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Cultivation of mushroom on different agricultural wastes and soil

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Abstract
The present investigation entitled "Cultivation of Mushroom on different Agricultural Wastes and Soil" and was conducted during *rabi* season 2018-19 in a dark room on crop research farm, SHUATS, Prayagraj, the experiment was laid out in randomized block design (RBD), with twelve treatments, replicated thrice with an objective to studied the growth, yield and nutrition content of mushroom with physical and chemical properties of soil which was used for growing of mushroom. Agriculture waste such as Wheat Straw, Paddy Straw, Rice Bran, Saw dust, Rice Straw including control. Both the mushroom grown on straw gave the significant height, weight and width. From the findings it is found that the T1 (100% wheat straw @ + oyster mushroom) was found at par than anyother treatments in terms of growth, yield and quality of mushroom. T2 (paddy straw @ 100% + oyster mushroom) was found to be at par with T1 (wheat straw @ 100% + oyster mushroom) in height, weight and width of mushroom. All the soil parameters *viz*., bulk density (g cm-3), particle density (g cm-3), pore space (%), water holding capacity (%), organic carbon (%), available nitrogen (kg ha-1), phosphorus (kg ha-1), potassium (kg ha-1) respectively was also recorded maximum in T1. The highest benefit cost ratio (1:1.75) was obtained in T2 (100% paddy straw @ + oyster mushroom).

Keywords: Oyster and button mushrooms, soil properties *etc.*

Introduction
Oyster mushroom (*Pleurotus* spp.), commonly known as "Dhingri" in India, is a lignocellulose loving fungus growing in nature on living or dead tree trunks/stumps or bark. They are easily recognized in nature due to their peculiar morphology with an eccentric short stem or stipe. Cultivation technology of oyster mushroom is very simple which does not require costly infrastructure facilities. The cultivation of oyster mushroom in India is mainly done in seasonal low cost growing rooms with very less expenditure on infrastructure. There is no organized market where one can sell his produce or purchase fresh or dry oyster mushroom throughout the year. Therefore, the production of oyster mushroom on a commercial scale is rare in our country as compared to *Agaricus bisporus* (button mushroom). Theoretically each crop takes 45 days and under controlled conditions and hence there can be 8 crops per year. Mushroom with their great variety of species, constitute a cost-effective means of both supplementing the nutrition to human kinds 4-5 species of mushroom are of industrial significance throughout the world (Chang and Miles, 1992) [3]. In India only three species, namely Agaricus bisporus, Pleurotus sajorcaju and are preferred for commercial cultivation of the three cultivated species. The white button mushroom have the highest consumer preference and account for about 90% of the total mushroom production. The Oyster mushroom grows during winter months only therefore, it needs proper preservation techniques to promote their comsumption among the common people and the excess of mushroom is processed into food products acceptable to consumers. Mushrooms contain 90 percent moisture. Oyster mushroom (*Pleurotus bisporus* spp) belonging to class Basidiomycetes and family Agaricaceae is popularly known as "Dhingri" in India and grows naturally in the temperate and tropical forests on dead and decaying wooden logs or sometimes on dying trunks of deciduous or coniforest woods. It may also grow on decaying organic matter. Produces protein rich food oyster mushrooms are the third largest cultivated mushroom. The economic importance of the mushroom lies primarily in its use as food for human consumption. It is rich in Vitamin C and B complex and the protein content varies between 1.6 to 2.5 percent and mineral salts required for the human body. Oyster mushroom is the third most cultivated edible mushroom in the

world. Oyster mushrooms are easiest to grow as they can grow on many substrates but their cultivation has one drawback as some people are allergic to their spores. In these cases, air-cleaning equipment or respirators are necessary in order to safely work in the production facility. Because of the short shelf life this species offer a special advantage to the local grower who markets directly and can continuously deliver a fresh, high-quality product. For the cultivation of *Pleurotus* rice straw, wheat straw and cotton straw are the substrates that are commonly used while for *Agaricus*, it is wheat straw which is usually used. A disadvantage of straw is that it should be prepared first, especially if mushrooms are to be grown indoors. Through the provision of income and improved nutrition, successful cultivation and trade in mushrooms can strengthen livelihood assets, which cannot only reduce vulnerability to shocks, but enhance an individual's and a community's capacity to act upon other economic opportunities. Mushroom development usually starts at the first sign of buttons, often on a 7-10 days cycle and may last for 1½ -2 months. Timing is important as mushroom grow quickly doubling their size within 24 hours.

