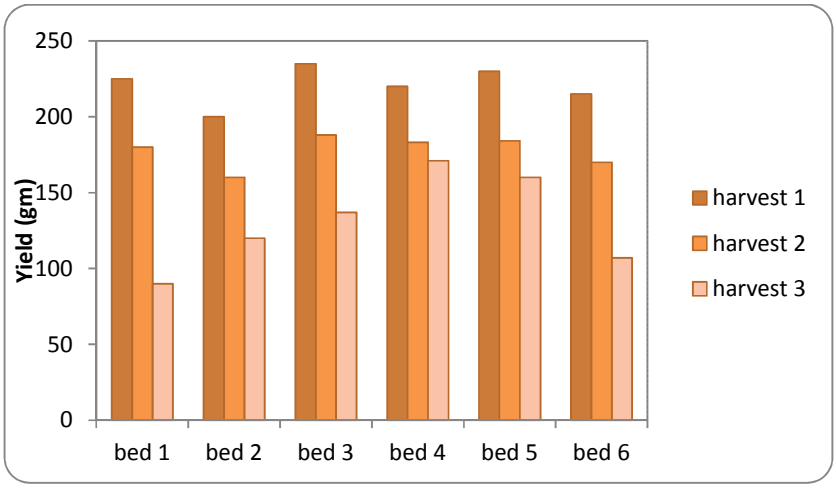

Fig. 3. Mushroom yield at 24°C greenhouse temperature and 84% relative humidity in different mushroom beds

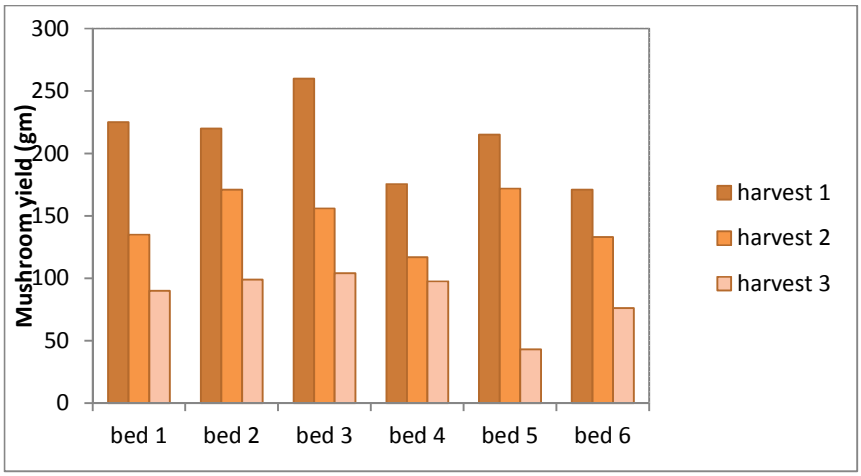

Fig. 4. Mushroom yield at 28°C greenhouse temperature and 79% relative humidityin different mushroom beds

3.2 Mushroom Yield at 28°C Greenhouse Temperature

At a temperature of 28°C and 79% RH. The yield obtained from the mushroom beds is decreasing from first harvest to last harvest i.e., 1266.5 g, 884 g and 509.5 g respectively for first, second and third harvests.

The total yield obtained is about 2660 g. Pin head formation occurred within 14 days after casing. The mushrooms yield at 28°C temperature and 79% relative humidity is graphically represented in the Fig. 4.

3.3 Mushroom Yield at 32°C Greenhouse Temperature

Mushroom beds when subjected to a temperature of 32°C and 72% relative humidity, pin head formation occurred within 15 days after casing. Yield of about 1190 g is obtained during first harvest and there is an abrupt decrease in yield to about 714 g in second harvest and 476 g in third harvest. The total yield of 2380 g is obtained. The average yield per bed per harvest is 198 g, 119 g and 79 g respectively for first, second and third harvests. The yield of mushrooms at 32°C temperature and 72% relative humidity is graphically represented in the Fig. 5.

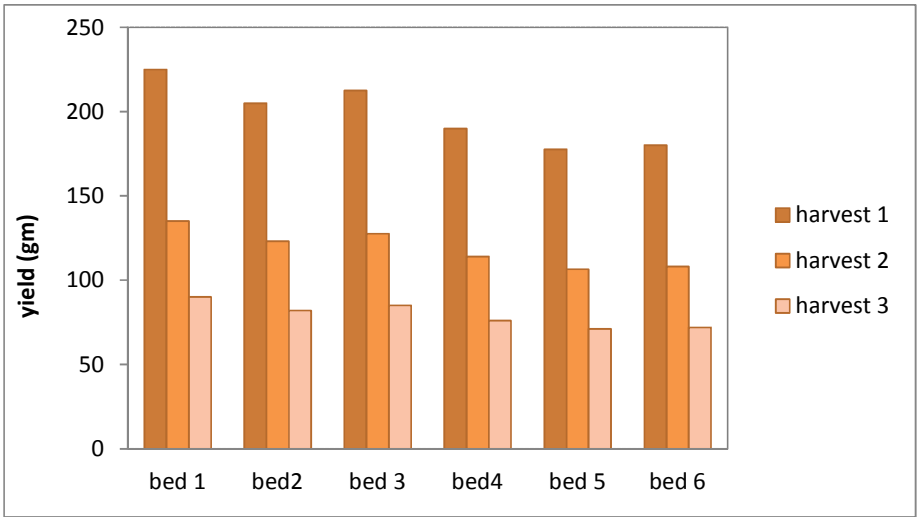

Fig. 5. Mushroom yield at 32°C greenhouse temperature and 72% relative humidity in different mushroom beds

