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Investigating biological approaches for controlling common Mould disease in mushroom cultivation

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Abstract
The importance of mushroom production is growing on a global scale because of its therapeutic and dietary advantages. Common mould infections, on the other hand, provide a significant obstacle to productive agriculture, resulting in crop losses and decreased yields. This research paper explores environmentally friendly and sustainable ways to fight such mould diseases. In this research, the effectiveness of many biological treatments—including wheat straw mixed with garlic and neem water extracts was assessed as an alternative to chemical fungicides. To determine their effects on spawn run, pinhead formation, and overall yield, these treatments were used at various phases of mushroom cultivation. Our research showed that wheat straw and 0.15% garlic water extract produced the most encouraging outcomes, successfully preventing mould growth and encouraging ideal mycelial colonization. In comparison to other non-chemical and chemical treatments, pinhead production was markedly accelerated in this one, and the harvested fruiting bodies showed greater average weights. By using these biological methods, prevalent mould diseases in the mushroom industry can be managed in a way that is sustainable and environmentally benign while also reducing the negative effects of artificial fungicides. By putting these practices into practice, mushroom growers can increase their operations' security, efficiency, and general quality while also satisfying the growing global demand for dietary and medicinal mushrooms.

The following goals will be pursued in the current investigation
1. To evaluate the efficacy of chemical and botanicals treatments in controlling common mould diseases in mushroom cultivation.
2. To determine the most effective and sustainable approach for managing common mould diseases in terms of productivity.and direct influence on seed yield per plant. These traits may be considered for selection and to improve the yield of mustard genotypes.

Keywords: Spawn run, pinhead formation, overall yield

1. Introduction
Mushrooms are a well-known fungus that is now important because of their usage as dietary supplements and their therapeutic advantages, both in India and around the world. "Mushroom" mostly refers to fungi with a stipe, cap, hymenium, and spores on the underside of the cap. Mushrooms are now widely acknowledged to include all the necessary ingredients for a well-balanced diet. In addition to having a high protein content, mushrooms also have high levels of several vitamins, including vitamins B, C, and D, riboflavin, thiamine, and five nicotinic acids. In addition to folic acid, the mushrooms are a good source of potassium, phosphorus and iron. they unable to manufacture lack own food and must instead rely on the organic substrate because According to (Masarirambi *et al.*, 2011) [15], the. chlorophyll. phosphorus, name "Mushroom" mostly refers to fungi with a stipe, cap, hymenium, and spores on the underside of the cap people Nowadays, it is well accepted that mushrooms provide all the components of a well-balanced diet For mushrooms to grow properly, spawn quality, substrates, temperature, moisture, and medium are all crucial considerations. Mushroom beds are attacked all through the growth season by various common mould, bacteria, etc. The common moulds that have been detected include Aspergillus flavus, *Aspergillus niger*, *Trichoderma sp*., *Rhizopus stolinifera*, *Penicillium sp*., *Fusarium sp*., and *Chaetomium sp*. To avert widespread mould infections in mushroom farming, which have the potential to harm both humans and the environment, it is imperative to stop overusing fungicides. Therefore, research into effective biological control methods is essential.

