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Original Research Article

Management of the Common Moulds Diseases of Mushroom through Chemical and Non-chemicals

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A B S T R A C T

The maximum inhibition by chemical combinations Wheat straw + Bavistin (0.15%), 90% followed by Wheat straw + Bavistin (0.10%), 86.12% and Wheat straw + Bavistin (0.05%), 82.14%. Effect of chemical and non-chemicals on inhibition of *Aspergillus flavus* presented in reveal that 93% inhibition achieved by the use of Wheat straw + Bavistin 0.15% as highest followed by 88% Wheat straw + Bavistin (0.10%) and 80.16%. The maximum inhibition was observed through chemical as compare to non-chemicals, the highest 92.16% and lowest 84.20% using Wheat straw + Bavistin (0.15% and 0.05%). *Penicillium* sp. show the highest inhibition by chemical as compared to non-chemicals, the highest 92.80% and lowest 78.24% inhibition using Wheat straw + Bavistin (0.15% and 0.05). The 93% inhibition was found in Wheat straw + Bavistin (0.15%) followed by Wheat straw + Bavistin (0.10%) and Wheat straw + Bavistin (0.05%) *i.e*. 85.00% and 83.20% respectively while in non-chemicals. The inhibition of *Fusarium sp*. by chemical and non-chemicals exhibits significant variation among combinations were (Wheat straw + Bavistin 0.05%, 0.10% and 0.15%) ranged between 82.16% and 91.60%. The inhibition of *Chaetomium* sp. was recorded significant by the chemical combinations Wheat straw + Bavistin (0.15%), 90.20% maximum followed by Wheat straw + Bavistin (0.10%), Wheat straw + Bavistin (0.05%) was 83.00% and 80.14% respectively.

Keywords

Common moulds, Chemicals, Spawn running, Mushroom

Introduction

The first mushroom was cultivated in China around 600 A.D. This was *Auricularia auricula*. *Agaricus* is the only one that was not first cultivated in China. The mushroom belongs to Basidiomycota division (Randive 2012). The mushroom is a saprophytic fungus that grows on dead and decaying organic matter. Due to the absence of chlorophyll, it is unable to synthesize its own food and hence is dependent upon the organic substrate for food. As mushrooms are primitive organism. The term mushroom applies mostly to those fungi that have stem (stipe), cap (pileus), hymenium (lamellae) and spores on the underside of the cap (Masarirambi *et al.,* 2011). The mushroom as an excellent food source to alleviate malnutrition in developing countries due to their flavour, texture, nutritional value and high productivity per unit area (Eswaran and Ramabadran, 2000). The Oyster mushroom

can be grown at temperature ranging from 20 to 30^{0}C and relative humidity 55%-70%. The best growing season is during March/April to September/October and in the lower regions from September/October to March/April. *Pleurotus sajor-caju* is rich source of proteins, carbohydrates, minerals & vitamins. It contains digestible proteins (10%-40%), carbohydrates (3%-21%), dietary fibre (3%-35%), on dry weight basis which is higher than those of vegetables and fruits and is of superior quality **(**Mallavadhani *et al.,* 2006). Gunde and Cinerman (1995) reported that Oyster mushroom at maturity has a cap spanning diameter of 5 to 25 cm. The fruiting body of Oyster mushroom differs with respect to stipe length and girth, and pileus width when grown in different farm substrates (Shah *et al.,* 2004). The various crop residues have been used in producing mushrooms either as main substrates or in combination with supplements (Ashraf, 2013). The mushrooms can be grown on various substrates including paddy straw, maize stalks/cobs, vegetable plant residues, sugarcane bagasse (Mendez *et al*., 2005; Hassan *et al*., 2011). The preferred method of cultivation is dependent on the mushroom variety, market demand, farmer's preferences, and availability of growing media (Atikpo *et al*., 2008). The reuse of agricultural wastes for mushroom cultivation serves a dual purpose by eliminating wastes and giving it an added value through production of nutritious low-cost food (Villas Boas *et al.,* 2002).

A number of harmful fungi attack the compost and casing soil during the cultivation and many of these acts as competitor moulds thereby adversely affecting spawn run whereas, others attack the fruiting bodies at various stages of crop growth. At time thus causing complete crop failure depending upon the stage of infection, quality of compost and environmental conditions. General distribution of various competitor moulds and pathogenic fungi are: -

a. Green mould (*Trichoderma* sp.)
b. White plaster mould (*Scopulariosis fimicola*)
c. Yellow mould (*Myceliophthora lutea*).

