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A Guide for White Button Mushroom (*Agaricusbisporus*) Production

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Abstract

The white button mushroom (*Agaricusbisporus*) is very popular throughout the world and is the most important mushroom of commercial significance in India. It can be successfully cultivated in places where the environmental conditions are favorable but it is cultivated in North India in winter seasons due to the favorable conditions. The optimum temperature for mycelial growth is 22°C -25°C and that for fruit body formation 14°C -18°C and a high percentage of relative humidity. The substrate for cultivation is specially prepared compost. The mushroom cultivation rooms should have facilities for temperature control and pasteurization processes. Inside the house, shelf or tray system is usually adopted for increase the area of cultivation. Buildings are constructed of wood or bamboos or hollow cement bricks or double walls. Although good hygiene is the key of business but many competitor molds and pest can arose a huge problem during the cultivation and lead to a low product.

This review article is focused upon the different problems arose during Button mushroom cultivation.

Introduction

Mushroom production is a growing business in India as the demand is increasing from last few years.

Mushroom cultivation is a matter of practice and technical knowledge rather than labor intensive farming with a high value of return in short time.

Mushroom production has some key raw materials to get good yields. Spawn, Compost and Casing Soil are three raw materials are used in it.

Spawn

Spawn is just equivalent to the seed of a plant, although, it is only pure mushroom mycelium (vegetative part of fungus) growing on a sterilized grain medium (in case of solid spawn). The grain medium is prepared by boiled grains of cereal or millet like wheat, bajra, jowar and rye mixed with calcium source (chalk-powder and gypsum). The medium is sterilized after in heat resistant glass bottles or polypropylene bags at 121°C and 15 lbps pressure or for 2 hours at 100°C and inoculated with pure primary culture of *A. bisporus* (Figure 1). The medium is incubated at 25°C and soon gets impregnated with mushroom mycelium. This spawn would be ready for use in 2–3 weeks.

Compost

The substrate used for button mushroom is a prepared after partial digestion of organic matter prepared under aerobic conditions and is generally termed as Champost (dutch style) or compost. In India, straw of wheat or paddy have been generally used. It is known as synthetic compost. Out of several formulations of compost, the most commonly used are:

- Long method compost (unpasteurized) (Table 1-3)
- Short Method Compost (Pasteurized) (Table 4)

Any of the formulations can be used for preparing the compost (LMC) according to the available materials. It is completed outdoors in about 28 days. The constituents include in the formulations, ensure the initial Nitrogen levels at 1.5–1.75 and final level at 1.25%. The Carbon: Nitrogen lay in between 25 and 30 at beginning and 16–18 in the end. The straw is thoroughly wet for 24 hr and mixed with the bran and fertilizer mixture prepared separately with 2/3 quantities of ammonium sulphate and urea and the entire quantity of SSP and SOP added to 75 kg of well moistened wheat bran and left for 16 hrs (overnight) covered with wet gunny sheets. The substrate so prepared is formed into a large heap of 5-6 feet width and 5-7 feet height to encourage intense microbial activities causing the generation of heat reaching up to 75°C–80°C. This heap is broken on the 6th day and remade after adding the bran and fertilizer mixture made the previous night with the remaining ingredients and mixture slurry made with molasses, nematicide and insecticides in 50 liters of water. This breaking and remaking process is called turning. Turing has to be done every 3–4 days after adding water to maintain around 75% moisture and allowing passing the air and getting the aerobic conditions. Normally 7–8 turnings are necessary. Gypsum is added at 3rd and BHC or Lindane at the last or second last turning. If free from ammonia the compost is ready for spawning after 7th or 8th turning, otherwise more turnings are necessary until it is completely free form ammonia. This is very

Figure 1: White button mushroom (Agaricus bisporus).

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much necessary to get rid of ammonia at this stage. This short method composting (Table 4) needs equipment and can be completed in 18–20 days in outdoor and indoor phases.

The phase-I composting

In outdoor phase, the straw is pre-wetted and entire quantities of chicken manure and Brewer's grains are added in layers. Plenty of water and trampling makes the loose stack which is almost anaerobic. A turning is given after 2–3 days. An aerobic heap is prepared 2 days later after adding the full quota of urea. About 3–4 turnings on each 2nd day complete the outdoor phase.

