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Ravi Kumar
Department of Plant Pathology, C. S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

SK Biswas
Department of Plant Pathology, C. S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Shivam Kumar
Department of Plant Pathology, C. S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Saurabh Kumar
Department of Plant Pathology, C. S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Arshad Husain
Department of Plant Pathology, C. S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Naimish Kumar
Department of Plant Pathology, C. S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Kishan Lal
Department of Plant Pathology, C S Azad University of Agriculture and Technology Kanpur Uttar Pradesh India

Monal Singh
Department of Chemistry PPN (PG) College Kanpur, Uttar Pradesh, India

Corresponding Author
SK Biswas
Department of Plant Pathology, C. S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Comparative studies on growth behavior and yield potential of *Pleurotus florida* and *Pleurotus sajor-caju* due to effect of organic growth supplements

Ravi Kumar, SK Biswas, Shivam Kumar, Saurabh Kumar, Arshad Husain, Naimish Kumar, Kishan Lal and Monal Singh

Abstract
Effect of two organic growth supplements, Wheat bran and Molasses individually and in combinations on growth behavior and yield potential of two different species of oyster mushroom *viz*., *Pleurotus florida* and *Pleurotus sajor-caju* revealed that the treatment T_{14} (Wheat bran 800 g + Molasses 400 ml) consider best in terms of minimum mycelium growth, spawn running, pin head formation and harvesting days among all the treatments. In case of *P. sajar caju* 2.33 days while, in *P. florida* 2.67 days required for mycelium growth initiation, 13 and 14 days for spawn running period, 18 and 20 days for pin head formation respectively. The harvesting of first flush of *P. florida* required less average number of days 21.67 than 22 days of *P. sajor-caju*. The maximum production of *P. florida* obtained from T_{14} treatment (molasses 400 ml + wheat bran 800 g) as 590 g, 430 g, 292 g and 182 g at 1st, 2nd, 3rd and 4th flushes of harvesting respectively with total production was 1494 g which is 53.54% increase over control while, in *P. sajor-caju* maximum production was obtained as 623 g, 455 g, 280 g and 135 g respectively, at 1st, 2nd, 3rd and 4th flushes of harvesting respectively, total production was 1493 g which is 42.05% increase over control.

Keywords: Mushroom, *Pleurotus florida*, *Pleurotus sajor-caju*, yield potential, comparative study

Introduction
Mushroom is considered as "Food of the God" and is considered as a special kind of food since ancient time. It is achlorophyllus fungal plant occurring seasonally all over the world in various habitats with quiet different characters like shape, size, color appearance and edibility. Mushroom has been defined as a macro fungus with a distinctive fruiting body which can be either epigeous or hypogeous and large enough to be seen with naked eye and picked by hand (Chang and Miles, 1991) [2]. There are various types of mushroom available in the market but *Pleurotus* is very easy to cultivate. The *Pleurotus* has gained its name from the Greek world 'Pleuro' which means formed laterally or in a side way position, referring to lateral position of the stipe in relation to pileus (Jandaik, 1997) [10]. The word 'Oyster' refers to the shellfish like appearance of the fruiting bodies.

The Global food and nutritional security of growing population is a great challenge, so it is need to search for new crop that have ability to complete demand of food and nutritions. In this context, mushrooms are source of prestigious food that has very less amount of fat content, low in calories but rich in protein, and the nutritionally, placed between meat and vegetable and therefore mushrooms may be called as vegetable meat. In the present diet conscious era, mushrooms are increasingly considered as a future vegetable owing to its medicinal and nutritional properties. World production of cultivated, edible mushrooms has increased more than 30 fold since 1978 as 1 billion kg to 34 billion kg in 2013 which constituted 4.70 kg per capita consumption. Mushroom production of Asian countries in 2019 are 9854391 tons, among them China contributed 8948099 tons, Japan 470000 tons, and India 182000 tons contributing 1.5% of total mushroom production in the world (FAOSTAT, 2019) [7]. Therefore, there is a need more production of mushroom to contribute more on world production. Mushroom is grown wide range of substrate like sawdust, wheat straw, paddy straw, husk of pulses *etc*. Many investigators used different substrates for cultivation of oyster mushroom. Substrates cotton lint waste, maize wastes (stover), jatropha cake, corncobs, wood shavings and wheat straw were evaluated for their productivity and impact on mushroom market quality of *Pleurotus ostreatus* (Chitamba *et al*., 2012) [4].