The successful production of mushroom depends upon the quality of spawn, substrates, temperature, moisture and medium. A number of common moulds, bacteria etc. attack mushroom beds throughout its cropping period. Large number of common moulds *viz. Aspergillus flavus*, *Aspergillus niger*, *Trichoderma* sp., *Rhizopus stolonifera*, *Penicillium sp.*, *Fusarium sp.* and *Chaetomium* sp. have been recorded (Sharma *et al*., 2017). One of the most common and destructive diseases in mushroom cultivation is the green mould which mainly caused by different species of *Trichoderma, Penicillium* and *Aspergillus*. Among these moulds, *Trichoderma* species induce significant quantitative and qualitative losses in the yield of *Agaricus bisporus*, *Pleurotus* species *Auricularia*, *Calocybe indica* and *Lentinula edodes.* The different species of *Trichoderma* (*Trichoderma asperellum*, *Trichoderma atroviride*, *Trichoderma citrinoviride*, *Trichoderma harzianum*, *Trichoderma longibrachiatum*, *Trichoderma pleurotum*, *Trichoderma pleuroticola* and *Trichoderma virens*) cause green moulds on mushroom but *Trichoderma harzianum* is recognised as causing the most severe problems (Seaby, 1996). The crop losses due to green mould are variable; (Jandaik and Guleria, 1999) reported 5-46.87% and 6.25-50.0% yield losses due to *Trichoderma viride* and *Trichoderma harzianum*, respectively. The green mould generally appears in compost rich in carbohydrates and deficient in nitrogen. A dense, pure white growth of mycelium may appear on casing surface or in compost which resembles to mushroom

mycelium. Later on, mycelial mat turns to green colour of green mould because of heavy sporulation of causal agent which is a characteristic symptom of the disease.

The green mould can be prevented by very good hygiene, proper pasteurization and conditioning of compost, using the correct concentration of formalin (maximum 2%) and weekly sprays of mancozeb (0.2%) or bavistin (0.1%) have given effective control of the disease. The yellow mould mainly caused by *Myceliophthora lutea*, *Chrysosporium luteum* and *Chrysosporium sulphureum.* The yellow mould inducing 5-20% loss on the yield of button mushrooms under natural conditions. In India, *Myceliophthora lutea* has been reported to induce mat disease. The yellow moulds may develop in a layer below the casing (mat disease), form circular colonies in the compost where the mycelium is whitish at first then yellow to dark tan with restricted growth and creamish or dull white sporulation as a result fungus forms a yellow brown corky mycelial layer at the interphase of compost and casing which is difficult to detect during the impregnation of casing layer by the spawn and even during the first break. It becomes apparent when it develops its stroma like morphology and mushroom production is severely inhibited. The disease severity is generally more at 70% moisture content of the compost and 19-20°C temperature. The proper pasteurization of the casing mixture is very essential. The fungus does not survive the exposure for 6 hrs. at 51°C or 4 hrs at 54°C.

The benomyl (400-500ppm) and blitox (400ppm) sprays have been found effective to control the disease and increase the yield (Seth and Bhardwaj, 1989). The plaster mould caused by *Scopulariopsis fimicola*. It inhibits the growth of mushroom mycelium causing yield loss to the extent of 5-30 percent. The mould appears as white patches in between or on the compost surface during spawn run stage or also in the casing layer. The white growth changes to light pink after a week of the formation of the spot. The spawn run is reduced significantly and under severe conditions complete crop failure are also recorded. The pathogen is favoured by under or over composted compost which still retains the smell of ammonia and has high pH (more than 8). The proper composting and addition of optimum quantities of water and gypsum are recommended. Sprays of benomyl (0.1%) and local application of formalin (4%) after the removal of the mat are helpful in controlling the disease.

Materials and Methods

Preparation of substrates

The wheat straw was soaked in fresh water for 3 to 4 times then excess water was allowed to drain off and spread in shady place on cleaned surface when optimum moisture level obtained then this substrate was pasteurized by chemical treatment with 150ml of formalin + 6g of bavistin solution per 100kg of substrates and kept for overnight thereafter substrate was put on a sieve for drained water after that substrate was spread on clean surface in shady place for optimum moisture level.

