INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2005/07–6–900–903
http://www.ijab.org

Yield Performance of Oyster Mushroom on Different Substrates

SH. MUHAMMAD IQBAL[1], CH. ABDUL RAUF† AND M. IQBAL SHEIKH‡
National Agricultural Research Centre, Islamabad–Pakistan
†*University of Arid Agriculture, Rawalpindi–Pakistan*
‡*Directorate of Agriculture, Government of AJK, Muzaffarabad*
[1]Corresponding author's e-mail: iqbalsh65@hotmail.com

ABSTRACT

Investigations on the cultivation of oyster mushroom, *Pleurotus ostreatus* (local & exotic strains) and *P. sajarcaju* were conducted to find out the growth and yield performance on different substrates. Results regarding the time required for completion of spawn running, formation of pin-heads and maturation of fruiting bodies on different substrates showed that in all the three cases, they appeared earlier on sugarcane bagasse followed by cotton waste and the maximum number of flushes were obtained from wheat straw and banana leaves followed by cotton boll locules and cotton waste. Furthermore, the results revealed that the minimum flush to flush interval was obtained on millet followed by wheat straw and sugarcane leaves and the maximum yield percentage on fresh and dry weight basis was obtained from banana leaves followed by paddy and wheat straw.

Key Words: Oyster mushroom; *Pleurotus ostreatus; P. sajarcaju*; Substrates; Yield

INTRODUCTION

The importance of mushroom in the agrarian economy of the world needs no emphasis because of its nutritional and medicinal value. The mushrooms have long ago drawn attention of human beings as a food, nutritionally and medicinally and now-a-days is a leading food component. Protein content of mushrooms varies from 4-44% according to the species (Crisan & Sands, 1978); whereas, the other foods like beef, wheat and potatoe contain proteins 16 and 1%, respectively (Boris, 1985). Mushrooms are better source of essential vitamins such as niacin, riboflavin and vitamin-C. They also contain folic acid, which is blood building vitamin and counteracts the pernicious anaemia, and is also highly rich in minerals such as calcium, phosphorus and potassium. Mushrooms grow in places like fields, woods, forests, water channels, manure heaps, bunds and grassy grounds (Atkinson, 1961). In Pakistan, mushrooms are observed during the rainy season on the manure heaps and dump places with abundance of humus. They can be easily grown under local conditions if proper requirements of food and humidity for its growth are fulfilled. Mushrooms are cultivated on agricultural and industrial wastes and the wastes have to go through the process of boiling, pasteurization and fermentation. Kurtzman (1975) tried straw, paper, saw dust and logs and Park *et al*. (1975) tried rice and wheat straw as substrates. The yield on rice straw was slightly higher than wheat straw and significantly higher than on tree logs. Poppe (1974) cultivated *P. ostreatus* on manure, wood and straw substrates at a temperature of 10-20^{0}C in light intensities of 40-80 Ix. He obtained earliest fructification with continuous white florescent light of about 40 Ix at optimum temperature of 12^{0}C. Imbernon *et al*. (1977) grew several species of *Pleurotus* on tree bark and concluded that such substrates could replace corn cobs and straw for commercial cultivation. Khan and Ali (1981) cultivated oyster mushroom on cotton boll locules in polythene bags and kept in semi-dark thatched cottage with the atmospheric temperature range of 16-20^{0}C. Singh (1981) reported that an edible mushroom *P. sajarcaju* could be grown successfully on paddy straw at a temperature range of 19.1-30.5^{0}C with 65-85% relative humidity. Whereas, Sivaprakasam and Kandaswamy (1981) reported a wide variety of substrates like waste papers, sugarcane bagasse, hulled maize cobs and rice straw for the production of its sporophores. Tan (1981) studied cotton waste as a substrate for the cultivation of *P. ostreatus* along with other *Pleurotus* species and showed that spawn running took 3 weeks and fruiting bodies appeared after 2-3 days when exposed to light. Ramzan (1982) cultivated *Pleurotus* spp. and got 3-5 flushes of the crop and paddy straw proved to be the best substrate followed by wheat straw. Bhatti (1984) cultivated *Pleurotus* spp. on chopped wheat straw, paddy straw, cotton waste and saw dust at 22-28^{0}C and 80-85% humidity for spawn running and 12-18^{0}C for pin heads formation and maturity of fruiting bodies. Methew *et al*. (1996) successfully cultivated five species of oyster mushroom on paddy straw. According to Jiskani (1999), it can easily and successfully be cultivated on wheat, paddy, barley, oat and gram straw, banana, sugarcane and maize leaves, empty corn cobs and millet heads, cotton waste, sticks and boll locules, sugarcane baggasse, banana pseudostems, saw dust, logs, straw papers, manure etc. Keeping in view the importance of mushroom in Pakistan, cultivation of oyster mushroom on agricultural and industrial waste products was conducted to study its performance for yield and yield parameters.

