Integrated effect of different substrates on growth parameters and yield of *Pleurotus sajor caju*

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Various agricultural waste like wheat, lentil, paddy, mustard, urd, moong, pea, maize, grass straw, sugarcane bagasses have been integrated in different combinations and found variable response on growth parameters and yield of *Pleurotus sajor caju*. Among the various combinations, the minimum 11 days require for spawn running stage in T5 treatments where combinations are as 3/4wheat straw+1/ 4mustard straw+100gm wheat bran which was followed by T10 treatment. Similarly, the minimum days require for pin head initiation is noted in T5 treatment which is only 16 days against 35 day in case of T29 treatment where only grasses are used as substrates. The maximum number of stripe length was found T5 treatment which is 4 cm at the time of harvesting against 1.5 cm in case of T28 treatments but in case of wheat straw, the value 2.5 cm only. The crop of *Pleurotus sajor caju* was harvested in 5 flushes, the maximum yield was obtained in the first flush, than the second and third flushes in all the treatments. The maximum yield was obtained from T5 treatment where combination of substrates were given as (3/4 wheat straw+1/4 mustard straw+100gm wheat bran) representing the value 1483 gm per bag.

Key words: Oyster mushroom, agricultural waste, spawn, growth parameters, yield

INTRODUCTION

Pleurotus mushroom commonly known as Oyster mushroom or 'Dhingri' mushroom (Northern India) is the most important one which grown in a wide range of temperature and substrates made by cellulose, hemicelluloses and lignin. The major Oyster mushroom producing states in India are Orissa ranked first followed by Punjab, Maharashtra, Tamil Nadu, West Bengal, Bihar, Uttara Khand and Gujarat. Uttar Pradesh is growing very small quantities of Oyster Mushroom. The total production of Oyster mushroom is about 21272 metric tons out of 129782 metric tons of total amount of mushroom during 2016 (Anonymous, 2016). The Pleurotus mushroom is known for its good nutritive value in comparison to other edible mushrooms like paddy straw mushroom and white button mushroom. It is a lignocellulolytic fungus and grows naturally in the temperate and tropical forests on dead and decaying wooden logs or some times on drying trunks of deciduous or coniferous woods. There are 38 species of genus *Pleurotus* which are reported all over the world. Out of 38 species, 25 species are commercially cultivated in different parts of the world. Among these, *Pleurotus sajor caju* is one of the best species on the genus due to excellence on cap and stem consistency, very long shelf life as well as acting as a massive source for a wide range of bioactive compounds than any other oyster mushroom.

The fungus can grow in wide range of agricultural and industrial wastes which are made up by cellulose, hemicelluloses and lignin. The most extensively used waste for edible mushroom production has been wheat and rice straws, sawdust, hard wood chips, sugarcane bagasse, cotton seed hulls, corn cobs, rice, and wheat bran (Saber *et al*. 2010). Wheat straw has a large potential for plant nutrients in organic farming. The straw accounts for 35–40 % N, 10–15 % P, and 80–90 % K (Davari *et al*. 2012). Substrate source

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is one of the important factors in mushroom production because it supports mycelial growth and development into mushroom fruit bodies. The variability in colour of mushroom was also influenced by the temperature, light intensity and nutrients of the substrates. Considering the above point in views the study was undertaken as "Integrated effect of different substrates on growth parameters and yield of *Pleurotus sajor caju*" in the present investigation.

MATERIALS AND METHODS

Collection of different substrates

All the substrates like wheat, lentil, paddy, mustard, urd, mong, pea, maize, grass straw and sugarcane bagasses were obtained from the Student Experimental Research Farm, Chandra Shekhar Azad University of Agriculture and Technology Kanpur. Wheat and rice bran were purchased from Kanpur market. Chemicals and glassware's were procured from the Mushroom Research and Development Centre, Department of Plant Pathology, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur to conduct the present investigation.

Preparation and chemical sterilization of substrates

All the substrates like wheat, lentil, paddy, mustard, urd, mong, pea, maize, grass straw, sugarcane bagasses were chopped (3-5 cm size) in to small pieces, and then chemically treated by soaking in solution of formalin (2-4 %) for 10-12 hr. The next day, all these wet substrates were separated from water and excess water was removed properly. The substrates were kept on the concrete floor which was previous sterilized by formalin @ 2-4%. The substrates were thus ready to be used in spawning for mushroom cultivation.