Buttons are small unopened mushroom at the flat stage while the caps are the older button which has begun to open and have fully expanded to expose all the gills. The fruiting bodies are harvested by hand with a twisting motion. The stem is trimmed and the mushroom is usually graded straight into boxes for transport and sale. Mushrooms are highly perishable and should be marketed as soon as possible after harvesting. Hence, the present investigation was carried out to study the Cultivation Oyster mushroom (*Pleurotus ostreatus*) and Button mushroom (*Agaricus bisporus*) to different Agricultural waste and soil.

Materials and Methods

Mother spawn was brought from Kanpur University. Wheat grains were used as substrates for the preparation of mother spawn. Grains were cleaned and broken and undersized grains were removed. These were thoroughly washed and dipped in tap water for 12 hours. The grains were boil for 0-15 minutes till they became soft without rupturing the epidermis. Various waste materials such as rice bran, wheat bran, rice straw, sawdust, banana leaf and sugarcane baggage were used for determination of suitable spawn substrate. The wheat grain, were washed several times to remove any suspended particles. The grains were boiled in a container with water till they soften and then spread over a polythene sheet under shade for draining excess water from grains surface. Each substrate like rice bran, wheat bran, rice straw, sawdust, banana leaf and sugarcane baggage were soaked separately in water for about 8-9 hour and then excess amount of water was drained out. Then 50% wheat grains and 50% rice bran, wheat bran, rice straw, sawdust, banana leaf and sugarcane baggage (w/w) each were spread over a polythene sheet 20g of Calcium carbonate were added to 1kg of each combination and mixed together properly in a container (Sanchez *et al*., 2002) [11]. Paddy straw and wheat straw were chopped into pieces of 4-5 cm with the help of a chaff cutter. The straw substrates were dip in water (already mixed with 75 ppm bavistin and 500 ppm formaldehyde) for 14 hours as per the method. Excess water was drained off by spreading the straw in the sloppy cemented floor till the moisture content of straw reached to 65-70%. Before spawning, formaldehyde was sprinkled on the floor, the spawn was then mixed to the substrate was done in an open room. The spawn substrate was filled in the polythene bags (12''x 18''- 150 gauge) and nylon strings was employed for tying the mouth of the bags. Perforations were made with the help of nail to allow free passage of air within the polythene bags. The filled bags were kept in the cropping room roofing. High Humidity in the cropping room was maintained by frequent watering of the bags and of the floor. Polythene covers were removed after the completion of spawn run (days) was observed when the straw were fully covered with milky white mycelial growth of the fungus (*Agaricus bisporus*, *Pleurotus ostreatus*).

Five fruiting bodies were selected randomly from each bag and tagged. The height of these mushroom was measured from the ground level up to the cap of mushroom. Mushroom height was recorded at 15, 30 and 45 DAS. Five fruiting bodies were selected randomly from each bag and tagged. The width of these mushroom were measured. Mushroom width was recorded at 15, 30 and 45 DAS. Five fruiting bodies were pick randomly from each bag and dry in the oven. The weight of these mushroom were measured. Mushroom weight was recorded at 15, 30 and 45 DAS. Diffused light and good ventilation was provided during the entire cropping period. Standard procedure was followed to collect the data for growth and yield parameters. The collected data were analysed statistically by using Ronald Fisher analysis of variance technique and CD at 5% probability was used to compare the differences among the treatment means.

Mushroom consumed in India

Mushroom cultivation in India is about 4 decades old, with a rapid increase in the production over the last 10 – 12 years. From the meagre production of about 4000 tonnes in 1985, India now produces more than 80000 tonnes of mushroom annually of which about 90% is of Button mushroom. The remaining 10% production is accounted for by the Oyster mushroom.

Production of mushrooms, especially of white button mushroom in India, has gone up during recent years creating marketing problems. The market for processed food has yet to develop in the country and basically fresh fruits and vegetables are preferred. Per capita consumption of mushrooms in India is hardly 5g as against over a kg in develop countries.

