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EFFICACY OF DIFFERENT WEEDS AND AGRICULTURAL SUBSTRATES FOR CULTIVATION OF *PLEUROTUS OSTREATUS* (JACQ. FR.)

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ABSTRACT

Oyster mushrooms are fleshy edible fungi which acquire huge importance due to their nutritional and medicinal properties. These mushrooms are cultivated upon various substrates which directly affect the yield and time taken to reach the maturity. So the present experiment was designed to study different weeds, agricultural wastes and their mixtures for efficacy regarding time taken to achieve 100% mycelial growth and yield attributes. Our results illustrated that cotton waste showed better performance as substrate as it took minimum days i.e. 20.5 followed by *Chenopodium album* and mixture of cotton waste + *Chenopodium album* which relatively taken 24.5 days to reach maximum growth level. These substrates also provided better yield as compared to all other substrates by recording 650.36, 583.41 and 530.43 grams yield respectively. The performance of all other substrates was below power. Hence we conclude that *Chenopodium album* anonymously or mixture of particular weed and cotton waste can be utilized for efficient cultivation of mushrooms.
Keywords: *Oyster mushroom, Yield, Maturity, Effectiveness, P1 white strain*

INTRODUCTION

Mushrooms are edible and fleshy fungi which are cultivated upon organic substrates (Ashraf et al., 2013). Due to their medicinal and nutritive properties, they acquire a very important place in human food chain (Etich et al., 2013). Their importance is continuously increasing day by day as they acquire valuable vitamins, proteins and minerals. All the edible mushrooms exhibit vitamin A, B1, B5, B6, C and D (Manzi et al., 2001; Syed et al., 2009). Stanley (2011) has reported that *Pleurotus oestreatus* (Oyster mushroom) incorporates 2-5% fats, 7-38%, 8-12% minerals, mycocellulose, 17-47% sugars and 25-50% proteins.

Various agricultural substrates such as paddy straw, vegetable residues, maize stalks and cotton waste are utilized for cultivation of oyster mushroom (Hassan et al., 2011). The growth of the mushroom is considered to be dependent upon the performance of the substrates (Iqbal et al., 2005; Kimenju et al., 2009). But the substrates which have high levels of nitrogen and carbohydrate contents are categorized as ideal for mushroom growth (Khare et al., 2010). In developing countries recycling and management of the organic wastes has become a challenge but these can be efficiently utilized in cultivation of oyster mushroom which will ultimately reduce the malnutrition problems in these countries and will also reduce the pollution (Eswaran and Ramabadran, 2000). Oyster mushroom has many industrial and medical uses as they possess anti oxidant, anti microbial, anti hypersensitive, anti inflammatory, anti tumor and food additive properties (Chang, 2007).

Pakistan being agricultural country posses 70% of its population in villages and all this population are directly or indirectly involved in cultivation of different agricultural crops (Noman et al., 2015), which lead to the production of huge agricultural waste (Anonymous, 2001). Sarwar et al (2002) estimated that Pakistan produces around 11.3 and 3.2 million tons of wheat and paddy straw per year. All this can be efficiently utilized in mushroom cultivation. China and Zimbabwe are considered as the largest producer of oyster mushroom and they use bag and tray method for its cultivation (Oei, 2003). Even after the availability of huge amount of agricultural waste, Pakistan has not accelerated the production of mushrooms which may be due to lack of knowledge and awareness (Helrich, 1990). So there is an urgent need to aware the people regarding mushroom cultivation and evaluation of different substrates for the better and efficient production of mushrooms.

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Keeping in view the importance of substrates in cultivation of oyster mushrooms (P1-white strain), we tried to evaluate different weeds, agricultural substrates and their relative mixtures to identify their efficacy.

MATERIALS AND METHODS

1. Collection and execution of experiment

Weeds (*Amaranthus viridis, Chenopodium album, Trianthem portulacastrum*) and agricultural bi-products (Wheat straw, rice straw and cotton waste) were collected from industrial area of Faisalabad and agronomic research area of university of agriculture, Faisalabad. The experiment was laid out by following completely randomized design with three replications in mushroom experimental room at university of agriculture Faisalabad, Pakistan.