Disinfection of mushroom house

The rooms which are used for spawning, spawn running, and cropping was cleaned and washed thoroughly with clean tap water. The rooms were sprayed with 5% solution of bavistin. The rooms were also fumigated with 2.5 percent formaldehyde for 48 hours.

Preparation of mushroom bed

The sterilized polythene bags (20''×16'') with 2% solution of formalin and corner of the bags tied with string for bed assume

round shape. During filling the wheat straw substrate spawning was done in multi-layered @ 3 percent of wet weight of the substrate. The bags were filled up to 3/4 portion of the capacity and mouths were closed tightly with threads with the help of sterilized needle, about 25-30 minutes holes all-round the filled bags were made for the release at gases formed.

Crop management

After spawning, the bags were placed in dark room with optimum temperature 26^0C in mushroom house. During spawn run no light and cross ventilation allowed. substrate fully covered with mycelium, the polythene bags were removed to expose the substrate surface for initiation of pinhead formation and kept on iron racks with 40cm gap between two shelve in cropping room of the mushroom house for fruiting. The water was sprayed regularly on the compact mass of substrate to keep it wet. The temperature of mushroom house was maintained between 21 to 26^0C during the experimental period. The humidity of the cropping room was maintained at 85 to 90% by humidifier during the cropping period light was provided 2-3 hours by 40 watts bulbs and 3-4 hours cross ventilation by opening doors and windows. The open beds were observed carefully still harvesting.

Results and Discussions

The experiment was designed in laboratory taking the said chemical and non-chemicals. The data is presented in (Table-1 and Fig. 1).

Aspergillus niger and *Aspergillus flavus*

The maximum inhibition by chemical combinations Wheat straw + Bavistin (0.15%), 90% followed by Wheat straw + Bavistin (0.10%), 86.12% and Wheat straw + Bavistin (0.05%), 82.14%. These combinations were at par with each other, while 64.16% was recorded using non-chemicals Wheat straw + Neem water extract (15%) followed by 54.20% by Wheat straw + neem water extract (10%), 44.14% through Wheat straw + Neem water extract (05%) and the inhibition ranging of *Aspergillus niger* by the Wheat straw + Jivamrut was recorded 22.28%-43.20% but 43.20% inhibition at Wheat straw + Jivamrut (10%) and 22.28% inhibition at Wheat straw + Jivamrut (05%) was the lowest inhibition among all combinations (Wheat straw + Bavistin 0.05%, 0.10%, 0.15%, Wheat straw + Neem water extract 05%, 10%, 15% & Jivamrut 05%, 10%, 15%) show in table-1. Data on effect of chemical & non-chemicals on inhibition of *Aspergillus flavus* presented in table 1 reveal that 93% inhibition achieved by the use of Wheat straw + Bavistin 0.15% as highest followed by 88% Wheat straw + Bavistin (0.10%) & 80.16% Wheat straw + Bavistin(0.05%) whereas in case of non-chemicals, the Wheat straw + Neem water extract inhibits 68.40% by 15% concentrations was maximum among non-chemicals followed by 56% at 10%, 42.16% at 15% concentrations and Wheat straw + Jivamrut has 43.20% by 10%, 32% by 15% & 25.36% by 05% concentrations.