Source:https://www.researchgate.net/publication/322520732%20Status%20of%20mushroom%20production%20in%20India#:~:targetText=Compared%20to%20other%20vegetables%3B%20per,than%20100%20grams%20per%20year

Result and Discussion

Growth and yield of mushroom

Significantly higher mushroom height was recorded under treatment T1 100% wheat straw @ bag + oyster mushroom (6.41). However, mushroom height recorded under the treatments T2 100% paddy straw @ bag + oyster mushroom, T5 100% saw dust @ bag + oyster mushroom, T7 75% paddy straw @ bag + 25% sandy loam soil @ bag + button mushroom, was found to be at par with T1 100% wheat straw @ bag + oyster mushroom. Higher mushroom weight was recorded under treatment T1100% wheat straw @ bag + oyster mushroom (14.56). The maximum height, weight and width were recorded by oyster mushroom. This might bedue to their inherent characteristic. Similar finding was also reported by Rosado *et al*., (2002) [10]. The highest width of mushroom was recorded under treatment T1 100% wheat straw @ bag + oyster mushroom (5.28). However, mushroom width recorded under the treatment T2 100% paddy straw @

bag + oyster mushroom, T5 100% saw dust @ bag + oyster mushroom, T6 90% wheat straw @ bag + 10% sandy loam soil @ bag + button mushroom was found to be at par with T1 100% wheat straw @ bag + oyster mushroom. Suitability of paddy straw in Oyster mushroom cultivation has been reported by Ram, (2010) [9]; and Arya and Arya, (2003) [2]. Lower amount of sandy loam soil gave the good performance in widthof mushroom. This might be due to the soil particles break the growth of mycelium ofmushroom and can be used as casing layer. Similar results was reported by Sassine *et al.*, (2007) [12]; Manjulal *et al.*, (2004) [6].

Appraisal of the mean data showed significant variation on yield of mushroom. Significantly higher mushroom yield was recorded for treatment T1 100% wheat straw @ bag + oyster mushroom (2.78), However, mushroom yield recorded under the treatments T2 100% paddy straw @ bag + oyster mushroom was found to be at par with T1 100% wheat straw @ bag + oyster mushroom.

Yield is a complex character resulting from the interaction from primary inherited character of the mushroom and with the environment and management. For top fruiting bodies yield, the trio- complex of ecological situation, the genetic potential and the management practices are of utmost importance. If the previous two requirements are commonly shared, the fate of the crop will naturally by determined by management practices. The maximum yield was recorded by oyster mushroom. This might be due to their inherent characteristic. Oyster mushroom can grow at moderate temperatures, ranging from 20 to 300 C, and at a humidity of 55-70% on various agricultural waste materials used as substrate. All the rice straw treatment recorded the highest yield of mushroom. (Table 1, 2 and 3).

Table 1: Effect of different agricultural waste on height, weight, width and yield of button and oyster mushroom + total volume of per bag 5kg + of agricultural waste.

S. No.	Treatment	Height of mushroom (cm)	Weight of mushroom (g)	Width of mushroom (cm)	Yield of mushroom (kg bag-1)
T0	100% sandy loam soil @ bag + button mushroom	2.88	8.05	2.22	2.13
T1	100% wheat straw @ bag + oyster mushroom	6.41	14.56	5.28	2.78
T2	100% paddy straw @ bag + oystermushroom	6.21	13.11	5.00	2.71
T3	100% rice straw @ bag + oyster mushroom	3.56	9.38	3.22	2.31
T4	100% rice bran @ bag + oyster mushroom	3.11	8.42	2.42	2.18
T5	100% saw dust @ bag + oyster mushroom	5.56	12.59	4.75	2.66
T6	90% wheat straw @ bag + 10% sandy loam soil @ bag + button mushroom	5.21	11.60	4.37	2.53
T7	75% paddy straw @ bag + 25% sandy loam soil @ bag + button mushroom	4.67	10.65	4.01	2.45
T8	75% rice straw @ bag + 25% sandy loam soil @ bag +button mushroom	3.43	8.77	2.81	2.27
T9	75% rice bran @ bag + 25% sandy loam soil @ bag + button mushroom	3.08	8.33	2.33	2.15
T10	90% saw dust @ bag +10% sandy loam soil @ bag + button mushroom	3.96	10.35	3.86	2.38
	F test	S	S	S	S
	S Ed±	0.70	0.45	0.46	0.05
	CD (P=0.05)	1.45	0.93	0.96	0.10