2. Preparation of substrates

Substrates were prepared in the following concentrations and treatments. Where T1= *Amaranthus virdis* (100%), T2= *Chenopodium album* (100%), T3= *Trianthem portulacastrum* (100%), T4= *Amaranthus virdis* (50%) + wheat straw (50%), T5= *Trianthem portulacastrum* + rice straw (50%), T6= *Chenopodium album* (50%) + cotton waste (50%) and T7= cotton waste (100%). For this process, all the weeds plants were dried under sunlight, chopped into small (1-2cm) pieces, weighed upon electronic scale and soaked for overnight. Drying out the excessive water, all the weeds were spread upon the clean floor surface. 65% moisture level was achieved through spraying of water and $CaCO_3$ @ 2% was added for enhancing the fusion of substrates for 24 hours upon the floor surface. After removing any gluts, the substrates were placed into the polypropylene bags (7 x 11 cm) according to above mentioned treatments. All the bags were closed via tying the rubber bands and were autoclaved for an hour for sterilization.

3. Spawning of bags and controlled conditions

For all the replications and treatments, spawning of polypropylene bags were done specifically at 7% dry weight and each bag was incorporated with 56 grams of spawn and incubation of these bags was done at 25^0C in complete darkness. Required temperature was achieved though heating via electrical heater and data was recorded till 100% growth was achieved in all bags. Similarly required humidity i.e. 80-90% was maintained through sprinkling of water upon floor surface. Furthermore, required moisture for bags was achieved by sprinkling the water on the bags thrice a day. Ventilation was maintained by operating the exhaust fan 3-4 times a day for air flushing and fulfilling the oxygen requirements for fructification of mushrooms.

4. Data recording

The data regarding growth of mycelium upon substrates in polypropylene bags was recorded upon completion of 25%, 50%, 75% and 100% mycelial growth. The data for harvesting of mushrooms were recorded till 3rd flush where first harvesting was done at maturity level while data was recorded for all the harvesting levels. All the data was subjected to analysis of variance where P= 0.05 (Steel et al., 1997).

RESULTS

(A) Days taken to achieve targeted growth.

(i) Days taken to achieve 25% mycelial growth

Achievement of 25% mycelial growth was significantly affected by all the treatments (Fig, 1). Great variation was observed regarding performance of different substrates and all the substrates exhibited different mean no. of days to attain the attributed target. But among all cotton waste (T7) proven relatively better and it taken only 6.5 days to reach 25% mycelial growth which was minimum time in comparison to all other substrates. Secondly, the performance of *Chenopodium album* (T2) was a little better as required mycelial growth was achieved in 9.5 days. Afterwards, comparative response was observed regarding T1 (*Amaranths viridis*) and T6 (*Chenopodium album* 50% + cotton waste 50%) which recorded mean days as 12 and 11.5 respectively. Response of all other treatments (T3, T4, T5) was poor as they exhibited more than 14 days to complete the 25% growth of *Pleurotus ostreatus*.

(ii) Days taken to achieve 50% mycelial growth

Comparison of means exhibited that T7 (cotton waste) which initially proven as a better substrate was again recorded better as 50% of mycelial growth was achieved in 12.5 days. But

interestingly, a similar performance was recorded by T2 (*Chenopodium album*) and T6 (*Chenopodium album* 50% + cotton waste 50%) as both taken 16.5 days to reach the recorded growth (Fig, 2). The statistical data further revealed that T1 (*Amaranthus virdis*) relatively taken 18.5 days while rest of the treatments (T3, T4, T5) were again categorized poor as they recorded more than 21 days to reach the same level.

(iii) Days taken to achieve 75% mycelial growth

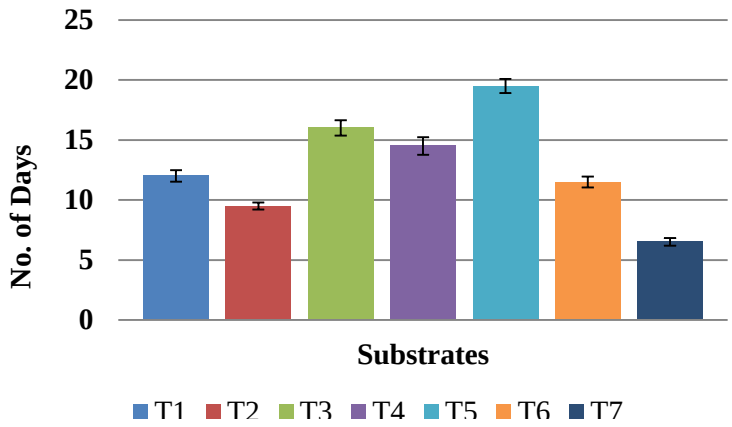
Fig 3 revealed that once again T7 continued to take the lead and 75% mycelial growth was achieved in just 17 days while interestingly the T2, T1 and T6 recorded results with were closed to each other by achieving the targeted growth in 20.5, 21.5 and 22 days respectively. Similarly T3, T4 and T5 continued their poor performance and these substrates taken more than 26 days to achieve the same target.