The phase-II compostingis

The phase-II compostingis done indoors either in a bulk chamber, pasteurization tunnel or in a pasteurization room. These indoor chambers are especially designed for phase-II composting and are fitted with boiler-fed steam-pipes and a blower. The phase-I compost is filled into the chamber up to a height of 6–7 feet, or if it is filled in trays or shelves to a depth of 15–20 cm for spawning in a pasteurization room. In either case, the temperature is rise first to 48°–50°C for 6-8hrs and then it is raised by steam injection to strictly 57°C–59°C for effective pasteurization of the compost. This temperature of air and compost is maintained at this range for 4–6hr, and allowed to fresh filtered air introduction slowly to lower down the compost temperature to 50°C–52°C for conditioning, which takes 3–4 days when the compost gets free of ammonia further air is introduced for bringing down the temperature of compost to 25°C–28°C. After cooling down, it is ready for seeding.

Spawning and Spawn Run

The compost made by long or short method (Phase-II compost) is ready for spawning. After mixing the spawn through compost @ 0.5%-0.75% compost is filled in trays or shelves or in poly bags up to 15-20 cm. The spawned compost are kept covered with 2% formalin dipped unprinted newspaper sheets or polythene or by closing the mouth of the bags. Temperature are then maintained at 24°C in the culture room, with relative humidity maintained between 80–85%, Mushroom mycelia start impregnation within 24-48 hrs after spawning. The spawn-run is completed in 2 weeks approximately at appropriate conditions (If temperature is lower than 24°C spawn run would take longer time). Identification of spawn is done when the compost color turns light brown from initial dark brown. Now this is ready for casing and called phase-III compost.

Nemagon (60%)	0.200 litre
Furadan 3 G	0.750 kg
Lindane or BHC 5% dust	1.250 kg
Potassiumsulphate or muriate of potash	15.0 kg
Urea (46% N)	18 kg
Molasses	25 kg
Calcium ammonium nitrate or ammonium sulphate (20.6% N)	45 kg
Wheat bran or	150 kg
Gypsum	150 kg
Spent brewer's grains	200 kg
Wheat straw	1500 kg

(For 5 MT of wet compost; assuming that approximately 65% of humidity)

Table 1: Long Method Compost (Unpasteurized): Solan.

Temik	0.200 kg
Kelthane or Ecalux	0.200 litre
BHC 5%	1.250 kg
Sulphate of potash	15 kg
Single super phosphate	15 kg
Urea	18 kg
Molasses	25 kg
Ammonium sulphate	45 kg
Wheat bran (or flour)	150 kg
Gypsum	150 kg
Paddy straw	2000 kg

(For 5 MT of wet compost; assuming that approximately 65% of humidity)

Table 2: Long Method Compost (Unpasteurized): Shillong.

Nemagon (60%)	0.200 litre
Furadan 3 G	0.750 kg
Lindane or BHC 5% dust	1.250 kg
Potassium sulphate or muriate of potash	15 kg
Single Super Phosphate	15 kg
Urea (46% N)	18 kg
Molasses or Sheera	25 kg
Calcium ammonium nitrate or ammonium sulphate (20.6% N)	45 kg
Wheat bran	150 kg
Gypsum	150 kg
Wheat straw	1500 kg
Nemagon (60%)	0.200 litre

(For 5MT of wet compost; assuming that approximately 65% of humidity)

Table 3: Long Method Compost (Unpasteurized): Our Method.

Urea	18.125 kg
Gypsum	37.5 kg
Wheat Bran	125 kg
Chicken manure	500 kg
Wheat straw	1250 kg

(For 5MT of wet compost; assuming that approximately 65% of humidity)

Table 4: Short Method Compost (Pasteurized).

Casing and Case Run

Casing is a 1–2" thick layer of casing material used to covered the spawn run bed. Without casing material mushrooms don't start fruiting or gives very low yield. Casing is necessary to initiate fruiting, although its role in fruiting is only partially understood. Casing material should not have any nutrient and should possess good water-holding capacity but a texture permitting good aeration and a pH range of 7–7.5. The most commonly used casing material is the peat-moss, and is directly used for casing after adjusting the pH with lime or chalk and pasteurization. However, but Peat moss is unavailable in India, so one of the following mixtures is being used in our country.