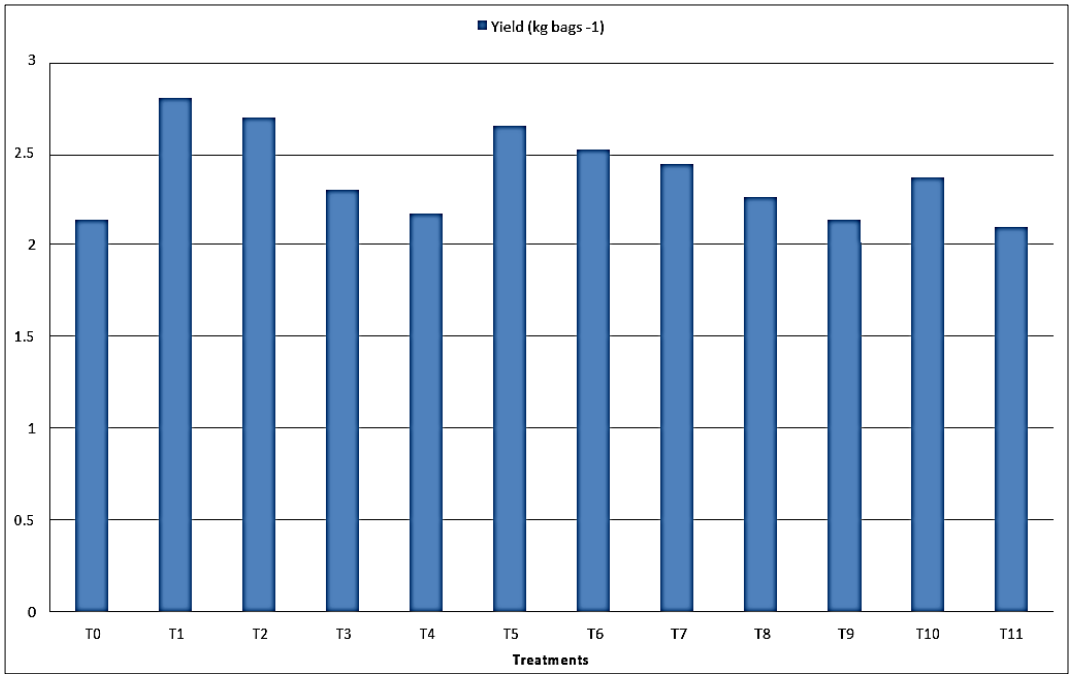

Fig 1: Effect of different agricultural wastes and sandy loam soil on yield of button and oyster mushroom

Table 2: Effect of button and oyster mushroom on different agricultural wastes and sandy loam soil on Nitrogen, Phosphorus and Potassium content (%) in mushroom at harvest.

S. No.	Treatment	Nitrogen (kg ha-1)	Phosphorus (kg ha-1)	Potassium (kg ha-1)
T0	100% sandy loam soil @ bag + button mushroom	1.11	0.16	0.11
T1	100% wheat straw @ bag + oyster mushroom	1.65	0.38	0.24
T2	100% paddy straw @ bag + oyster mushroom	1.24	0.29	0.22
T3	100% rice straw @ bag + oyster mushroom	1.18	0.22	0.13
T4	100% rice bran @ bag + oyster mushroom	1.13	0.20	0.12
T5	100% saw dust @ bag + oyster mushroom	1.27	0.27	0.19
T6	90% wheat straw @ bag + 10% sandy loam soil @ bag + button mushroom	1.23	0.26	0.17
T7	75% paddy straw @ bag+ 25% sandy loam soil @ bag + button mushroom	1.21	0.26	0.16
T8	75% rice straw @ bag +25% sandy loam soil @ bag + button mushroom	1.15	0.21	0.13
T9	75% rice bran @ bag + 25% sandy loam soil @ bag + button mushroom	1.12	0.18	0.11
T10	90% saw dust @ bag +10% sandy loam soil @ bag + button mushroom	1.20	0.24	0.16
	F test	1.09	0.14	0.10
	S Ed±	S	S	S
	CD (P=0.05)	0.04	0.02	0.02

Nitrogen, phosphorus and potassium content in mushroom

Available nitrogen

Available nitrogen content in soil was estimated by Alkaline potassium permanganate method as described by Subbiah and Asija (1956) [13].

