EFFECT OF DIFFERENT SUBSTRATES ON GROWTH AND YIELD OF *PLEUROTUS OSTREATUS*

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Abstract

Among different substrate, wheat straw shows minimum time for spawn run (18.75 days) while the maximum was seen in pine needle (33.25 days). The minimum time taken for pinhead formation was seen in case of wheat straw (23.50 days) while the maximum time was taken by pine needle (39.0 days). Wheat straw(30.25 days) exhibited the fastest growth in respect to fruiting body formation.Paddy straw showed the maximum stipe length (3.62 cm) and stipe width (0.88 cm) for *Pleurotus ostreatus*. Number of fruiting body and weight of fruiting body/ bag was more in case of wheat straw (8.91/bag) and (247.90 g). Cap diameter was recorded best in wheat straw (8.42 cm) while low size cap are found in case of pine needle (5.76 cm). Maximum yield was recorded on wheat straw (688.52 g) while minimum yield in was founded in pine needle (326.82 g). Biological efficiency was maximum in wheat straw followed by paddy straw.The total biological efficiency was maximum in wheat straw(68.84%).

Keywords- Nil

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INTRODUCTION

The mushroom cultivation had been began in China in 600 A.D. All over the world China produce 85% of it. The total production of *Pleutrous* in India is around 21272 metric tonnes, which is highest in Odisha *i.e.* 6310 metric tonnes (Sharma *et al*., 2017). *Pleurotus* spp. are popular and widely cultivated throughout the world (Mane *et al*., 2007; Alam and Raza, 2001; Shah *et al*., 2004; Flores, 2006). Among oyster mushroom *Pleurotus ostreatus* is one of the best known species. After *Agaricus bisporus* which as first cultivated in Germany (Flack, 1917), *Pleurotus ostreatus* is the second most cultivated edible mushroom with great economic significance (Sanchez, 2010).

Cultivation of *Pleurotus* spp. has greatly increased all over the world during the last few decades, especially in different Asian countries. Cultivation of edible mushroom is a controlled bioconversion of agro-industrial lingo-cellulosic wastes and residues, not only in recycling of agro-wastes but also helps in filling up the protein gap among large vegetarian population of the country.Oyster mushroom can grow and ultilize various kinds of substrate materials than any other mushrooms (Cohen *et al*., 2002). *Pleurotus* spp. can be grown on a vast variety of crop residues because it has a great ability to grow on residues (Mamiro *et al*., 2011). *Pleurotus ostreatus* can be grown on various substrates including wheat straw, paddy straw, pine needle, finger millet straw, chestnut leaves etc. *Pleurotus ostreatus* is a magical crop to be cultivated in developing countries, the first point would be that they can be grown on variety of agricultural residues and it converts a high percentage of the substrate to fruiting bodies, increasing profitability. *Pleurotus ostreatus* demands few environmental controls, and their fruiting bodies are not often attacked by diseases and pests, and they can be cultivated in a simple and economic way (Kues and Liu, 2000).

Biological efficiency of a mushroom is the percentage measurement of the yield of fresh mushrooms from the dry weight of the substrate. Oyster mushroom can be grown directly on unfermented substrate derived from a wide variety of crop residues. They utilize organic waste rich in lignocellulosics. Species of oyster mushroom show great adaptability to a wide range of temperature, which make it possible to grow this mushroom almost round the year without recourse to controlled climatic conditions. The mushroom is cultivated indoors using polyethylene bags. As a primary decomposer they are able to colonise and decompose dead plant tissue.

MATERIALS AND METHODS

The investigation was carried out in Department of Plant Pathology and mushroom demonstration unit, College of Horticulture, VCSG Uttarakhand University of Horticulture & Forestry Bharsar, Pauri Garhwal, Uttarakhand during 2018-2019..