By utilizing natural processes and helpful microbes, biological control offers a practical and environmentally beneficial method of treating these disorders. By utilizing biological control techniques, you may lessen your dependency on harmful pesticides while simultaneously increasing the security and general health of mushroom crop. By employing this method, we may successfully control common mould infections while preserving the growth of superb, nutritious mushrooms. Additionally, this study aims to identify the most efficient and long-lasting strategy for managing common mould illnesses in terms of productivity by assessing the effectiveness of chemical and non-chemical treatments in controlling common mould diseases in mushroom production. Additionally, employing biological control agents, such as Trichoderma species with antagonistic properties against the pathogenic Trichoderma harzianum, has shown promise in mitigating the threat. These biocontrol agents can be introduced early in the cultivation process to prevent the establishment and spread of the pathogen. Furthermore, implementing integrated pest management (IPM) strategies that combine cultural practices, fungicides, and biocontrol measures can prove effective in suppressing green mould growth and minimizing its impact on mushroom crops. Monitoring and early detection of disease symptoms are essential for timely intervention to prevent further spread. Continued research and development in the field of mushroom disease management are crucial to better understand the biology and behavior of green mould and identify novel and sustainable control methods. By adopting comprehensive disease management approaches, mushroom farmers can protect their crops from the devastating effects of green mould and ensure a healthier and more productive mushroom farming industry. Green mould poses a serious concern to mushroom growers all over the world since it can decimate whole crops, resulting in significant financial losses and, in extreme situations, even crop collapse. The warm, humid environments typical of mushroom growing facilities are ideal for this nefarious disease to flourish. It spreads quickly and colonises the compost and casing soil. When the green mould becomes established, it not only competes for vital nutrients but also emits harmful compounds that prevent the target mushroom species from growing and developing. Mushroom farmers must take a thorough and aggressive effort to counteract the destructive effects of green mould. A crucial step is making sure to use high-quality compost and casing soil because contaminated substrates can be the main point of infection. To stop the spread of spores and mycelium, strong sanitation procedures must be put in place, including routine sterilization of tools and growing areas. An environment that is less favorable for the formation of these dangerous moulds can be created by controlling temperature and humidity as well as providing proper ventilation. The crop's defences can also be strengthened by choosing mushroom strains that exhibit resistance to Trichoderma and other species that cause green mould. Constant watchfulness is essential in the fight against green mould since early identification and fast action are essential to lessening its effects. The removal and destruction of infected batches or targeted fungicidal treatments should be done as soon as symptoms of infection are visible. Working together with knowledgeable mycologists and researchers can offer insightful knowledge into the most recent advancements in green mould management, resulting in a more efficient and long-lasting control plan. Despite the fact that the threat of green mould presents serious difficulties for the mushroom farming industry, adherence to best practises, ongoing research, and the use of cutting-edge methods offer hope for reducing its negative effects and ensuring a successful and resilient mushroom cultivation industry.

Green mould can cause a variety of crop losses; recorded yield losses from *Trichoderma viride* and Introduction *Trichoderma harzianum* of 5-46.87% and 6.25-50.0%, respectively. Typically, the green mould grows in compost that is low in nitrogen and high in carbohydrates. Mycelium that resembles mushroom mycelium may grow in thick, pure white growths on casing surfaces or in compost. Later, excessive sporulation of the causative agent, a defining sign of the condition, causes mycelial mat to turn the green colour of green mould. The casing mixture must be properly pasteurized in order to function. The fungus cannot tolerate exposure to 51 °C for 6 hours or 54 °C for 4 hours. Benomyl and Blitox sprays at concentrations of 400–500 ppm and 400 ppm, respectively, have been proven to be beneficial in reducing illness and boosting their yield. *Scopulariopsis fimicola* caused plaster mould. It prevents the mushroom mycelium from growing, which reduces production by 5 to 30%. After a week from the spot's creation, the white growth turns pale pink. Significant reductions in the spawn run and full crop failures have also been observed in harsh conditions. The pathogen is favored by compost that has been under- or over-composted, has a high pH (greater than 8), and still smells of ammonia. It is advised to compost properly and to add the right amount of water and gypsum. After the mat has been removed, benomyl (0.1%) sprays and local formalin (4%) applications are useful for managing the illness. It is critical to stop overusing fungicides, which have the potential to harm both people and the environment, in order to prevent prevalent mould infections in mushroom cultivation. Therefore, it is crucial to investigate efficient biological control strategies. Biological control provides a viable and eco-friendly approach to treat these diseases by utilizing natural processes and advantageous bacteria. By using biological control methods, you may improve the safety and general health of mushroom production while also reducing your reliance on dangerous pesticides. By using this strategy, we may successfully manage widespread mould illnesses while maintaining the production of healthy, superior mushrooms. The following goals will be pursued in the current investigation: -

1. To evaluate the efficacy of chemical and botanicals treatments in controlling common mould diseases in mushroom cultivation.
2. To determine the most effective and sustainable approach for managing common mould diseases in terms of productivity.

