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Effect of grain substrates on spawn development and their impact on yield and yield attributing characters of *Pleurotus* spp.

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Abstract
An experiment was conducted to know the effect of different grains *i.e*. sorghum (*Sorghum bicolor*) and wheat (*T. aestivum*) on spawn development of different species of *Pleurotus.* On sorghum grains, PL-17-04 and PL-17-05 species of *Pleurotus* required significantly less (8.00 days) time for spawn development and at par with PL-17-03 and PL-17-12 (9.00 days), whereas more period taken by species PL-17-10 (14.00 days) for complete spawn development. On wheat grains, among the evaluated species PL-17-05 and PL-17-12 took significantly less (10 days) period for spawn development and all the grains were uniformly covered by white mycelial growth, however, the grains inoculated with species PL-17-07 and PL-17-09 required more (15 days) period for complete spawn development. The other species required 11-13 days for complete spawn development. On sorghum grains raised spawn, significantly less (7.00 days) period for complete spawn run was noticed in species PL-17-06, Pl-17-08, Pl-17-12 and it was significantly more (13.00 days) observed in species PL-17-05. Pin head initiation was significantly earlier (3.00 days) noticed in species PL-17-11 and PL-17-12 while, it was significantly more (10.0 days) in species PL-17-10. The species Pl-17-08 gave significantly bigger (8.38 cm) size of pileus and smallest (4.16 cm) noted in species PL-17-04. Significantly highest (3.8 cm) and shortest (0.88 cm) length of stipe was recorded in species PL-17-11 and PL- 17-12 respectively. The yield in different species of *Pleurotus* differs significantly with each other and maximum (668.0 gm) yield was obtained from species PL-17-11 while species PL-17-10 gave minimum (251.0 gm) yield of *Pleurotus.* On wheat grains raised spawn, PL-17-12 gave significantly faster (7.00 days) spawn run and it was significantly slower (16.00 days) noticed in species PL-17-07. Significantly earliest pinhead initiation was observed in species PL-17-11 and PL-17-12 (3.00 days) while, it was slowest (9.00 days) noted in species PL-17-10. Significantly biggest (8.76 cm) pileus was found in species PL-17-08 and smallest (4.26 cm) was recorded in species PL-17-10. The highest (3.8 cm) stipe length was recorded in species PL-17-11 and shortest (0.87 cm) was recorded in PL-17-12. Wheat grains raised spawn showed significant difference in yield with respect to different species of *Pleurotus* and significantly more (546.00 gm) yield was obtained from species PL-17-11 and it was significantly less (298.00 gm) found in species PL-17-10. The biological efficiency in different species of *Pleurotus* in accordance with that of yield on both grains used for spawns development.

Keywords: Grains, *Pleurotus* spp., dhingri, yield and BE

Introduction
Oyster mushroom (*Pleurotus* sp.) belonging to Class Basidiomycetes and Family Agaricaceae and popularly known as *"dhingri.*" Naturally it grows on wood logs in temperate and subtropical forests on dead and decaying wood logs and it may also grow on decaying organic matter. The fruit bodies of this mushroom are distinctly shell or spatula shaped with different shades of white, cream, grey, yellow, pink or light brown depending upon the species. Oyster mushroom is the third largest cultivated mushroom. The economic importance of the mushroom lies primarily in its use as food for human consumption. It is rich with Vitamin C and B complex and the protein content varies between 1.6 to 2.5 percent & mineral salts are available which is required for the human body. The niacin content is about ten times higher than any other vegetables. The folic acid present in oyster mushrooms helps to cure anemia. It is suitable for people suffering from hyper-tension, obesity and diabetes due to its low sodium: potassium ratio, starch, fat and calorific value. Alkaline ash and high fiber content makes them suitable for those having hyperacidity and constipation (Randiev, 2012) [1].

Mostly grain spawn is used for cultivation of oyster mushroom. Moorthy and Mohanan (1991) [2] have grown stock spawn on sorghum grains. Mansur *et al*., (1992) [3] reported that the different spawn substrates showed the order: wheat seeds better than millet seeds better than ground maize cobs. Cangy and Peerally (1995) [4] reported that 10 different species of *Pleurotus* exhibited maximum growth rate (14-15 mm/day) at 25-30 ºC.