(iv) Days taken to achieve 100% mycelial growth

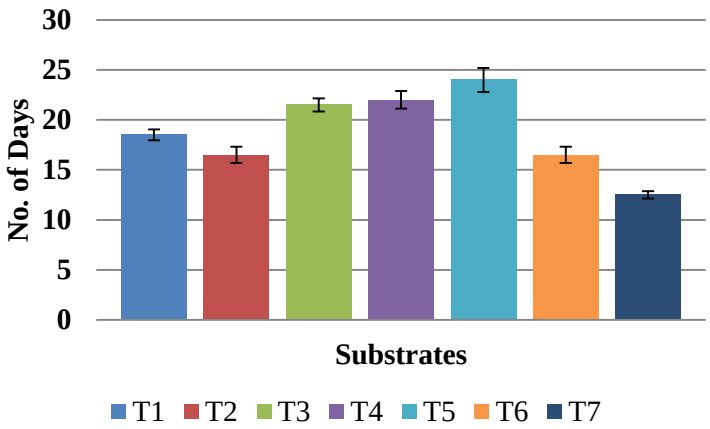
Comparison of means for the final attribute again exhibited that cotton waste (T7) which initially recorded better results achieved 100% mycelial growth in only 20.5 days followed by T2, T6 and T1 which were comparative to each other and recorded 24.5, 24.5 and 25.5 days simultaneously. Here again it was proved that T3, T4 and T5 were poor substrates and they relatively taken too long time i.e. > 30 days to achieve 100% growth of *Pleurotus ostreatus* (Fig 4).

(B) Yield performance

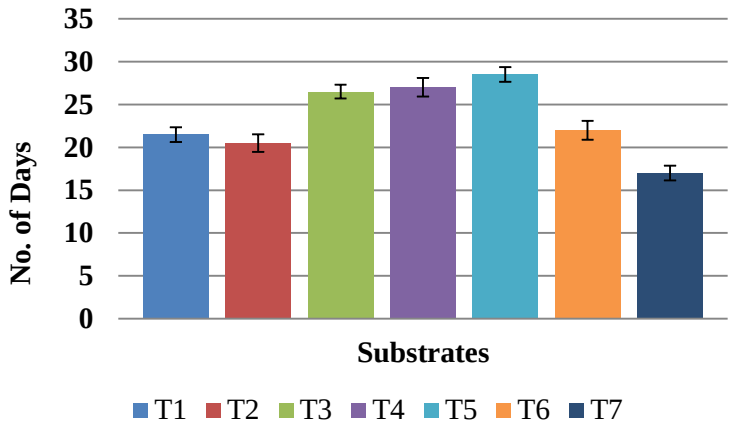
Fig, 5 extensively reveals that all the substrates exhibited significant results regarding yield of *Pleurotus ostreatus.* Statistical data and comparison of means clarify that after calculating the yield of all the three flushes, cotton waste (T7) performed extensively well by recording the yield as 650.36 grams followed by T2 (*Chenopodium album*) and T6 (*Chenopodium album* 50% + cotton waste 50%) which given 583.41 grams and 530.43 grams respectively. Rest of the treatments (T1, T4, T3 and T5) relatively showed least yield i.e. 500.37, 464.42, 429.42 and 319.44 grams.



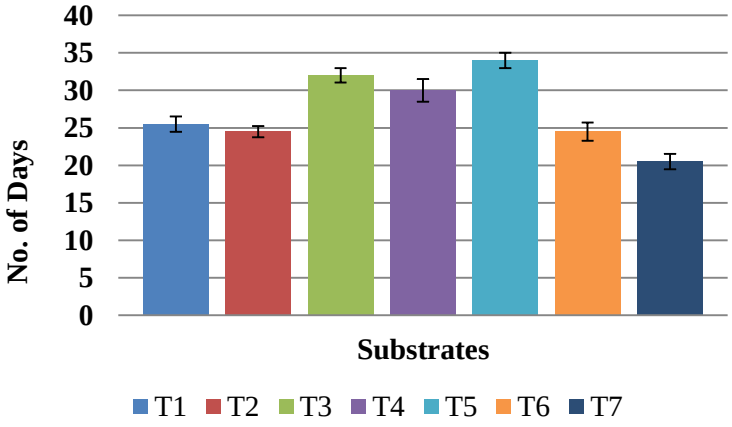
Fig, 1) Mean No. of days taken to complete 25% mycelial growth on different weed plants along with combination of agricultural waste materials