MATERIALS AND METHODS

Oyster mushroom, *Pleurotus ostreatus* (local & exotic strains) was cultivated in a growth room furnished with iron racks, desert cooler, exhaust fan and florescent lights at National Agricultural Research Centre, Islamabad. The required culture of oyster mushroom was obtained from Mushroom Laboratory, Directorate of Agriculture Muzaffarabad, and later on, the culture was multiplied from the fresh mushrooms by tissue culture method. These cultures were maintained throughout the experimental study at 25-30^{0}C. For cultivation of mushroom, various substrates viz. wheat straw, paddy straw, chickpea straw, sugarcane bagasse, corn cobs, cotton waste and sunflower heads were attempted. These substrates were chopped into small pieces of 1-3 cm. Cotton waste was soaked for 24 h before use. All substrates (dry & soaked) were boiled for 15-20 minutes and then spread over clean, slightly inclined surface in thin layers for cooling and draining of the excessive water. After cooling of the substrates (when the moisture content were left around 65-70%), they were filled in the polythene bags of 17x13 cm in size. Dry weight of the substrates were recorded before soaking and the bags full of different substrates weighed and were maintained at 1.5 Kg in a bag for each substrate. All the substrates were sterilized in an autoclave at 15 psi for an hour. Inoculation was made with pure grain spawn of *P. ostreatus* (local & exotic strains) at 10 g per kg of substrate on dry weight basis under aseptic conditions. These inoculated bags were placed in growth room with 70-80% humidity and between 25-30^{0}C temperature, for impregnation of the substrate with mushroom spawn i.e. spawn running. Growth of mushroom was recorded daily for all the treatments. When such bags become full of growth and pin-heads started appearing, the bags were mouth opened to facilitate the development of fruiting bodies. As soon as the fruiting bodies developed and attained their full size, they were cut just above surface of the substrate with sharp knife or blade.

The yield parameters recorded were, days taken for the completion of spawn running, time (days) taken for the first appearance of pin-head formation, time (days) taken for the maturity of fruiting bodies, number of flushes, time interval (days) between flushes and yield of fresh mushroom on different crop wastes.

RESULTS AND DISCUSSION

The results regarding the completion of spawn running, pin-head formation, maturity of fruiting bodies, number of flushes of fruiting bodies, time required between flushes and yield performance of *P. ostreatus* (local & exotic strains) and *P. sajracaju* on different substrates are presented in Tables I - VI.

It is evident from Table I that the spawn running completed earlier on sugarcane bagasse 20, 37 and 20 days, respectively in local and exotic strains of *P.ostreatus* and *P. sajarcaju* followed by cotton waste. Maximum time period was required in case of wheat straw for all the test species. It was 41, 46 and 43 days, respectively. The pattern of spawn running among the substrates was significant. Tan (1981) reported the completion of spawn running in 21 days on the cotton waste. Patra and Pani (1995) recorded 13-16 days on paddy straw. Similar findings were also reported by Jiskani *et al.* (1999).

Sugarcane bagasse also proved a better substrate in case of pin-head formation (Table II). It was observed that time taken for first appearance of pinhead after spawning of the substrate was 16, 18 and 23 days, respectively in the local and exotic strains of *P. ostreatus* and *P. sajarcaju*. It was followed by cotton waste i.e., 27, 33 and 32 days, respectively for the test species. Maximum time (43.7, 49 & 46.3 days) was taken in case of wheat straw. Several workers reported different timings for pin-head formation of different mushroom species. For example, Rangaswami *et al.* (1975) reported pin-heads of *P. sajarcaju* in 20-25 days after inoculation. Khan *et al.* (1981) got pin-heads of *P.ostreatus* (Strain,-467) in 36 days, the same of *P. sajarcaju* and *P. ostreatus* in 40 and 46 days, after spawning. Tan (1981) got fruiting bodies after 23-26 days. Ramzan (1982) obtained pin-heads of five strains of *P. ostreatus* on two substrates, wheat and rice straw between 20-40 days Patra and Pani (1995) recorded 20-24 days on paddy straw.