When available nitrogen in the soil is measured by organic carbon method, soil test nitrogen response equation developed based on alkaline potassium permanganate method cannot be directly used. Available nitrogen estimated by alkaline potassium permanganate method, has to be predicted from the easily oxidizable organic based on the regression equations developed between these two methods for different soils. For Old alluvium grey – grayish yellow light textured soil is-

$$Y = 103.3 + 321.0\ X$$

Where,
Y = N obtained by Alkaline KMnO4
X =% Organic Carbon

Available Phosphorus

Available phosphorus was extracted by 0.5m NaHCo3 as per procedure of Olsen's determined calorimetrically by molybdophosphoric blue colour method as described by Olsen *et al.* (1954) [7]. First, we made Olsen Extractant. Took 2.5g soil + 0.5g activity charcoal (phosphorus free) in a 250 ml flask and added 50 ml Olsen's extractant to it which was shaken for 30 minutes on a mechanical shaker and filtered it through Whatman filter paper No.1.A blank should also run side by side. Then, 10ml of extract was taken in a 50 ml Volumetric flask and 1-2 drops of 2, 4 dinitrophenol indicator was added and adjust the pH 3.5 by adding 5N NH4OH. The end point was colourless. After adjustment of pH, added 8ml of ascorbic acid solution to make up the volume 50ml with distilled water. The intensity of colour measured after 30 minutes and before 2 hours of colour development with the help of calorimeter using mu wavelength or red filter after adjusting the instrument at zero reading with blank. The amount of P was calculated in extrate by comparing the reading with standard curve for phosphorus. Available phosphorus in soil is calculated by following formula –

$$\text{Amount of P in soil (kg/ha)} = \frac{2 \times V \times E \times G}{S \times F}$$

Where,
S = Soil taken (g)
E = Extracting Solution taken (ml) to extract P from
F = Amount of soil extract (filtrate) taken to colour develop (ml) V = Final Volume made (ml)
R = Calorimetric reading
G = Corresponding ppm of P as per standard graph on R value

Available potassium

Available potassium in soil sample was determined by using neutral ammonium acetate solution as described by Jackson (1973) [4]. The reading was taken on a flame photometer using potassium filter. 5g of soil and 25 ml of neutral 1N ammonium acetate was taken in a shaken bottle and it is shake on a Horizontal shaker for 5 minutes. Then the solution was filtered through whatman filter paper No. 1. The amount of K in extract was determined in the flame photometer after necessary setting and standardizing of instrument with 10, 20 and 30 ppm K solution.

$$\text{Amount of K in soil (kg/ha)} = R \frac{\text{Volume of the extract}}{\text{Weight of the soil}} \times \frac{224 \times 10^4}{10^6}$$

Where,
R = µg/ml of K in the extract (obtained from the standard curve)

A close scrutiny of mean data showed higher phosphorus and potassium content in mushroom under treatment T1 100% wheat straw @ bag + oyster mushroom (0.38, 0.24). However treatments T2 100% paddy straw @ bag + oyster mushroom, T5 100% saw dust @ bag + oyster mushroom, T6 90% wheat straw @ bag + 10% sandy loam soil @ bag + button mushroom were found to be at par with T1 100% wheat straw @ bag + oyster mushroom. The higher nitrogen content in mushroom was recorded under the treatment of T1 might be due to rice straw is to provide a reservoir of cellulose, hemicellulose, lignin and nitrogen which is highly utilized by oyster mushroom. Similar result was reported by Yildiz *et al*., (2002) [15]. Similarly, maximum phosphorus and potassium content were recorded under T1 might be due to the maximum phosphorus and potassium content in soil and wheat straw. It may be concluded that treatment T1- 100% wheat straw @ bag + oyster mushroom gave the maximum height, weight, width and yield of mushroom. Treatment T1- 100% Wheat straw @ bag + oyster mushroom gave the higher

yield. However, all the combinations of 25 % soil + 75% wheat straw gave the better response with oyster mushroom. So, it is recommended for the marginal farmers as well as small and big farmers. The compost obtained after the harvesting of mushroom is good manure and can be utilize for crop production.