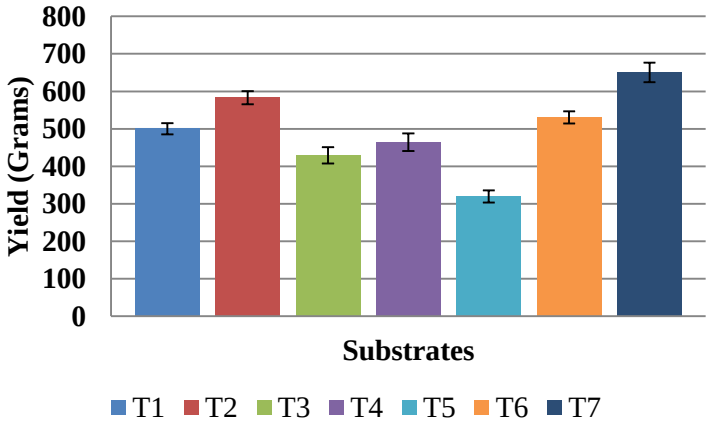
Fig, 2) Mean No. of days taken to complete 50% mycelial growth on different weed plants along with combination of agricultural waste materials.



Fig, 3) Mean No. of days taken to complete 75% mycelial growth on different weed plants along with combination of agricultural waste materials.



Fig, 4) Mean No. of days taken to complete 100% mycelial growth on different weed plants along with combination of agricultural waste materials.



Fig, 5) Total yield of three flushes (grams) on different weed plants along with combination of agricultural waste materials

DISCUSSION

Different substrates and their mixtures can be utilized for the better cultivation of oyster mushrooms which may include various crop residues, weeds, agricultural wastes and supplements. These substrates directly affect the time frame to attain the maximum mycelial growth and also take part in the Yield attribute for oyster mushrooms. Previous reports of better yield of oyster mushrooms via utilization of different agricultural substrates attracted our mind towards it (Mendez et al., 2005; Kalmis et al., 2008; Onyango et al., 2011). Various products, bi-products, weeds and agricultural wastes which are full of nutrients can act as bio stimulants for micro organism growth such as mushrooms (Zafar et al., 2016). The organic products may include agricultural substrates, weeds and their mixtures for their effect upon time taken to achieve 100% mycelial growth and yield of the oyster mushrooms. Our results illustrated that cotton substrates relatively proven better for both the attributes as they

recorded the highest yield (650.36grams) in three flushes and only taken 20.5 days to achieve the maximum mycelial growth. These results are in-line with the findings of Khan et al. (2010) who achieved a yield of 844 grams in four flushes of *Pleurotus ostreatus florida spp*. Our experiment also included the mixture of cotton waste and *Chenopodium album* substrate which also recorded significant results by giving 583.41 grams yield and completed the targeted growth in 24.5 days. Once again the findings were collaborated with Khan et al. (2010) who documented 795 grams yield of local oyster specie via using mixture of cotton waste with other substrates. Similarly improved performance of cotton waste regarding better yield of oyster mushrooms have been proved coordinating with previous reports (Fan et al., 2006; Kimenju et al., 2009). We also utilized mixture of wheat straw and *Amaranthus virdis* and observed 464.42 gram yield in three flushes and taken 30 days to reach 100% growth level. Our results are nearing to Dundar (2008) who cultivated different local and exotic species of *Pleurotus* on wheat stalk substrate and explained that the substrate took around two month to achieve maximum growth regarding all the species. Therefore our findings show that using the mixture of wheat straw along with weed (*Amaranthus virdis*) literally improved the performance of substrate. In our studies, we also incorporated the mixture of rice straw and another weed (*Trianthem portulacastrum*) and found that it took 34 days for maximum maturity and given 319.44 grams yield. Our findings approximately match with Baysal (2003) who investigated paper waste supplemented with rice husk as substrate and exhibited 350.2 grams yield of *Pleurotus ostreatus*. Recent studies of Mintesnot et al (2013) include the cultivation of different species of oyster mushrooms via utilization of various weed substrates. He recorded a total yield of 840 grams upon weed (*Parthenium hysterophorus*) substrate. Similarly, Kholoud et al., 2014 utilized date palm leaves and several other agricultural wastes efficiently to cultivate oyster mushrooms which also strengthen our results.

CONCLUSION

The results explain that the selection of better substrate not only increase the yield of the *Pleurotus ostreatus* (P1-white strain) but also reduces the time of maturity and gives early harvesting. Our results explain that cotton waste or the mixture of cotton waste and *Chenopodium album* are better substrates for the cultivation of oyster mushroom. The utilization of these weeds and agriculture wastes as substrates will not only enhance the yield of oyster mushrooms but also help in reduction of weeds and wastes.

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CONFLICTS OF INTERESTS

The authors declare that they don't have any conflicts of interest.

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