Marimuthu (1995) [5] reviewed the use of crop residues as growing media for oyster mushroom (*Pleurotus*) production in Tamil Nadu and stated that *Pleurotus* has high potential because of its low-cost production technology, the possibility for direct use of agro-wastes and the suitability of the climate. Cultivation of *Pleurotus* species offers the opportunity to utilize renewable resources in the production of edible, protein-rich food that will sustain food security for people in developing countries (Sanchez *et al*., 2002) [6]. Cultivation of edible mushrooms is one of the most economically viable processes for the bioconversion of lignocellulosic wastes (Bano *et al*., 1993; Cohen *et al*., 2002) [7-8]. The technology can also limit air pollution associated with burning agriculture wastes as well as to decrease rodents, pests and deleterious fungal inoculum populations. In present experiment, wheat and sorghum grains were used for spawn development of 12 *Pleurotus* species and prepared spawn was cultivated for yield and yield attributing characters.

Materials and Methods

Pure culture of *Pleurotus* species

Pure culture of 12 *Pleurotus* species (PL-17-01, PL-17-02, PL-17-03, PL-17-04, PL-17-05, PL-17-06, PL-17-07, PL-17-08, PL-17-09, PL-17-10, PL-17-11 and PL-17-12) were collected from AICRP on mushroom, Department of Plant Pathology, CoA, IGKV, Raipur, Chhattisgarh. Other required materials and articles for experiments were procurement from the Mushroom Laboratory.

Preparation of spawn and cultivation

Two types of cereal grains *i.e*. wheat and sorghum, were taken to see their effect on spawn development of different spp. of *Pleurotus*. The above grains were processed by the standard procedure and filled in bottles (250g) than sterilized at 20 lbs PSI for 2hrs. Inoculated flasks were incubated at 25 ± 2 ºC and observations were recorded when the mycelium covered the entire grains in any treatment, five replications were kept in each treatment. To know the impact of yield attributing characters spawning was done by layer method @ 4% (W/W) basis. Spawned straw (0.5 kg dry straw /bag) was filled in poly propylene bags and transferred to growing room at the existing environmental conditions. After 20-22 days, when bags were fully impregnated with white mycelium, they were transferred into cropping room and the polythene covers were removed and open blocks were kept on racks. Mushrooms were grown in a temperature range of 20-33 ºC. Relative humidity was maintained by spraying water twice a day on the walls and floor of the room. A light spray of water was given on blocks as soon as the small pin heads appeared. First flush was taken one week after the appearance of pinhead and next flushes taken in 6-7 days of interval.

Biological efficiency

The yield was expressed in biological efficiency and calculated using formula (Chang *et. al.*, 1981) [9].

$$\text{Biological Efficiency (\%)} = \frac{\text{Fresh weight of mushroom}}{\text{Dry weight of substrate}} \times 100$$

Design and statistical analysis

Completely randomized design (CRD) was used in experiment. All observed and recorded data were calculated online using OPSTAT statistical software package for agricultural research workers developed by Sheoran *et al*. (1998) [10] at CCS HAU, Hisar. Critical difference was calculated at the level of 0.05% degree of freedom.

Results and discussion

Evaluation of grains substrate for spawn development

Spawn development of different *Pleurotus* spp. differed significantly with each other in wheat grains. On wheat grains among the evaluated species of *Pleurotus*, 03 spp. (PL-17-05, PL-17-08 and PL-17-12 required significantly less (10 days) for complete spawn development and next were PL-17-01, PL-17-05, PL-17-03 and L-17-06 which took 11.00 days to complete colonize the wheat grain and were at par with each other. However, PL-17-07 and PL-17-09 required statistically more (15.00 days) period for full covering of all grins. In other species it was complete within 12-13 days. On sorghum grains, significantly earliest (8.00 days) spawn preparation was found in PL-17-04 and PL-17-05 and closely followed by PL-17-03(9.00 days) and PL-17-12 (9.0 days) which were at par with each other, while it was significantly delayed in PL-17-10 (14.00 days) with all the *Pleurotus* species, while other species completed in 10.0 -12.0 days, in PL-17-01, PL-17-02, PL-17-06, PL-17-07, PL-17-08, PL-17-09 and PL-17-11, grains were fully covered by grayish to white mycelial growth and held tightly with each other. However PL-17-10 white mycelial growth and it was slow. The current obtained results are closely related to the research work done by Munjal (1973) [11], Singh *et al*. (1986) [12], and Similarly studies were also conducted by Saayir and Yildiz, (2004) [13] who reported sorghum grains were better than barley and wheat grains for spawn development of *Pleurotus* spp.