Combined effect of different substrates on growth parameters and yield of Pleurotus sojar caju

The experiment was conducted at Mushroom Research and Development Centre, Department of Plant Pathology, Chandra Shekher Azad University of Agriculture and Technology, Kanpur during 2016–18. Polybag methods were used to conduct the experiment. The crop rooms were maintained as temperature- 24^{0}C, relative humidity-85-90%, darkness of room, closed the room. After 10-12 days, bags were opened and the temperature was maintained at temperature 18-20^{0}C, relative humidity- around 85%, provide ventilation for 4-6 hrs, provide light for 3-4 hrs twice in a day and water spray was necessary to prevent drying of bags.

The details of the treatments are as given below

T1= 3/4 wheat straw+1/4 sugarcane bagasses+100g wheat bran ;T 2 = 3/4wheat straw+1/4lentil straw+100g wheat bran ;T3 = 3/4wheat straw +1/4paddy straw+100g wheat bran ;T4 = 3/4wheat straw+1/4grass+100g wheat bran ;T5 = 3/4wheat straw+1/4mustard straw +100g wheat bran ;T6 = 3/4wheat straw+1/4urd straw+100g wheat bran ;T7 = 3/4wheat straw+1/4mong straw+100g wheat bran ;T8 =3/4wheat straw+1/4pea straw+100g wheat bran ; T9 = 3 / 4wheat straw+1/4maize Cob+100g wheat bran ;T10 =3/4wheat straw+1/4sugarcane bagasses +100g rice bran ;T11 =3/4wheat straw+1/4lentil +100g rice bran ;T12 =3/4wheat straw+1/4paddy straw+100g rice bran T13 = 3/4wheat straw+1/4grass+100g rice bran ;T14 = 3 /4wheat straw+1/4 mustard straw +100g rice bran ;T15 = 3/4wheat straw+1/4urd straw+100g rice bran ;T16 =3/4wheat straw+1/4mong straw+100g rice bran;T17 =wheat straw +1/4pea straw+100g rice bran ;T18 = wheat straw+ maize cob+100g rice bran ;T19 =3/4wheat straw+1/4sugarcane bagasses+100g wheat bran+100g rice bran ;T20 =3/4wheat straw+1/4lentil straw+100g wheat bran+100g rice bran ;T21 = 3/4wheat straw+1/4paddy straw+100g wheat bran+100g rice bran ;T22 = 3/4wheat straw+1/4grass+100g wheat bran+100g rice bran ;T 23 =3/4wheat straw+1/4mustaed straw+100g wheat bran+100g rice bran ;T24 = 3/4wheat straw+1/4urd straw+100g wheat bran+100g rice bran ;T25 =3/4wheat straw+1/4mong straw+100gm wheat bran+100g rice bran ;T26 = wheat straw +1/4pea straw+100g wheat bran+100g rice bran ;T 27 = wheat straw maize cob+100g wheat bran+100g rice bran ;T28 =wheat straw ;T29 = control (grasses)

The observations were recorded on the following parameters

(1) Days taken for spawn running ; (2)Days taken for pin head formation ;(3)Yield data: - Number

and weight of fruiting bodies per treatment;(4)Size of pileus :(5) Size of stripe:(6)Biological efficiency;(7) Fresh weight of mushroom and (8) Dry weight of mushroom.

RESULTS AND DISCUSSION

Effect of various combinations of substrates on the spawn running, pin head formation harvesting days of Pleurotus sajor caju

The data presented in the Table 1 showed the different combinations of substrates gave variable response on spawn running, pin head formation and harvesting days of *Pleurotus sajor caju.* Among the various combinations the minimum 11 days was required for spawn running stage, in T5 treatments where combinations are as 3/4wheat straw+1/4mustard straw+100g wheat bran which was followed by T10 treatment, representing the value 12 days. From the Table, it was also cleared that the maximum days required for spawn running stages in the treatment T29 where only locally available grasses are used as substrates.

On the other hands, the minimum days required for pin head initiation was noted in T5 treatment (3/4wheat straw+1/4mustard straw+100g wheat bran) which is only 16 days against 35 day in case of T29 treatment where only grasses are used as substrates. The treatment T10 (3/4 wheat straw+1/4sugarcane bagasses +100g rice bran) required 17 days for pin head initiation, which was followed by T1 treatment, where combination was given as 3/4wheat straw+1/4 sugarcane bagasses+100gm wheat bran.