- 1–2 years old cow manure + clay loam soil (1:1).
- 1–2 years rotten cow dung + clay loam soil + 2 years old spent compost (1:1:2).
- 2 years old spent compost + sand(4:1)
- Garden loam soil + sand (4:1)
- 1-2 years old cow manure + Ashes (1:4)
- Fired Brick Chips

It works very well and even easier to use brick chips than any other

casing. They must be from fired bricks, not mud bricks. All casing needs water and lime. The good thing about peat is that it holds water. Coir does not wet easily, brick chips do, but none of them hold water well, so less water, more often is what is needed. Actually, the chips can be reused, after they are washed and more lime added. They shake off easily and leave the mushrooms clean. One important thing, DO NOT mix different kinds of casing on the same bed. It is a good idea, to try several kinds on different beds in the same room.

In my experience, adding peat to soil might make the soil a little better for casing, but it would still be a much poorer casing than either the peat or the brick chips.

The casing material is pasteurized either by steaming (60°C–65°C for 6 hr) or by adding 5% formalin solution, covering with a polythene sheet for 48-72 hrs. Before casing, the material is allowed to cool or become completely free from formaldehyde traces. This is a very important step because heat and formalin both would harm the mycelia.

For mushroom mycelium growth in the casing soil, temperature is in the room is maintained around 24°C for next 7–10 days. When the casing soil is infiltrated with mushroom mycelia, room temperature is brought down to 14°C–18°C and ample ventilation is provided to reduce CO2 level, preferably below 1,000 ppm. These conditions initiate the fruiting in mushrooms. The relative humidity of the room is maintained between 85 and 90% all the time. The casing layer is given light spray of water to prevent its drying and for evaporation.

Influence of Casing Soil on Mushrooms

The type of casing soil has a big influence on the weight of the individual mushrooms, the size and how they spread over the beds, stated simply the heavier the structure of the casing soil, the heavier the mushrooms. The number of mushrooms declines with a heavy casing soil, as there is less mycelium growth in heavy casing soil, so its development is coarser and larger. This type of casing soil growth doesn't get completely colonized by mycelium so therefore dehydrates less quickly. As there is less mycelium, fewer pinheads are formed. The biggest problems with too many pinheads that fail to develop occur when there is too much mycelium with a bad structure.

The type of casing soil chosen by growers depends on a number of practical aspects:

- Which size of mushroom can I sell?
- How many mushrooms do I want per m^2?
- How large should the spread be in the first flush?
- Is my climate installation good enough to create continuous evaporation?
- What type of casing soil can my staff and machinery cope with?

An important factor when choosing casing soil is uniformity in structure and a constant supply of the same casing soil. Casing soil with a different moisture content and structure demands a new approach to growing each time, which is absolutely unacceptable. The structure of casing soil is equally important. For good quality mushrooms, constant evaporation is essential. This is only possible if the casing soil contains enough long fibres. These fibres ensure the casing soil retains its open structure, even after heavy watering. Applying copious water is needed to produce the number of kilos required.

Structure is unfortunately the weak point with most types of casing soil. Making casing soil using black peat, blond peat and a form of calcium carbonate as raw materials is general practice. The difference between good and bad casing soil is usually found in the quality of the peat and the fibres used. These should come from peat dug out at depth, and not be dried out or ground. Damaged fibres cannot absorb any more water and dry out very quickly. Far too often so-called peat moss (blonde peat) supplied in huge bales is used as the main ingredient. The result is casing soil that absorbs water quickly, but just as quickly loses it again. The structure is also too fine. Casing soil with a very fine structure also gives an over smooth surface, without any gaps and spaces. This means the number of harvesting days is reduced, as it is more difficult to create a good spread on smooth and fine casing soil. Picking costs will rise and mushroom quality will fall. This is usually the case on the third picking day in the first flush, and in the second flush.

Casing and Spraying

When casing, growers must decide which type of casing soil suits the growing methods best, and what the market is currently asking for in terms of quality and size. If large mushrooms are popular, then a heavier casing soil is the best option. If the market for small mushrooms is good and picking is no problem, growers can use a finer casing soil. Remember that the structure will become even finer during casing if this is done mechanically. The more intensive the treatment of casing soil, the finer the structure will be. Manual casing retains the structure better, but this method is virtually impossible with heavy casing soil.