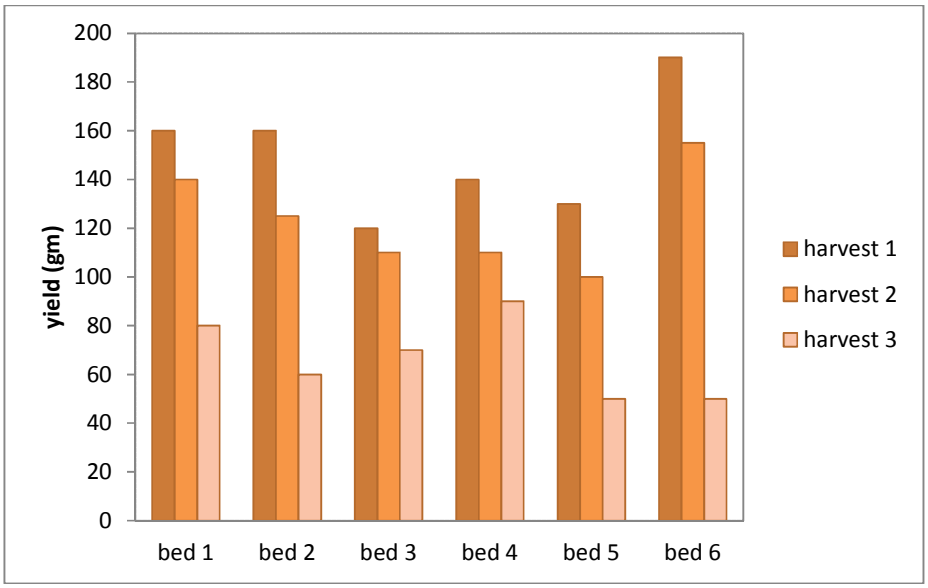

Fig. 6. Mushroom yield under conventional method in different mushroom beds

3.4 Mushroom Beds Yield under Control

The yield from the mushroom beds cultivated under conventional practice was recorded. The total yield is 900 g, 740 g and 400 g for first, second and third harvests respectively. Mushroom yield is graphically represented in Fig.6. The average yield per bed per harvest is 150 g, 123 g and 67 g respectively for first, second and third harvest.

3.5 Comparison of Yield Parameter from Three Experiments and Conventional Method

Under favourable conditions i.e., at 24°C temperature and 84% relative humidity, yield obtained is comparatively high than control and the other two conditions 28°C and 32°C temperature. The comparison of yield parameter from all the three experiments and control is graphically represented in Fig. 7.

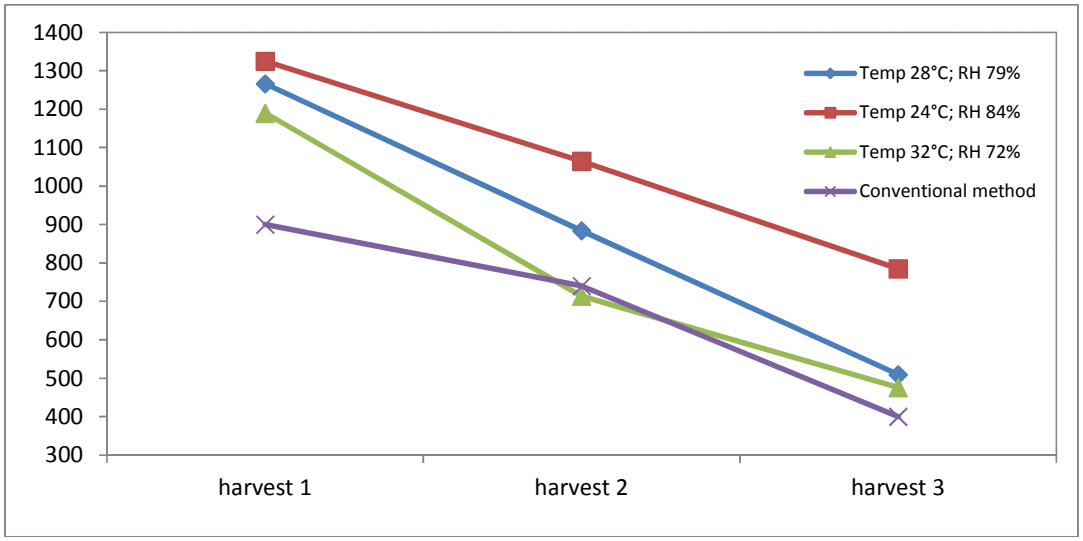

Fig. 7. Yield comparison among the three experiments and conventional method

The yield from mushroom beds is found decreasing from first harvest to last harvest in all the three experiments and also in conventional method. The average yield per bed per harvest is found high at 24°C temperature and 84% relative humidity and it gradually decreased in other two experiments. Highest yield per bed per harvest recorded is about 529 g at 24°C temperature and 84% relative humidity and the least recorded is about 396 g at 32°C temperature and 72% relative humidity.

4. CONCLUSION

Experimental study on cultivation of milky mushroom (C*alocybeindica*) taken up in greenhouse found that the mushroom yield obtained at a temperature of 24°C and relative humidity of 84% recorded higher than the other two conditions and also from control. The total yield obtained at 24°C is 19%, 33% and 56% higher than the yields obtained at 28°C , 32°C and control conditions respectively. The mushroom yield obtained is found comparatively decreased from first harvest to last harvest in all the three experiments and also in control. Number of days for pin head formation at a temperature of 24°C was less than the days recorded during the other conditions. The average size of mushrooms obtained in greenhouse cultivation is higher than the average size of mushrooms obtained in conventional practice. Mushroom cultivation in greenhouse is found economical and high quality yield is gained when compared with the conventional practice.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/68511