Similarly, the minimum 21 days was required for ready to harvest the crop in T5 treatment where combinations was given as ¾ wheat straw+1/ 4mustard straw+100g wheat bran which was followed by T10 treatment (3/4 wheat straw+1/ 4sugarcane bagasses +100g rice bran) where 23 days required for ready to harvest the crops. Among the various combinations, the maximum days required for ready to harvest the crop was found on T26 treatment which in 36 days, followed by 23 days in T10 (3/4 wheat straw+1/4sugarcane bagasses +100g rice bran). Zerihun (2015) found that oyster mushroom mycelial growth was very fast on the mixture of cotton waste and coffee pulp compare to the mixture of wood chips and Teff straw. It was reported that *Pleurotus ostreatus*

Table 1: Effect of different combinations of substrate on spawn running pin head formation and number of days require for harvesting

Treatment	Average number of days for spawn running	Average number of days for pinhead inition	Number of days require for harvesting
T1	14.00	18.00	25.00
T2	18.00	22.00	30.00
T3	19.00	23.00	32.00
T4	26.00	31.00	38.00
T5	11.00	16.00	21.00
T6	17.00	21.00	28.000
T7	22.00	26.00	35.00
T8	24.00	28.00	36.00
T9	21.00	25.00	33.00
T10	12.00	17.00	23.00
T11	18.00	22.00	30.00
T12	27.00	32.00	39.00
T13	20.00	23.00	32.00
T14	15.00	19.00	26.00
T15	17.00	21.00	29.00
T16	22.00	26.00	35.00
T17	21.00	25.00	34.00
T18	25.00	29.00	37.00
T19	20.00	25.00	33.00
T20	19.00	22.00	31.00
T21	25.00	30.00	37.00
T22	23.00	27.00	36.00
T23	16.00	20.00	27.00
T24	18.00	22.00	30.00
T25	21.00	26.00	34.00
T26	24.00	28.00	36.00
T27	13.00	17.00	24.00
T28	15.00	19.00	28.00
T29	30.00	35.00	40.00

Table 2: Effect of different combinations of substrates on fruiting ability of and picking of *pleurotus sajor caju* at every 5 days interval

Treatments	Fruiting ability of *Pleurotus sajor caju*					Total amount of fruit body production (g)
	1th (g)	2nd (g)	3rd (g)	4th (g)	5th (g)	
T1	365	328	252	228	186	1339
T2	334	297	239	201	171	1404
T3	316	283	227	189	162	1177
T4	224	196	117	138	118	793
T5	380	348	278	256	221	1483
T6	348	315	245	215	184	1307
T7	278	249	203	166	138	1034
T8	254	218	185	150	125	932
T9	302	266	216	172	150	1111
T10	374	340	268	243	215	1440
T11	328	291	235	197	168	1219
T12	215	185	172	136	114	822
T13	310	223	198	184	158	1073
T14	358	324	249	224	192\	1347
T15	345	309	242	209	180	1285
T16	272	246	198	162	135	1013
T17	295	262	213	173	146	1089
T18	250	213	181	146	122	912
T19	305	271	220	181	155	1132
T20	322	287	231	193	165	1198
T21	236	204	176	142	120	878
T22	266	239	194	158	131	988
T23	352	320	247	219	188	1326
T24	338	302	239	205	175	1239
T25	284	255	208	171	141	1058
T26	260	224	190	154	128	996
T27	368	336	254	232	205	1335
T28	290	263	245	190	163	1151

Table 3: Effect of different combinations of substrates on growth parameters of *Pleurotus sajor caju*

Treatment	No of fruting bodies	Average Stripe length (cm)	Average Pileus width (cm)
T1	22	3.2	7.9
T2	18	2.6	7.2
T3	17	2.5	6.9
T4	12	1.7	5.7
T5	30	4.0	10
T6	19	2.9	7.3
T7	15	2.2	6.3
T8	13	2.0	6.0
T9	15	2.3	6.4
T10	27	3.5	8.5
T11	17	2.5	7.2
T12	11	1.6	5.9
T13	16	2.4	6.9
T14	21	3.1	7.6
T15	19	2.8	7.3
T16	15	2.2	6.3
T17	13	1.9	5.9
T18	16	1.3	4.0
T19	14	1.2	6.5
T20	17	2.5	7.0
T21	13	1.8	5.8
T22	15	2.2	6.2
T23	20	3.0	7.5
T24	18	2.7	7.2
T25	15	2.3	6.4
T26	14	2.3	7.1
T27	23	3.3	8.0
T28	13	2.5	6.8

completed spawn running in 17-34 days on different substrates and time for pinheads formation at 17-20° C.