Table 3: Economic of different treatment on cultivation of mushroom on different agricultural waste and Soil

Treatment	Treatment cost (₹/bag)	Common cost (₹/bag)	Total cost of Cultivation (₹/bag)	Gross return (₹/bag)	Net return (₹/bag)	B:C ratio
T0	45.00	650.00	695.00	958.50	263.50	1:1.37
T1	45.00	650.00	695.00	1201.00	506.00	1:1.72
T2	45.00	650.00	695.00	1219.50	524.50	1:1.75
T3	45.00	650.00	695.00	1039.50	344.50	1:1.49
T4	45.00	650.00	695.00	981.00	286.00	1:1.41
T5	45.00	650.00	695.00	1197.00	502.00	1:1.72
T6	40.50	650.00	690.50	1138.50	448.00	1:1.64
T7	33.75	650.00	683.75	1102.50	418.75	1:1.61
T8	33.75	650.00	683.75	1021.50	337.75	1:1.49
T9	33.75	650.00	683.75	967.50	283.75	1:1.41
T10	40.50	650.00	690.50	1071.00	380.50	1:1.55
T11	33.75	650.00	683.75	940.50	256.75	1:1.37

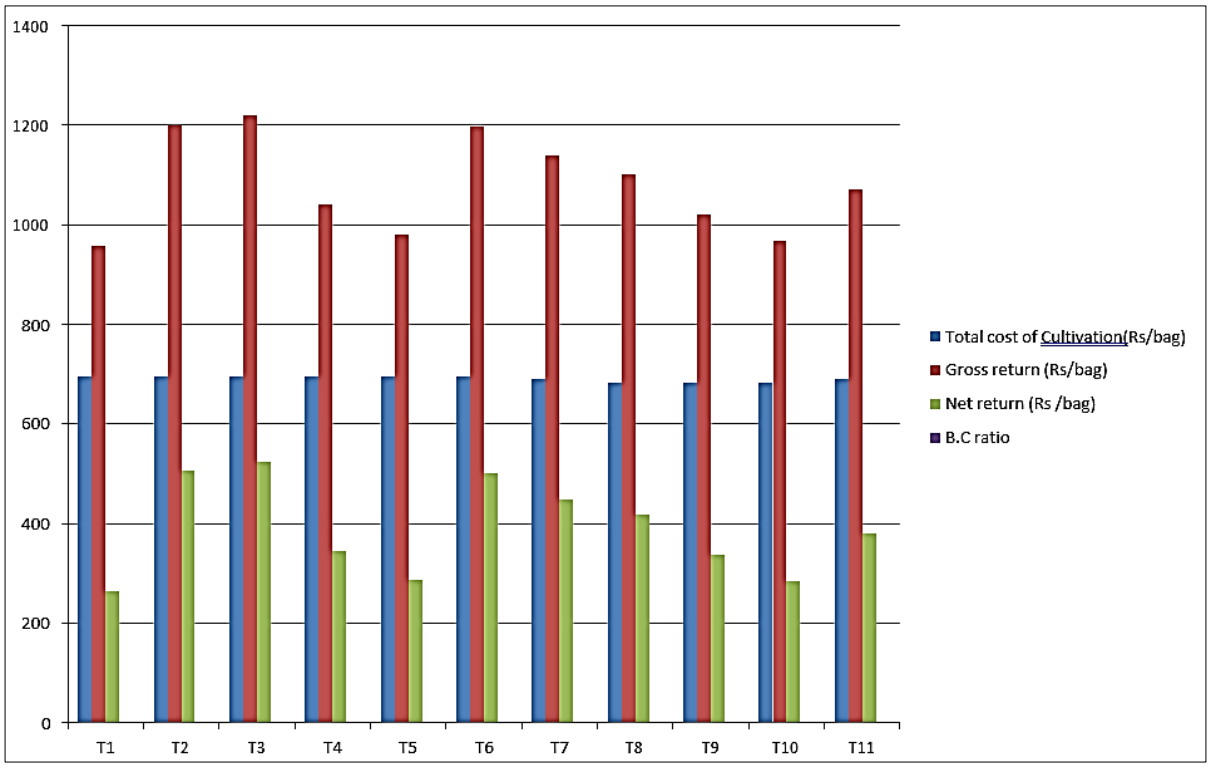

Fig 2: Economic of different treatment on cultivation of mushroom on different agricultural waste and soil