Preparation of mother culture

Preparation of spawn is done by using wheat grains as a substrate. First the grains

were cleaned manually. The cleaned grains were thoroughly washed and soaked in tap water then the rotten grains or other floating on the surface of water were removed. Then the cleaned grains were boiled in tap water for at least 30 minutes. The grains should not be over boiled and not be rupture. After that, the grains were drained and excess water removed with keeping on a wire mesh for 8-10 h, in the ratio of 1:3 Chalk powder and Gypsum were added to the boiled grains to prevent sticking of grains and to maintain proper pH.

The grains were filled in polypropylene bags; in each polythene bags about 200gm of grains were packed. The polypropylene bags were sealed using cotton plugged and then after autoclaved at 121°C with a pressure of 15 psi for 2 hours for sterilization, allow the sterilized bags to cool for 24 hours. After cooling, these bags were immediately transferred to laminar air flow cabinet (inoculation chamber) and kept under UV light for minimum 45-60 minutes for surface sterilization to avoid any contamination. After that bags were immediately inoculated with mycelial culture of *Pleurotus osteratus*, and then these bags were kept into the incubator at the temperature of 25^{0}C till the grains were fully impregnated with the mycelium of inoculated fungus culture (10-15 days) and were ready as mother culture for further multiplication. These bags were stored at 4^{0}C and used for further multiplication of spawn.

***In vivo* experiment**

Effect of *Pleurotus osteratus* on different substrates.

Different agro-based wastes substrates were tried to see the ability of *Pleurotus osteratus* five test substrates were used namely wheat straw, paddy straw, finger millet straw, chestnut leaves and pine needle were used to colonize and form fruiting bodies are as follows: Firstly, substrates were washed in fresh water. The chopped substrates were dipped in clean water containing 75 ppm carbendazim + 500 ppm formaldehyde for 18 hours against the mould infestation. After 18 hours when the substrates were dry (75% moisture). The ingredients were mixed thoroughly with hands which were then filled in polythene bags (30gm/ bag) and spawning were done @ 3% wet weight basis of substrates by thoroughly mixing. Then these bags were transferred to crop room for spawn run. Temperature and relative humidity were maintained between 16 to 20^{0}C and 70 to 90% for spawn run. Four replication of each treatment were kept throughout the cultivation studies.

Spawn-run

Before mixing of substrates with spawn the surface and the cropping bags were thoroughly sterilized with 2% formalin solution to avoid the contamination. The sterilized substrates were inoculated aseptically on the surface with freshly prepared spawn @ 3%. Temperature was maintained between 18-25^{0}C and relative humidity was maintained between 75-85%. To maintain the humidity water is sprayed daily on the floor of the crop room. Then complete mycelial run time was recorded.

Incubation period and crop room

In dark room the bags filled with substrates were kept vertically. After complete spawn run the bags were then opened with sterilized knife to expose the surface of the bags. The time taken for complete spawn run on different substrates was recorded.After fully colonization the substrates were transferred to growth room placed on wood racks at the spacing of 15 cm. Proper ventilation was maintained in growth room. To keep the mycelial moist inoculated bags were watered in every 2-3 times in a day. With thermo-hydrometer room temperature and relative humidity were monitored and maintain and R.H. was maintained between 80-85% by spraying fine mist of water.

Harvesting

Daily the proper growth and development of mushroom were monitored. Mushroom was picked up by careful and slight twisting so that other mature sporophores did not get harmed or damaged. Yield was calculated as weight (gm) of mushrooms produced per gram of substrates.

EXPERIMENTAL RESULTS

The present investigation was carried out onthe topic entitled Comparative studies on growth and yield of *Pleurotus ostreatus* on different substrates. Department of Plant Pathology, College of Horticulture, VCSG Uttarakhand University of Horticulture & Forestry Bharsar, Pauri Garhwal, Uttarakhand during 2018-2019.The experimental results have been presented under the following headings.

Multiplication and maintenance of pure culture of *Pleurotus osteratus*

Potato dextrose agar media was found to be most suitable. *Pleurotus ostreatus* completely covered the Petri dishes on 10th day.The colour of colony was pure cottony.

Spawn growth and development

Preparation of quality spawn is very important, wheat grains substrate was used for the preparation of spawn. Under material and methods the sterilization and preparation of substrates was described. The spawn run period for *Pleurotus ostreatus* was 14.25 days.