In case of the maturity of fruiting bodies (Table III), it was revealed that the minimum number of days was taken on the sugarcane baggase (20.3, 22 & 37 days), which proved to be the best substrate followed by cotton waste (33.3, 38 & 37.7 days). Maximum time period (48.3, 53.3 & 50.7 days) was required for the maturity of fruiting bodies in case of wheat straw. A number of investigators have reported different timing period for fruiting bodies Khan and Ali (1981) obtained a crop from cotton boll locules between 21-28 days Khanna and Garcha (1981) found a crop in 104 days on paddy straw and Tan (1981) harvested the crop within a month from cotton waste.

The data regarding number of flushes are presented in Table IV showed that in *P. ostreatus* (local strain), maximum flushes (3.7) were obtained on wheat and chickpea straw while in case of exotic strains it was 4.0 on paddy straw, sugarcane bagasse, corn cobs and cotton waste. Oyster mushroom (*P. sajarcaju*) gave the maximum flushes (3.3) on wheat and cotton waste. Similar results were reported by many workers. Zadrazil (1973) got 2 flushes, Tan (1981) three flushes, Ramzan (1982) obtained 3-5 flushes from wheat and paddy straw and Bhatti (1984) got 4-6 flushes from different substrates.

The data regarding flushes intervals displayed that the minimum period on average basis between flushes was taken on paddy straw which was 6.3, 4.7 and 6 days, respectively in *P. ostreatus* local, exotic and *P. sajarcaju* (Table V). Maximum time intervals for flushing were observed in chickpea straw followed by wheat straw for *P.*

Table I. Time (days) taken for the completion of spawn running of *Pleurotus* spp./ strains on different crop wastes

Pleurotus spp. / strains	Wheat straw	Paddy Straw	Chickpea straw	Sugarcane baggas	Corn cobs	Cotton waste	Sunflower heads
Pleurotus ostreatus (Local)	41.0 a	39.7 a	31.0 b	14.0 b	26.0 b	24.0 b	30.0 a
Pleurotus ostreatus (exotic)	46.0 a	43.0 a	39.7 a	16.0 b	37.0 a	29.7 a	30.3 a
Pleurotus sajarcaju	43.0 a	41.3 a	31.3 b	20.0 a	32.3 ab	30.3 a	32.3 a

*Figures sharing the same letters are non-significant at 5% level of probability by using DMR test.

Table II. Time (days) taken for the pin-head formation of *Pleurotus* spp./ strains on different crop wastes

Pleurotus spp./ strains	Wheat straw	Paddy Straw	Chickpea straw	Sugarcane baggas	Corn cobs	Cotton waste	Sunflower heads
Pleurotus ostreatus (Local)	43.7 a	43.3 a	34.3 b	16.0 b	28.0 b	27.0 b	33.7 a
Pleurotus ostreatus (exotic)	49.0 a	47.3 a	40.7 a	18.0 b	38.7 a	33.0a	34.0 a
Pleurotus sajarcaju	46.3 a	45.3 a	33.3 b	23.0 a	34.7 ab	32.0 a	34.7 a

*Figures sharing the same letters are non-significant at 5% level of probability by using DMR test.

Table III. Time (days) taken for the maturity of fruiting bodies of *Pleurotus* spp./ strains on different crop wastes

Pleurotus spp./ strains	Wheat straw	Paddy Straw	Chickpea straw	Sugarcane baggas	Corn cobs	Cotton waste	Sunflower heads
Pleurotus ostreatus (Local)	48.3 a	49.0 a	39.0 b	20.3 b	34.7 b	33.3 b	39.3 a
Pleurotus ostreatus (exotic)	53.3 a	52.7 a	47.0 a	22.0 b	44.0 a	38.0 a	39.7 a
Pleurotus sajarcaju	50.7 a	50.0 a	38.0 b	27.0 a	41.0 ab	37.7 a	41.7 a

*Figures sharing the same letters are non-significant at 5% level of probability by using DMR test.