Effect of wheat grain raised spawn on yield and yield attributing characteristics

Wheat grain raised spawn was used for cultivation of different *Pleurotus* spp. and data are recorded for spawn run, pinhead initiation, sporophore size, yield and biological efficiency. Time taken for spawn run by different spp of *Pleurotus on* wheat grain raised spawn was differed significantly, the significantly less (7.00 days) taken by PL-17-12 which was found at par with PL-17-06 and PL-17-08 (8.00 days) and closest with 04 species PL-17- 01, PL-17-02, PL-17-04 and PL-17-11 (9.00 days) followed by PL-17-03, PL-17-05, PL-17-09 (11.00 days) and PL-17-10 (14.00 days). However, significantly more (16.00 days) time took by PL-17-07. The pinhead initiation was significantly fastest (3.00 days) observed in PL-17-11 and PL-17-12 and followed by 05 species PL-17-01, PL-17-03, PL-17-04, PL-17-08 and PL-17-09 (5 days) and PL-17-02, PL-17-05, PL-17-06 (6.00 days). While, it was significantly delayed (9.00 days) in PL-17-10 and PL-17-07 (7.00 days). Pileus diameter was significantly maximum (8.46 cm) found in PL-17-08, PL-17-06 followed by PL-17-12 (8.11 cm) and PL-17-07 (7.99 cm). While, the minimum (4.26 cm) pileus diameter was recorded in PL-17-10 and closely followed by PL-17-04, PL-17-05, Pl-17-09 and PL-17-03 (4.28, 4.62, 4.65, and 5.28cm) respectively. PL-17-02 had 6.12 cm and it was significantly more with PL-17-10, PL-17-04, PL-17-05, PL-17-09 but at par with PL-17-03. Significantly higher stipe length was observed in PL-17-11 (3.8 cm) and it was significantly less 0.87 cm) noted in PL-17-12, PL-17-02 (1.00cm) and PL-17-05 (1.23). The other species of *Pleurotus* showed 1.5-3.06 cm. The fresh yield in different spp of *Pleurotus* differed significantly and the higher (546 gm) yield was recorded in PL-17-11 with highest (109.2%) biological efficiency and next was PL-17-12 (480 gm) with BE (96%). However lowest (298 gm) fresh yield was obtained

from PL-17-10 with lowest (59.6%). The other species of *Pleurotus* gave 331.00-412.00gm fresh yield with corresponding BE 66.2-81.0 percent. In the conducted experiments there are different cereals and grains viz., paddy, wheat, sorghum, pearl millet and maize used by (Ratainh and Surargairy, 1994) [14] for spawn production of *Pleurotus* spp. and showed that sorghum and wheat grains raised spawn gave better yield of *Pleurotus* spp.

Effect of sorghum grain raised spawn on yield and yield attributing characteristics

Sorghum grain raised spawn was used for cultivation of different spp of oyster mushroom and data are recorded for spawn run, pinhead initiation, sporophore size, yield and biological efficiency was recorded. Minimum days for spawn run was found PL-17-06, PL-17-08 and PL-17-12(7.00 days) at par with PL-17-01 and PL-17-11 (8 days) followed by PL-17-02 and PL-17-10 (9 days) while maximum days for spawn run took by PL-17-05 (13.00 days). The appearance of pin head initiation significantly influenced by different species of *Pleurotus* and it was earlier found in PL-17-11 and PL-17-12 (3.00 days) which were at par with PL-17-08 and PL-17-09 (4.00 days) whereas maximum days required for pin head appearance was recorded in PL-17-10 (10.00 days). The other species of *Pleurotus* took 5-9 days for pin head appearance. On an average 10 fruiting bodies Sporophore size was recovered and largest pileus diameter was observed in PL-17-08 (8.38 cm) and PL-17-12 (8.36 cm) at par with PL-17-07 (8.24 cm) followed by PL-17-06 (7.66 cm),PL-17-01 (7.36 cm), PL-17-11(7.28 cm) and smallest pileus diameter was noted in PL-17-04 (4.16 cm) and similarly longest stipe length was observed in PL-17-11(3.80 cm). Smallest stipe length was observed in PL-17-12 (0.88cm). and next was PL-17-02(1.00cm),at par with each other. Significantly highest yield obtained in PL-17-11 (668.0 gm) with B.E. 133.6% while it was significantly lowest recorded in PL-17-10 (251.0 gm) B.E (50.20%), the other species of *Pleurotus* gave 340.0-486.0gm with 68.0-97.2% biological efficiency. The findings are very close to the work done by Pal *et al.* (2008) [15] evaluated different grains for spawn development and their impact on yield of *P. eous*. They concluded that wheat and sorghum grains raised spawn gave higher yield of *P. eous.*