Effect of substrates on quality of *Pleurotus ostreatus*

Spawn run period (days)

The data presented in Table 1 showed that the minimum time for spawn run was recorded in wheat straw(18.75 days). The next minimum time for spawn run was recorded inpaddy straw (22.75 days) which was found statistically at par with finger millet straw (23.75 days). Spawn run period for chestnut leaves (30.50 days) while maximum in case pine needle 33.25 days.

Maturation of pinhead (days)

The result presented in Table 1 indicated that the minimum time for the maturation of pinhead was taken by wheat straw (23.50 days). The next minimum time for the maturation of pinhead was recorded in paddy straw (28.5 days) which was statistically at par

with finger millet straw (30.50 days). Chestnut leaves took 36.75 days while, maximum time of 39.00 days was recorded in case of pine needle.

Fruiting body formation (days)

The result of the experiment was presented in Table 4.1. It was observed that wheat straw takes the minimum time for fruiting body formation (30.25 days) followed by paddy straw (36.00 days), finger millet straw (38.25 days),chestnut leaves (43.00 days) and maximum days was taken by pine needle (54.50 days).

Table 1. Effect of different substrates on spawn run, pinhead formation and fruiting body formation

S. No.	Name of the substrates	Spawn run(days) ±SE(m)	Pinhead formation(days) ±SE (m)	Fruiting body formation(days) ±SE (m)
1	Wheat straw	18.75±0.25	23.50±0.28	30.25±0.47
2	Paddy straw	22.75±1.10	28.50±0.64	36.00±0.40
3	Fingermillet straw	23.75±0.85	30.50±0.64	38.25±0.47
4	Chestnut leaves	30.50±0.64	36.75±0.75	43.00±0.40
5	Pineneedle	33.25±0.85	39.00±0.91	54.50±0.28

Stipe length (cm)

The data recorded in Table 2 indicate that the maximum stipe length was found in paddy straw (3.62 cm) and it wasfound statistically at par with wheat straw (3.59 cm) while minimum stipe length was recorded in pine needle (1.98 cm) and it wasfound statistically at par with chestnut leaves (2.11 cm).

Stipe width (cm)

The data exhibited in Table 2 revealed that the maximum stipe width was recorded in paddy straw (0.88 cm) and it was found statistically at par with wheat straw (0.78 cm) while minimum stipe width was recorded in pine needle (0.23 cm).

Number of fruits/ bag

The result of experiment for the number of fruits/ bag is presented in Table 2. It was observed that the maximum number of fruits/ bag was in case of wheat straw (8.91) which was found statistically at par with paddy straw (7.59) while it ended

with pine needle which had minimum number of fruiting body (4.73) which was statistically at par with chestnut leaves (5.07).

Table 2Effect of different substrates on stipe length, stipe width and number of fruiting body/ bag

S. No.	Name of substrates	Stipe length (cm) ± SE(m)	Stipe width (cm) ± SE(m)	No. of fruiting body /bag ± SE(m)
1	Wheat straw	3.59±0.31	0.78±0.02	8.91±0.57
2	Paddy straw	3.62±0.40	0.88±0.08	7.59±0.88
3	Fingermillet straw	2.63±0.13	0.70±0.01	6.92±0.06
4	Chestnut leaves	2.11±0.01	0.38±0.01	5.07±0.04
5	Pine needle	1.98±0.05	0.23±0.02	4.73±0.08

Weight of fruits (gm) / bag

The data recorded in Table 3indicates that the fruiting body present in wheat straw had maximum weight (247.90 gm) followed by paddy straw (195.02 gm), finger millet straw (145.77 gm) and chestnut leaves (103.30 gm) while minimum weight of fruit was recorded in case of pine needle (66.60 gm).

Cap diameter (cm)

The data recorded in Table 3 revealed that the maximum cap diameter was seen in case of wheat straw (8.42 cm) which was found statistically at par withpaddy straw (7.81cm) while minimum size of cap diameter was recorded in pine needle (5.76 cm) which was found statistically at par with chestnut leaves (5.97 cm) and finger millet straw (6.56 cm).