Table IV. Number of flushes of *Pleurotus* spp./ strains on different crop wastes

Pleurotus spp./ strains	Wheat straw	Paddy Straw	Chickpea straw	Sugarcane baggas	Corn cobs	Cotton waste	Sunflower heads
Pleurotus ostreatus (Local)	3.7 a	3.3 a	3.7 a	3.3 a	3.3 a	3.0 a	3.3 a
Pleurotus ostreatus (exotic)	3.7 a	4.0 a	3.3 ab	4.0 a	4.0 a	4.0 a	3.7 a
Pleurotus sajarcaju	3.3 a	3.0 a	2.7 b	3.0 a	3.0 a	3.3 a	3.0 a

*Figures sharing the same letters are non-significant at 5% level of probability by using DMR test.

Table V. Flushing intervals of *Pleurotus* spp./ strains on different crop wastes

Pleurotus spp./ strains	Wheat straw	Paddy Straw	Chickpea straw	Sugarcane baggas	Corn cobs	Cotton waste	Sunflower heads
Pleurotus ostreatus (Local)	8.0 a	6.3	9.3 a	7.0 a	7.3 ab	7.7 ab	8.3 a
Pleurotus ostreatus (exotic)	6.0 a	4.7	6.3 b	8.0 a	6.0 b	6.7 b	5.3 b
Pleurotus sajarcaju	7.0 a	6.0	8.3 a	8.3 a	8.7 a	8.0 a	8.0 a

*Figures sharing the same letters are non-significant at 5% level of probability by using DMR test.

Table VI. Yield (g) of *Pleurotus* spp./ strains on different crop wastes

Pleurotus spp./ strains	Wheat straw	Paddy Straw	Chickpea straw	Sugarcane baggas	Corn cobs	Cotton waste	Sunflower heads
Pleurotus ostreatus (Local)	48.3 a	44.7 a	62.7 a	37.0 a	34.0 a	37.0 b	40.7 b
Pleurotus ostreatus (exotic)	57.0 a	56.7 a	66.7 a	52.0 a	39.0 a	46.0 a	56.7 a
Pleurotus sajarcaju	38.7 a	40.7 a	47.0 b	43.3 a	24.7 b	35.0 b	31.0 c

*Figures sharing the same letters are non-significant at 5% level of probability by using DMR test.

ostreatus local strain. In case of *P. ostreatus* exotic, it was the minimum on paddy straw (4.7 days) and the maximum on sugarcane bagasse (8 days). For *P. sajoncaju*, it was the minimum on paddy straw (6.0 days) and the maximum on corn cobs (8.7 days). Bhatti (1984) supported this study by getting different flushes with an interval of 5-6 days.

Yield data of fresh mushroom revealed that the maximum yield on fresh weight basis was obtained from chickpea straw (62.7, 66.7 & 47.0 g, respectively for the tested strains) followed by wheat straw (48.3 & 57.0 g) for local and exotic strains of *P. ostreatus* while in case of *P. sajarcaju*, it was 43.3 g on sugarcane bagasse (Table VI). The least effective substrate for yield was corn cob for all the strains. It is concluded form the results that wheat straw proved to be the best substrate. Zadrazil (1973) obtained the yield (weight as a percentage of the wet substrate) of 20.6% for first and 4.2% for the second flush. Khan and Ali (1981) obtained yield of fruiting bodies on an average of 70% from cotton boll locules. Khanna and Garcha (1981) recorded cumulative yield of 32% in 104 days from paddy straw. Tan (1981) reported 100% yield of the dry weight of the cotton waste substrate.

Based on the investigations, it can be concluded that crop of oyster mushroom, *P. ostreatus* (local & exotic

strains) and *P. sajarcaju* appeared earlier on sugarcane bagasse followed by cotton waste, sunflower heads and chickpea straw and the maximum flushes were obtained from wheat straw and chickpea straw. The minimum flush to flush interval was taken on paddy straw followed by corn cobs, and the maximum yield on fresh basis was obtained from chickpea straw followed by wheat straw.