Effect of various combinations of substrates on fruiting ability of Pleurotus sajor caju

The crop of *Pleurotus sajor caju* was harvested in 5 flushes and the data presented in the Table2 showed that the maximum yield was obtained in the first flush, than the second and third flushes. It is evident from the Table 2 that maximum amount of total fresh weight of *P. sajor caju* was obtained from T5 treatment where substrate combinations were given as 3/4wheat straw +1/4 mustard straw+100g wheat bran, representing the values 380, 348, 278, 256 and 221g per bag at 1th, 2nd, 3rd, 4th and 5th flushing stages, respectively indicating highest with the value of 1483g yield per bag among the treatment. The treatment T10 (3/4 wheat straw+1/4sugarcane bagasses +100g rice bran) showing 374, 340,268 243 and 215 gm fresh weight of mushroom per bag at 1th, 2nd, 3rd, 4th and 5th flushing stages, respectively with the total weight of 1440g per bag which is second highest among the treatments.

The treatment T28, where only wheat straw was used as substrates , the yield of 290, 263, 245, 190 and 163g fresh weight of mushroom per bag were obtained at 1th, 2nd, 3rd, 4th and 5th flushing stages, respectively and total weight of 1151g/bag which is superior over control and inferior over most of the combinations. Lowest amount as 200, 180, 150, 135 and 115g of fresh mushroom weight at 1th, 2nd, 3rd, 4th and 5th flushing stage were obtained from T29 treatment where only local grasses are used as substrates. From the Tables, it is also cleared that the maximum amount of fresh mushroom was obtained from 1st flushing stages which is gradually decreased from 2nd to 3rd, 4th and 5th flushing stages in all the treatments. Sharma *et al*. (2013) grews *P. ostreatuson* combination of different substrates such as rice straw, rice straw + wheat straw, rice straw+ paper, sugarcane bagasse and sawdust of alder and it was with rice straw (control) was found to have best substrate with yield (381.85 gm) and biological efficiency (95.46%).

Effect of different combinations of substrates on growth parameters of Pleurotus sajor caju

Number of fruiting

Growth is important parameter for higher yield of any crops and mushrooms is not exception from them. The data presented in the Table3, showed that the maximum number of fruiting bodies is produced in T5 treatment where combinations is given as ¾ wheat straw+1/4mustard straw+100g wheat bran with the value 30 per bags against 10 fruiting bodies in case of T29 treatment where only grasses is used as substrates. The treatment T10 (3/4 wheat straw+1/4 sugarcane bagasses +100g rice bran) showing 27 fruiting bodies per bag representing second highest among the treatment, which was followed by T1 treatment (3/4 wheat straw+1/4 sugarcane bagasses+100g wheat bran). Zerihun (2015) found that the number of fruit bodies recorded is related to their mycelial colonization. According to him, the mixture of cotton waste and coffee pulp yielded the highest total weight and number of fruit bodies.

Length of stripe

Similarly, the average maximum stripe length was found in T5 treatment (3/4wheat straw+1/4 mustard straw+100g wheat bran) which is 4 cm at the time of harvesting against 1.5 cm in case of T28 treatments where only wheat straw is used as substrates .Among the treatments second highest was found in case of T10 treatment (3/4wheat straw+1/4 sugarcane bagasses +100g rice bran) followed by T27 treatment (3/4 wheat straw maize cob+100g wheat bran+100g rice bran) and T1 (3/4 wheat straw+1/4 sugarcane bagasses+100g wheat bran) treatment, representing value 3.5, 3.3 and 3.2 cm, respectively (Table 3).

Width of pileus

Length and width are the important parameters for higher yield of mushroom. The data presented in the Table 3 showed that the maximum average width of pileus was found in T5 treatment (3/4wheat straw+1/4mustard straw+100g wheat bran) as 10 cm diameter, which was followed by T10 (3/4 wheat straw+1/4 sugarcane bagasses +100g rice bran) and T27 (3/4 wheat straw+1/4 maize cob+100g wheat bran+100g rice bran) treatments indicating 8.5 and 8.0 cm, respectively. Among the all combinations, the minimum diameter of pileus was found in T4 treatment where combination was given as 3/4 wheat straw+1/4 grass+100g wheat bran. Results further indicate that the widest girths were obtained in mushrooms grown in substrates 4, 3 and 2 at both first sprouting and maturity.

Onokpise *et al.* (2007) established that palm kernel cake improves the thickness of fruiting bodies of mushroom species. This increase in thickness of the stipe was recorded at maturity in mushrooms grown in substrates 3 and 4. Zerihun (2015) found that mixture of cotton waste and coffee pulp yielded the highest total weight and number of fruit bodies and also had a wider pileus diameter.

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