Summary and Conclusion

Present study was conducted to observe the effect of supplements in upgradation of nutritional status of composting substrate with respect to yield potential of *Agaricus bisporus* and *Pleurotus bisporus*. Cultivation of Button and Oyster mushroom was carried out with strains on such like wheat straw paddy straw etc. based on compost was carried out during the rabi season in the year 2018-2019 in a dark room on a crop research farm of Makino school, SHUATS Prayagraj. The experiment was laid out in randomized block design with three replications. There were twelve treatment *viz* T0 100% sandy loam soil @ bag + button mushroom (Total volume of bag 5 kg), T1 100% wheat straw @ bag + oyster mushroom, T2 100% paddy straw @ bag + oyster mushroom, T3 100% rice straw @ bag + oyster mushroom, T4100% rice bran @ bag + oyster mushroom, T5 100% saw dust @ bag + oyster mushroom, T6 90% wheat straw @ bag + 10% sandy loam soil @ bag + button mushroom, T7 75% paddy straw @ bag+ 25% sandy loam soil @ bag + button mushroom, T8 75% rice straw @ bag + 25% sandy loam soil @ bag + button mushroom, T9 75% rice bran @ bag + 25% sandy loam soil @ bag + button mushroom, T10 90% saw dust @ bag+10% sandy loam soil @ bag + button mushroom, T11-75% poultry manure @ bag+ 25% sandy loam soil @ bag + button mushroom. The different treatments were allocated randomly in each replication and results of the investigation are summarized below.

Perusal of the mean data showed significantly higher mushroom height under treatment T1 100% wheat straw @ bag + oyster mushroom (Total volume of bag 5 kg) (7.51, 7.39 and 4.33 cm) at 15, 30 and 45 DAS. Appraisal of the mean data shows significant variation at 15, 30 and 45 DAS. Higher mushroom weight was recorded under treatment T1 100% wheat straw @ bag + oyster mushroom (Total volume of bag 5 kg) (16.08, 15.10 and 12.51) at 15, 30 and 45 DAS.

At 15, 30 and 45 DAS, significantly higher mushroom width was recorded for treatment T1 100% wheat straw @ bag + oyster mushroom (Total volume of bag 5 kg) (6.33, 5.19 and 4.31). Appraisal of the mean data showed significant variation on yield of mushroom. Significantly higher mushroom yield was recorded for treatment T1 100% Wheat straw @ bag + oyster mushroom (Total volume of bag 5 kg) (2.78) at post-harvest. Significantly higher nitrogen content in mushroom was recorded under treatment T1 100% wheat straw @ bag + oyster mushroom (Total volume of bag 5 kg) (1.65) at post-harvest. A close scrutiny of mean data showed higher phosphorus and potassium content in mushroom under treatment T1 100% wheat straw @ bag + oyster mushroom (Total volume of bag 5 kg) (0.38, 0.24) at post-harvest.

Conclusion

Agaricus bisporus mushroom is a useful bio-factor for agro waste recycling and can be grown on various composts, such as composts of wheat straw, reed plants, waste paper, oat straw, waste tea leaves and some water plants. *A. bisporus* has many dietary usages due to its content of proteins, carbohydrates, low calories, trace elements, and vitamins. It may be included that treatment T2 100% paddy straw @ bag + oyster mushroom gave the maximum height, weight, width and yield of mushroom. Treatment T2 100% paddy straw @ bag + oyster mushroom gave the higher gross return, net return and benefit cost ratio. However, all the combination of 25% and 75% paddy straw gave the better response with Oyster mushroom. So, it is recommended for the marginal farmers as well as small and big farmers. The compost obtained after the harvesting of mushroom is good manure and can be utilize for crop production. Since the result is based on single trial further experimental trials are needed to confirm the result.

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