Biological efficiency (%)

The overall biological efficiency was recorded in Table 3 The maximum efficiency was observed on wheat straw (68.84%) followed by paddy straw (56.16%), finger millet straw (49.49%), chestnut leaves (43.19%) while minimum was seen in pine needle (32.68%).

Table 3 Effect of different substrates on weight of fruiting body, cap diameter and biological efficiency

S. No.	Name of substrates	Weight of fruiting body (gm)/ 1 kg bag± SE (m)	Cap diameter (cm)± SE(m)	Biological efficiency (%)
1	Wheat straw	247.90±7.57	8.42±0.16	68.84
2	Paddy straw	195.02±7.09	7.81±0.67	56.16
3	Fingermillet straw	144.77±3.33	6.56±0.08	48.49
4	Chestnut leaves	103.30±3.21	5.97±0.04	43.19
5	Pine needle	66.60±4.38	5.76±0.08	32.68

Yield on different substrates

Flush wise yield (gm)

The flush wise yield data has been presented in Table 4. In different substrate *i.e.*wheat straw, paddy straw, finger millet straw, chestnut leaves and pine needle, the result obtained for 1st flush is (262.72 gm), (237.47 gm), (207.50 gm), (184.84 gm) and (156.71 gm) respectively while in second flush the wheat straw yielded (213.11 gm), paddy straw (184.55 gm), finger millet (163.55 gm), chestnut leaves (150.85 gm) and pine needle yielded (115.66 gm). However, the minimum yield was recorded in 3rd flush for the respective substrates wheat straw (162.69 gm), paddy straw (139.60 gm), finger millet straw (123.90 gm), chestnut leaves (96.24 gm) and pine needle (54.45 gm).

Total yield (g)

The data in Table 4 exhibited that the total yield was maximum in wheat straw (638.52 gm) followed by paddy straw (561.62 gm), finger millet straw (494.95 gm), chestnut leaves (431.93 gm) while minimum yield was recorded in pine needle (326.82 gm).

Average yield of different flushes (g)

The data exhibited in Table 4, indicated that the average yield of different flushes was maximum in wheat straw (212.84 gm) followed by paddy straw (187.20 gm), finger millet strawrecorded average yield of (164.98 gm), chestnut leaves (143.97 gm) while minimum average yield was recorded in pine needle (108.93 gm).

Table 4 Effect of differentsubstrates on different flushes and total yield

S. No	Name of substrates	First flush (gm)± SE(m)	Second flush(gm) ± SE(m)	Third flush (gm)± SE(m)	Total yield (gm)± SE(m)	Average yield (gm)± SE(m)
1	**Wheat straw**	262.72 ± 6.50	213.11±3.66	162.69±3.19	638.452±9.06	212.89±3.04
2	**Paddy straw**	237.47± 0.87	184.55±2.10	139.60±3.64	561.62±3.32	187.20±1.10
3	**Fingermillet straw**	207.50± 2.71	163.55±2.27	123.90±0.92	494.95±4.02	164.98±1.33
4	**Chestnut leaves**	184.84±2.15	150.85±3.06	96.24±1.65	431.93±3.44	143.97±1.14
5	**Pineneedle**	156.71±0.90	115.66±1.95	54.45±2.01	326.82±1.52	108.93±0.50