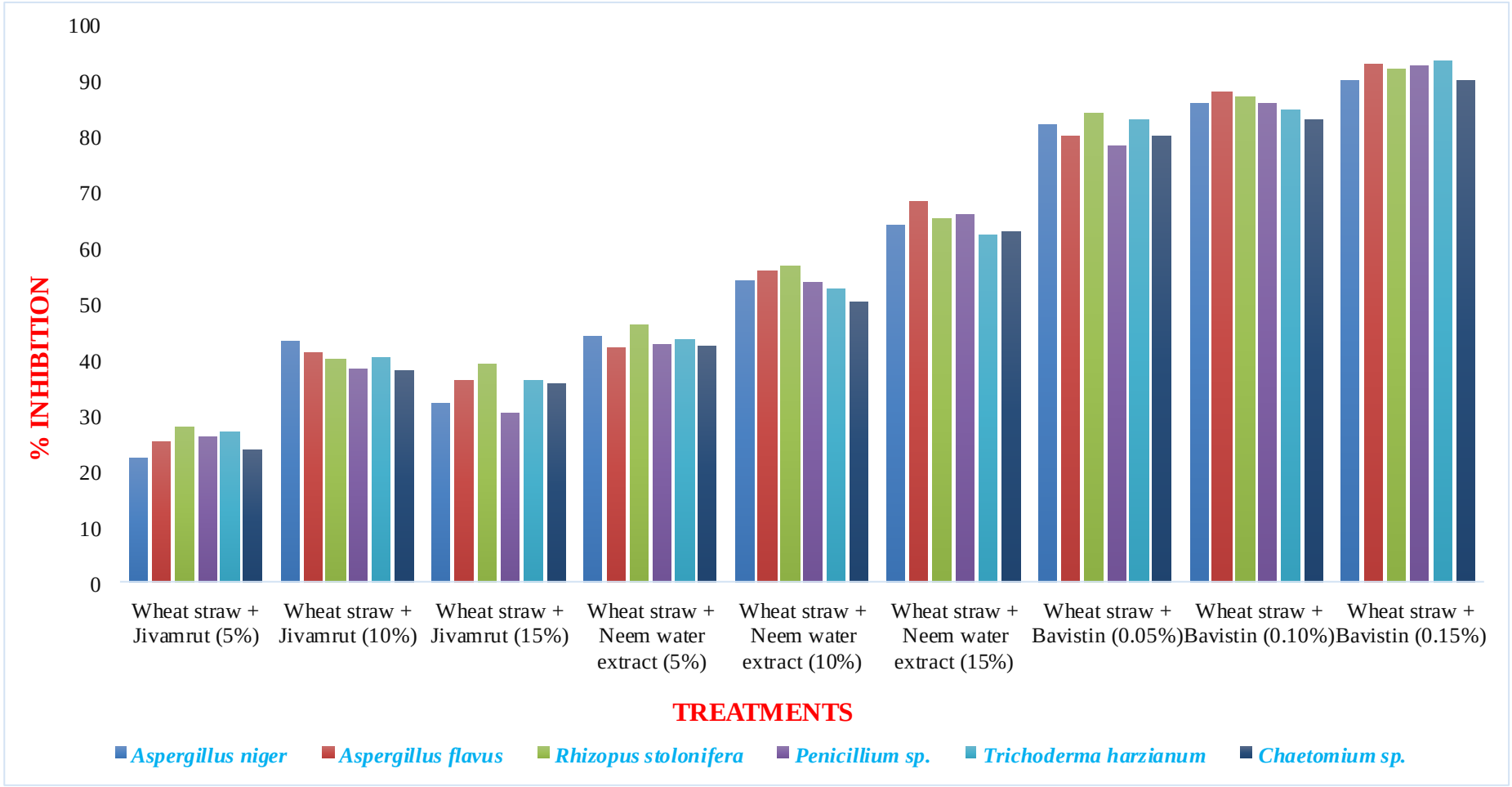
Rhizopus stolonifera, Penicillium sp. and *Trichoderma harzianum*

The maximum inhibition was observed through chemical as compare to non-chemicals, the highest 92.16% & lowest 84.20% using Wheat straw + Bavistin (0.15% & 0.05%), respectively while in non-chemicals the Wheat straw + Neem water extract (15% & 5%) and Wheat straw + Jivamrut (10% & 5%) recorded inhibition ranging 46.14% to 65.30% & 28,04 to 40.20% respectively.

Table.1 Evaluation of different chemical and non-chemicals inhibition mould *in vitro* condition

% inhibition							
Treatments	*Aspergillus niger*	*Aspergillus flavus*	*Rhizopus stolonifera*	*Penicillium* sp.	*Trichoderma harzianum*	*Fusarium* sp.	*Chaetomium* sp.
Wheat straw + Jivamrut (5%)	22.28	25.36	28.04	26.26	27.21	22.23	24.00
Wheat straw + Jivamrut (10%)	43.20	41.30	40.20	38.44	40.24	36.16	38.04
Wheat straw + Jivamrut (15%)	32.16	36.38	39.30	30.40	36.36	34.15	35.60
Wheat straw + Neem water extract (5%)	44.14	42.16	46.14	42.80	43.60	41.40	42.40
Wheat straw + Neem water extract (10%)	54.20	56.00	56.80	53.86	52.60	52.00	50.40
Wheat straw + Neem water extract (15%)	64.16	68.40	65.30	66.00	62.40	60.00	63.20
Wheat straw + Bavistin (0.05%)	82.14	80.16	84.20	78.24	83.20	82.16	80.14
Wheat straw + Bavistin (0.10%)	86.15	88.00	87.20	86.00	85.00	87.00	83.00
Wheat straw + Bavistin (0.15%)	90.10	93.00	92.16	92.80	93.76	91.60	90.20
Control	00.00	00.00	00.00	00.00	00.00	00.00	00.00
C.D.	9.283	10.012	9.418	9.235	9.226	8.268	7.983
C.V.	10.398	10.998	10.288	10.460	10.259	9.514	9.180
SE±(m)	3.125	3.370	3.170	3.109	3.106	2.783	2.687
SE(d)	4.419	4.766	4.483	4.396	4.392	3.936	3.800