2. Materials and Methods

I. Experimental details

Design	Completely Randomized Design
Replication	03
Treatments	10
Total number of bags	30
Crop	Mushroom

II. Treatment Details

Treatments	Treatment Details
T_1	Wheat straw + 5% Jivamrut
T_2	Wheat straw + 10% Jivamrut
T_3	Wheat straw + 15% Jivamrut
T_4	Wheat straw + 5% Neem water extract
T_5	Wheat straw + 10% Neem water extract
T_6	Wheat straw + 15% Neem water extract
T_7	Wheat straw + 5% Garlic water extract
T_8	Wheat straw + 10% Garlic water extract
T_9	Wheat straw + 15% Garlic water extract
T_{10}	Wheat straw (Control)

III. Observations recorded

a) Days required for mycelial growth of mushrooms

This was recorded by counting days from bag filling to the completion of mycelial growth or spawning runs in individual bags of every treatment.

b) Days required for pinhead formation of mushrooms

Pinhead formation was observed by recording the time taken in days from the filing date of bags to the pinhead formation of each treatment.

c) Days required for the appearance of disease on mushrooms

Disease appearance is to be recorded by counting the days from filling the bags to the appearance of disease symptoms on compost and mushrooms.

d) Total yield

This was calculated by weighing the fresh fruiting body of the total harvested fruiting body of each treatment during the cropping season.

Results

A. Common pathogens associated with the compost of mushrooms

The prevalence of common moulds in mushroom compost was investigated at the Grassroots Agri, Dehradun. The recording of various contaminants and common moulds is shown in Table No. 01 as *Aspergillus niger*, *Aspergillus flavus*, *Rhizopus stolonifera*, *Penicillium sp*., *Trichoderma harzianum*, *Fusarium sp*., and *Chaetomium sp*. *Trichoderma harzianum* accounted for 64.50% of the total, followed by *Rhizopus stolonifera* (18.96%).

B. Evaluation of chemical and non-chemical agents against common moulds

a) Spawn runs (b) and illness incidence (%)

b) Runs of spawn (b) illness incidence (%)

Table 3 presents the outcomes of treating the substrate with a standard dose of 70 ppm of garlic water extract during the spawn run. Wheat straw + Garlic water extract (0.05%) took the shortest time of 13 days to complete the spawn run, whereas the combination of Wheat straw + Garlic water extract (0.15%) required 14 days, and no mold attacks were observed during this period. Another set of results in Table No. 3 illustrates the various timeframes needed for the entire spawn run with a typical dose of botanicals (4%). These findings suggest that the choice and concentration of botanical treatments can significantly affect the speed and success of the spawn run in mushroom cultivation. The formation of a pinhead takes approximately 20 to 28 days. Among the combinations tested, wheat straw and garlic water extract (0.10%) showed the quickest pinning, completing in 20 days.

c) Yield (g/kg)

The total yield was calculated based on the total mushrooms fruiting body harvest after cropping. Yield is the total production of mushrooms. During this research I found the most effective replication is wheat straw and garlic water treatments in this replication we got 500 kg production with 10% garlic water treatments.

Table 1: Shows in average weight of fruiting body and spawn run

Treatments	Inhibition %				
	Incidence of disease	Spawn run	Pinning	Average weight of fruiting body	Yield g/kg
Wheat straw + Jivamrut 5%	4.1	18	23	6	470
Wheat straw + Jivamrut 10%	5	15	23	6.5	473
Wheat straw + Jivamrut 15%	4.3	16	24	6.8	461
Wheat straw + Neem water extract 5%	3	17	24	6.7	450
Wheat straw + Neem water extract 10%	2.9	16	28	6.8	478
Wheat straw + Neem water extract 15%	2.4	14	26	6.75	470
Wheat straw + Garlic water extract 5%	1.2	13	23	7	490
Wheat straw + Garlic water extract 10%	1	14	20	7.2	495
Wheat straw + Garlic water extract 15%	0.5	0.72	0.74	0.6	500
Wheat straw (Control)	2.1	16	23	5.7	396