DISCUSSION

A wide range of grains have been used for spawn preparation. Out of various grains wheat grain is universally expected for the spawn production of various *Pleurotus* species as it takes the minimum time for mycelium growth *i.e.* 10-15 days. Similar findings were also reported by Tesfaw *et al*. (2015) that *P. osteratus* covered the wheat grain with fully mycelium growth within 10-15 day.In present study wheat straw (18.75 days) gave the best results followed by paddy straw, finger millet straw, chestnut leaves and pine needle exhibited good growth. This outcome was comparatively similar to the findings of some authors *i.e.* Holkar and Chandra (2016), Kimenju *et al*.(2009) who reported that *Pleurotus osteratus* takes two to three weeks for complete spawn run.The appearance of pinhead was seen earlier in wheat straw (23.5 days) and pine needle (39 days) ended with the slowest growth. Similar results were seen by Kimenji *et al*. (2009) who reported that wheat straw takes 28.80 days for pin head formation. Naeem *et al*. (2014), Sharma *et al*. (2013) also found same results.The results recorded revealed that, the minimum number of days taken for pin head maturation was in case wheat straw (30.25 days) and maximum number of days were taken in pine needle (54.50 days). Earlier workers like Iqbal *et al*. (2005), Sharma *et al*. (2013) and Ashraf *et al*. (2013) also found compatibility between these.In present investigation, the maximum stipe length was found in paddy straw (3.62 cm) followed by wheat straw (3.59 cm) and minimum was seen in case of pine needle

(1.98 cm). Similar result was obtained by Girmay *et al*. (2016) that the length of stipe is (2.81 cm), Salama *et al.* (2016) also concluded the same result.The study revealed that the maximum stipe width was found in paddy straw (0.88 cm). Girmay *et al*. (2016) have also observed same result during their investigation.Thepresent investigation (Table 4.5) revealed that wheat straw had maximum number of fruiting body/bag (8.91) and minimum in pine needle (4.73). Earlier workers like Salama *et al.* (2016), Kumar *et al*. (2008) also found same result during their investigation.The result indicates that the maximum weight of fruiting body was observed in wheat straw (247.90 gm/bag). This outcome was comparatively similar to the findings of Salama *et al*. (2016), Kumar *et al*. (2018).The maximum size of cap diameter was recorded in wheat straw (8.42 cm) and minimum size of cap diameter was observed in pine needle (5.76 cm). Sharma *et al*. (2013) also found that the wheat straw have largest cap diameter of 8.60 cm. In different substrates *P. ostreatus* showed the highest flush wise yield on wheat straw (262.72 gm) and minimum in case of pine needle (156.71gm). Similar result were concluded by Kimenju *et al*. (2009), Holkar and Chandra (2016), Gorai and Sharma (2018) during their study.Among different substrates used wheat straw had highest average yield (212.84gm) while pine needle have minimum average yield (108.93gm). Holkar and Chandra (2014) found similar result during their research work.In present study wheat straw had maximum total yield in different flushes (638.52gm) while pine needle ended with the minimum total yield of (326.82gm). Kimenju *et al.* (2009) also reported that wheat straw (115.4 gm/ 250 gm of substrate) have maximum yield as compared to rice straw and finger millet straw. Sharma *et al*. (2013), Ashraf *et al*. (2013) concluded the same result during their investigation.In this experiment five treatments were observed and indicated that significant biological efficiency. The present study revealed that maximum biological efficiency was in case of wheat straw (68.84%) whereas minimum in case of pine needle (32.68%). Salama *et al*. (2016), Kimenju *et al.* (2009) also concluded same result during their investigation.

CONCLUSION

The minimum time for spawn run was recorded in wheat straw (18.75 days) while the maximum was seen in pine needle (33.25 days).The minimum time taken for pin head formation was seen in case of wheat straw (23.50 day) while the maximum time was taken by pine needle (39.0 days).In case of fruiting body formation, wheat straw exhibited the fastest growth.Paddy straw showed the maximum stipe length (3.62 cm) and stipe width (0.88 cm) for *Pleurotus ostreatus*.Number of fruiting body was maximum in case of paddy straw (8.91/ bag) while minimum number of fruiting body appeared in pine needle (4.73/ bag).Maximum weight of fruiting body/ bag was found in wheat straw (247.90 gm).Cap diameter was recorded best in wheat straw (8.42 cm) while low size cap are found in case of pine needle (5.76 cm).Maximum yield was recorded on

wheat straw (638.52 gm) and minimum yield in case of pine needle (326.82 gm).Biological efficiency was maximum in wheat straw followed by paddy straw.

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