Directly after casing growers can start spraying the casing soil to reach a good moisture level. Don't wait until the mycelium in the compost starts penetrating the casing soil, otherwise there's a risk of a layer of thin, grey mycelium forming in the lower layer of the casing soil, which can cause problems later. On the first day (the casing day) spraying can last until the compost is reached. With dry compost it's often beneficial to keep spraying until water flows into the compost. This is however, only possible with phase 3 compost that is not wetter than 65%. This is unnecessary if the compost is wetter to start with. If the compost is only moderately incubated, then caution is required. This type of compost can absorb water and that's not the idea here. Apply caution with watering on the second day so the mycelium has a chance to recover. From day three spraying can start again, but reduce the amounts as blow down approaches. Spray using a decreasing pattern. This means the casing soil has the right moisture content from the start and in the final days spraying is only necessary to replace the moisture lost through evaporation.

When spraying, be careful the right pressure is used. Too high pressure forces the fine peat particles out of the casing soil and creates an obstructive layer in the upper part of the casing soil. Later on this will cause problems with pin heading and mushroom growth.

The increasing competition and lower prices for mushrooms mean the pressure is on to perform well. In most countries, good phase 3 compost is currently available and the expertise of growers is good enough to enable good production. But frequently, the casing soil quality is a barrier to achieving the goal of good production one often heard argument is that there's nothing else available, or that better casing soil is too expensive. But bearing in mind that good casing soil gives higher production, better quality and a higher picking performance, then it's logical that good casing soil costs a bit more. For many growers it's high time they critically examined this aspect of growing. Many farms are otherwise missing out on the chance to improve their profits.

Harvesting and Postharvest Management

Mushroom pin-heads start appearing after another 7–10 days. They appear in flushes every 7–10 days and harvested accordingly. About 2/3 of the total crop can be harvested within first two flushes. The beds retain up to 3rd flush for fruiting. The growing rooms are then cooked out to kill pests/pathogens and emptied. This practice protects the subsequent crop-cycle from infection.

Generally mushrooms are harvested on the basis of maturity rather than size. At buttons stage, it is best to harvest (Grade-A) which if allowed to grow further ruptures 'veil' to reveal pink gills and are known as 'cup' (Grade-B). If they further grow in size and become fully 'open' or 'flat' (Grade-C) exposing dark gills. If the harvesting is not done even after, it deteriorates and dies soon.

Mushrooms have a very short shelf-life. It is better to sold them immediately after harvesting. If it has to be stored they should be stored dry in paper envelopes kept in plastic bags to prevent moisture loss and are stored in a refrigerator (lower shelves) for less than a week or after giving immediate cool temperature with vacuum refrigerator.

Precautions

Hygiene in and around the farm is the most important key to get the success in Mushroom farming. Strict sanitation and hygiene practices should be enough to ensure sufficient prevention. No pesticides should be used. Listed below are a number of general hygiene aspects to consider;

- Maintain cleanliness in and around the farm. There should be no herbs in 100 meter area around the farm.
- Never sweep - this creates too much dust. Always clean with water.
- Dust filters must be replaced after each cycle.
- Workers dresses should be cleaned all the time.
- Use double door system and DO NOT allow the culture room door open without any reason.
- All the opening of Growing rooms should be provided with insect-proof nets.
- Substrate must be prepared only on a cemented platform disinfected with 2% formalin solution.
- Only use of a good pasteurized compost and casing.
- Use healthy spawn free from contaminants. Never ever use a bag spawn showing even a little infection.
- Use a foot-dip (with germicidal solution-Potassium per magnate/ bleach or 3%formalin) before entering the growing area/rooms.
- All machinery, work floors and tools must be disinfected before filling with 2% formalin solution.
- Abort the flush with a high infection risk as quickly as possible.
- Cook out the compost and casing soil at the end of each harvest. Keep the compost temperature at 70° Celsius for 8 hours.
- Remove of all the used compost, casing soil and mushroom stalks etc after harvesting as quickly as possible. Disposing area must be at least 2 km away from farm.
- Disinfection of culture rooms before each new cycle with 5% formalin solution and close all air passage for 24 hrs.
- If very-very necessary, use safe and recommended doses of pesticides between the flushes.