Table 1: Effect of grain substrates on spawn development of *Pleurotus* species

Species	Wheat (Days)	Sorghum (Days)	Mycelial character	
			Wheat	Sorghum
PL-17-01	11.0	12.0	Growth was uniform and grains were fully intact by the mycelial mat	White cottony mycelial growth covering all the grains and giving it a compact texture
PL-17-02	13.0	10.0	Grains was tightly held with mycelial mat and compact	Grains were loosely held with mycelial mat
PL-17-03	11.0	9.0	grains were covered by mycelium and tights with each other	White mycelial mat that held all the grains tightly
PL-17-04	13.0	8.0	All the grains were fully intact by the mycelial mat	Grayish white mycelial cover up the grain substrate
PL-17-05	10.0	8.0	Hair like mycelium was observed that cover all the grain	Hair like mycelium observed that covered all the grains
PL-17-06	11.0	10.0	White fluffy mycelial growth was observed that cover the entire grains	Whitish mycelial growth covers the grain and held tightly
PL-17-07	15.0	10.0	Grains were covered by white mycelial but loosely attached to each other.	Grains were not fully intact, mycelial mat is loosely held with grains
PL-17-08	10.0	10.0	Whitish mycelium covering all the grain and held tightly with each other	White cottony growth, grains were fully intact by the mycelial
PL-17-09	15.0	10.0	Mycelial mat was loosely held with the grains were not fully intact	White mycelial growth and all the grains attached with each other
PL-17-10	13.0	14.0	Cottony mycelial growth was noticed and scattered in grain.	Off white mycelial growth on surface of grains and mycelial development is slow
PL-17-11	12.0	11.0	All the grains were fully intact by the mycelial mat	All the grains were fully intact by the mycelial mat
PL-17-12	10.0	9.0	White cottony mycelium growth covering all the grains, growth was uniform	Growth were uniform and mycelial completely l covered with grains
SEm±	0.58	0.48		
CD	1.67	1.37		

Table 2: Effect of wheat grain raised spawn on yield and yield attributing of different *Pleurotus* spp.

Species	Spawn *run (days)	Pinhead initiation* (days)	Sporophore size (cm)		Yield (gm)	B.E. (%)
			Pileus diameter	length		
PL-17-01	9.0	5.0	7.66	3.06	399	78.9
PL-17-02	9.0	6.0	6.12	1	389	77.8
PL-17-03	11.0	5.0	5.28	2.11	376	75.2
PL-17-04	9.0	5.0	4.28	1.53	356	71.2
PL-17-05	11.0	6.0	4.62	1.23	371	74.2
PL-17-06	8.0	6.0	8.46	2.25	405	81.0
PL-17-07	16.0	7.0	7.99	3	347	69.4
PL-17-08	8.0	5.0	8.76	2.25	412	82.4
PL-17-09	11.0	5.0	4.65	1.5	331	66.2
PL-17-10	14.0	9.0	4.26	2.46	298	59.6
PL-17-11	9.0	3.0	7.36	3.8	546	109.2
PL-17-12	7.0	3.0	8.11	0.87	480	96.0
SEm±	0.80	0.41	0.39	0.20	15.00	
CD (5%)	2.30	1.18	1.11	0.56	42.79	

Table 3: Effect of sorghum grain raised spawn on yield and yield attributing of different spp. of Pleurotus

Species	Spawn run (days)	Pinhead initiation(days)	Sporophore size(cm)		Yield(gm)	B.E. (%)
			Pileus diameter	Stipe length		
PL-17-01	8.0	5.0	7.36	2.68	409	81.8
PL-17-02	9.0	5.0	5.38	1.00	426	85.2
PL-17-03	11.0	5.0	5.18	2.16	376	75.2
PL-17-04	10.0	5.0	4.16	1.53	387	77.4
PL-17-05	13.0	5.0	4.38	1.80	402	80.4
PL-17-06	7.0	6.0	7.66	2.00	431	86.2
PL-17-07	12.0	9.0	8.24	2.37	348	69.6
PL-17-08	7.0	4.0	8.38	1.79	445	89.0
PL-17-09	11.0	4.0	4.58	1.50	340	68.0
PL-17-10	9.0	10.0	4.22	2.19	251	50.2
PL-17-11	8.0	3.0	7.28	3.80	668	133.6
PL-17-12	7.0	3.0	8.36	0.88	486	97.2
SEm±	0.38	0.97	0.37	0.18	12.60	
CD (5%)	1.09	0.34	1.05	0.51	35.95	

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