Fig.1 Evaluation of different non-chemicals and chemicals inhibition of mould *in-vitro* condition



Penicillium sp. show the highest inhibition by chemical as compared to non-chemicals, the highest 92.80% and lowest 78.24% inhibition using Wheat straw + Bavistin (0.15% & 0.05), respectively while in non-chemicals the Wheat straw + Neem water extract (15% & 5%) and Wheat straw + Jivamrut (15% & 5%) recorded inhibition ranging 66.00 % to 42.80% and 38.44% to 26.26% respectively. The chemical and non-chemicals found effective against *Trichoderma harzianum.* The data depicted in table 1 indicated the 93% inhibition was found in Wheat straw + Bavistin (0.15%) followed by Wheat straw + Bavistin (0.10%) and Wheat straw + Bavistin (0.05%) i.e. 85.00% & 83.20% respectively while in non-chemicals, Wheat straw + Neem water extract (05%, 10% & 15%) was more effective as compared to Wheat straw + Jivamrut (05%, 10% & 15%), the inhibition by neem water extract varies from 43.60% (05%) to 62.40% (15%) and by Jivamrut varies from 27.21% (05%) to 40.24% (10%).

Fusarium sp. and *Chaetomium* sp.

The inhibition of *Fusarium sp.* by chemical and non-chemicals exhibits significant variation among combinations were (Wheat straw + Bavistin 0.05%, 0.10% & 0.15%) ranged between 82.16% and 91.60%. The Wheat straw + Jivamrut (05%, 10% & 15%) was 22.23%, 36.16% & 34.15% inhibits *Fusarium* sp. whereas Wheat straw + Neem water extract (05%, 10% & 15%) was 41.40%, 52.00% & 60.00% was superior over the Wheat straw + Jivamrut. The inhibition of *Chaetomium* sp. was recorded significant by the chemical combinations Wheat straw + Bavistin (0.15%), 90.20% maximum followed by Wheat straw + Bavistin (0.10%), Wheat straw + Bavistin (0.05%) was 83.00% and 80.14% respectively whereas, in non-chemicals the combinations of Wheat straw + Neem water extract (15%) inhibits the *Chaetomium* sp**.** (61.20%), followed by Wheat straw + Neem water extract (10%) and Wheat straw + Neem water extract (05%) inhibit 50.40% & 42.40%. In the combinations of Wheat straw + Jivamrut (05%, 10%, & 15%) inhibits the mycelial growth of *Chaetomium* sp. were 24.00%, 38.04% & 35.60% respectively. The seven common moulds were isolated, identified from the combination of Wheat straw + Jivamrut (05%, 10%, 15%), Wheat straw + Neem water extract (05%, 10%, 15%), and Wheat straw + Bavistin (0.05%, 0.10%, 0.15%) as depicted in table 1, among all three combinations of bavistin exhibits highest inhibition, ranges from 80.14 to 90.20%. These results are quite similar to studies conducted by others Biswas and Biswas (2015) reported spawn run in wheat straw 14 days while Lalithadevy *et al*., (2014) 16-25 days in paddy straw.

In conclusion, a number of harmful fungi attack the compost and casing soil during the cultivation and many of these acts as competitor moulds thereby adversely affecting spawn run whereas, others attack the fruiting bodies at various stages of crop growth at time thus causing complete crop failure depending upon the stage of infection, quality of compost and environmental conditions.

The successful production of mushroom depends upon the quality of spawn, substrates, temperature, moisture and medium. A number of common moulds, bacteria etc. attack mushroom beds throughout its cropping period. A large number of common moulds *viz. Aspergillus flavus, Aspergillus niger, Trichoderma* sp., *Rhizopus stolonifera, Penicillium sp., Fusarium sp.* and *Chaetomium* sp. have been recorded.

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