REFERENCES

Atkinson, G.F., 1961. *Studies of American fungi. Mushrooms, Edible, Posionous, etc*, p. 332. Ithaca, New York

Bhatti, M.A., 1984. Mushrooms as commercial crop. *Progressive Farming*, 4: 5–10

Boris, A., 1985. *A Food Beneficial to Health*. Sputnik, Moscow

Crisan, E.V. and A. Sands, 1978. Nutritional value. *In:* Chang, S.T. and W.A. Hayee (Eds.). *The Biology and Cultivation of Edible Mushrooms.* CBS Publishers and Distributors, Delhi 110 032, India

Imbernon, M., J. Delmas, J. Laborde and N. Poitou, 1977. Culture de *P. ostreatus* Sur substrates a base decorces. *Mush. Sci*., 9: 175–97

Jiskani, M.M., 1999. *A brief outline "The Fungi" (Cultivation of Mushrooms)*, p. 94. Izhar Pub. Tandojam–Pakistan

Jiskani, M.M., M.A. Pathan and K.H. Wagan, 1999. Yield performance of oyster mushroom *Pleurotus florida* (strain PK, 401) on different substrates. *Pakistan J. Agric., Agric. Engg. Vet. Sci*., 15: 26–9

Khan, S.M., A.G. Kausar and M.A. Ali, 1980. Temperature requirements of the oyster mushroom (*Pleurotus cretaceous*). *Newsletter for the Tropics*, 1: 11–3

Khan, S.M., A.G. Kausar and M.A. Ali, 1981. Yield performance of different strains of oyster mushroom (*Pleurotus* spp.) on paddy straw in Pakistan. *Mush. Sci*., 11: 675–8

Khan, S.M. and M.A. Ali, 1981. Cultivation of oyster mushroom (*Pleurotus* spp.) on cotton boll locules. *Mush. Sci*., 11: 691–5

Khanna, P. and H.C. Garcha, 1981. Introducing the cultivation of *Pleurotus florida* in the plains of India. *Mush. Sci*., 11: 655–65

Kurtzman, R.H. Jr., 1975. Summary of mushroom culture. *In Proceedings of Seminar of Mushroom Research and Production*, pp. 15–22. PARC, Karachi–Pakistan

Mathew, A.V., G. Mathai and M. Suharban, 1996. Performance evaluation of five species of *Pleurtotus* (oyster Mushroom) in Kerala. *Mush. Res*., 5: 9–12

Park Y.N.S.J. Go and D.S. Kim, 1975. Studies on cultivation of oyster mushroom (*P. ostreatus*) using rice straw as substrate. *Research report of the office of Rural Development, Soil Science, Fertilizer, Plant Protection and Mycology*, 17: 103–7

Patra, A.K. and B.K. Pani, 1995. Yield response of different species of oyster mushroom (*Pleurotus*) to paddy straw. *Current Agric. Res*., 8: Supplement. 11–4

Poppe, J.A., 1974. The fruit regulating to action of light and chemicals in the culture of *P. ostreatus*. *Hort. Abst*., 44: 868

Ramzan, M., 1982. Studies on the cultivation of oyster mushroom (*Pleurotus* spp.) in Faisalabad. *M.Sc. Thesis*, Department P. Pathology, Faculty of Agriculture, University of Agriculture Faisalabad–Pakistan

Rangaswami, G., T.K. Kandaswamy and T.K. Ramaswamy, 1975. *Pleurotus sajor-caju* (Fr.) Dinger. A protein rich nitrogen fixing mushroom fungus. *Current Sci*., 44: 403–4

Singh, R.P., 1981. Cultivation of *Pleurotus sajor-caju* Fr. *Mush. Sci*., 11: 667–73

Sivaprakasam, K. and T.K. Kandaswamy, 1981. Waste materials for the cultivation of *P. sajor-caju*. *Mushroom J*., 101: 178–9

Tan, K.K., 1981. Cotton waste is good substrate for the cultivation of *P. ostreatus* the oyster mushroom. *Mush. Sci*., 11: 705–10

Zadrazil, F., 1973. Cultivation, yield and keeping quality of *P. florida* Fovo. Sc. *Champignon*, 13: 17–9

(Received 15 May 2005; Accepted 20 July 2005)