Discussion

The Grassroots Agri, Dehradun is where the current investigation's findings, which were covered in the preceding chapter, were conducted. the research's findings that were drawn from it. has the strongest inhibition, with a range of 80.14 to 90.20%, as indicated in table 2. The (Wheat straw + Jivamrut 05%) contained the longest spawn run. But for all combinations, the spawn run ranged 12 to 16 days and the pinning duration was between 20 and 28 days. These results are very similar to those from earlier study. The results of the 2015 investigation by Biswas and Biswas showed that the spawn run in wheat straw took roughly 14 days to complete. This finding differs from that of (Lalithadevy *et al*., research from 2014) [14], which noted a longer spawn run duration of 16 to 25 days when utilizing paddy straw as the substrate. These variations in the length of the spawn flow between various substrates highlight the importance of substrate choice in mushroom cultivation. The mycelium's rate of growth can be affected by variables like substrate composition, nutrient content, and physical characteristics, which can then affect the duration of cultivation. In order to maximize the spawn, run period and ensure successful and effective mushroom cultivation, mushroom farmers should carefully take these elements into account. Different chemical compositions may have a negative or positive impact on spawn run, which would explain the variation findings are very similar to those of spawn. Further research comparing different substrates and how that affects the length of the spawn run would be extremely instructive for improving growing techniques and increasing yields in the mushroom farming sector

Conclusion

The mushroom, a saprophytic fungus, depends on the organic substrate for nutrition because it lacks chlorophyll and is unable to synthesize its own food. It consumes organic matter that is decomposing and dead. In addition to having a lot of protein, mushrooms also have a lot of different vitamins, such as riboflavin, thiamine, nicotinic acid, vitamins B, C, and D. In addition to folic acid, the mushrooms are a good source of potassium, phosphorus, and iron. Because mushrooms have a high potassium to sodium ratio, they are a well-balanced source of nutrients that help those with heart and blood pressure issues. In addition to their nutritional value, edible mushrooms are frequently employed for their pharmacological and therapeutic properties.

Many of these serve as competitive moulds, which impede spawn run. For mushrooms to grow properly, spawn quality, substrates, temperature, moisture, and medium are all crucial considerations. Mushroom beds are attacked all during the growing season by a range of common moulds, bacteria, etc. *Coprinus sp.*, *Aspergillus flavus*, *Aspergillus Trichoderma species*, *Rhizopus stolonifera*, *Sclerotium rolfsii*, and *Nigella sp.* are just a few of the widespread moulds that have been identified.

The combination of (Wheat straw + Jivamrut 05%) had the longest spawn run. For all combinations, the spawn run lasts between 13 and 18 days, while the pinning lasts between 20 and 28 days. These results are very similar to those from earlier study. (Biswas and Biswas, 2015) [4] results that the spawn run of paddy straw occurred between 16 to 25 days, which is different from (Lalithadevy *et al*., 2014)'s [14] findings. Different chemical compositions may have a negative or positive impact on spawn run, which would explain the variation findings are very similar to those of the spawn run. The wheat straw with 0.10 percent compound produced the fastest pinning, while the wheat straw plus 10 percent neem water extract produced the slowest pinning, which took 28 days and was equivalent to studies conducted elsewhere. Different researchers reported variable times in many separate investigations that focused on pinhead development on paddy straw as a substrate. According to research done by (Fan *et al*. in 2000) [20], pinhead creation took place over the course of 20 to 23 days. Similar to this, Pinhead development was seen by (Patra and Pani, 1995) [21] to occur during a 20–24-day timeframe. On the other side, discovered that pinhead formation on paddy straw took place for a little while longer, between 23 and 27 days. These conflicting results highlight the complexity of mushroom culture, where a number of variables affect the timing of critical growth stages. The differences in pinhead development times could be explained by a number of variables, including the particular species of mushroom being studied, the environmental conditions present during growing, and the management strategies used by each research team. The pace of mycelium growth and subsequent pinhead initiation can be considerably impacted by changes in substrate quality, moisture content, and temperature. Mushroom farmers should take into account these variables and carry out trials customized to their own circumstances in order to build more reliable and effective farming practices. Improved growth conditions and more reliable and effective mushroom production can result from a deeper understanding of the underlying causes of pinhead formation. Unquestionably, more study in this area will advance the science of mushroom cultivation and offer beneficial information to the agricultural sector.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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