Highest percentage of biological efficiency (BE) of Oyster mushroom was obtained from cotton seed (Girmay *et al.*, 2016) [9]. Fermented moso bamboo sawdust having potential as an alternative substrate for the cultivation of *Pleurotus ostreatus* (Yamauchi *et al.*, 2018) [21]. Banana leaves, pea nut hull, corn leaves, wheat and rice straw, mango fruit and seed, sugarcane leaves and cotton waste, among them cotton waste given better result for cultivation of *Pleurotus* spp. (Raman *et al.*, 2021) [16]. *Pleurotus* spp. was successfully produced on fermented pine sawdust substrate supplemented with various levels of wheat bran (Oseni *et al.*, 2012) [14]. Molasses was the best supplement for growth and rice bran in addition, enhanced yield performance of *Pleurotus* mushroom (Nakalembe and Wong, 2011) [13]. Keeping all the points in view the study was under taken as "cpmparative studies on growth behavior and yield potential of *Pleurotus florida* and *Pleurotus sajor-caju* due to effect of organic growth supplements.

Material and Methods

Preparation and chemical sterilization of substrate

The substrate (wheat straw) was soaked in water for 12 hours in water tank containing 4% formalin. It was then removed from water and allow excess water to drained out. The moisture percent will be around 70% at the time of spawning. Growth substrate was sterilized in autoclave at 121.6 °C, 15 psi for 15 minutes. After sterilization the substrate was cooled and used for further study.

Experimental details

The experiment was conducted at Mushroom Research and Development Centre, Department of Plant Pathology, Chandra Shekhar Azad University of Agriculture and Technology**,** Kanpur. Wheat straw was supplemented with different combinations and doses of wheat bran and molasses. In present investigation, total quantity of wheat bran used was 20.4 kg which comprises of the doses 4% (200 g), 8% (400 g), 12% (600 g) and 16% (800 g) of substrate per bag in different combination. 25% solution of 2.4 kg of molasses used for prepare to solution add distilled water and makeup final volume 9600 ml then put on heater for 3-5 minutes and stirred continuously to prevent settling of molasses at bottom. The total volume of solution divided into different doses of 100 ml, 200 ml and 400 ml used to prepare combinations of treatment.

Percentage was calculated (weight by volume basis) by using following formula-

$$\text{Percent of solution} = \frac{Weight\ of\ molasses\ in\ gram}{Total\ volume} \times 100$$

$$= \frac{2400}{9600} \times 100 = 25\%$$

The treatment details were given as T_1 = WS + Molasses 400 ml, T_2 = WS + WB 800 (g), T_3 = WS + Molasses 100 ml + WB 200 (g), T_4 = WS + Molasses 100 ml + WB 400 (g), T_5 = WS + Molasses 100 ml + WB 600 (g), T_6 = WS + Molasses 100 ml + WB 800 (g), T_7 = WS + Molasses 200 ml + WB 200 (g)**,** T_8 = WS + Molasses 200 ml + WB 400 (g), T_9 = WS + Molasses 200 ml + WB 600 (g), T_{10} = WS + Molasses 200 ml + WB 800 (g), T_{11} = WS + Molasses 400 ml + WB 200 (g)**,** T_{12} = WS + Molasses 400 ml + WB 400 (g), T_{13} = WS + Molasses 400 ml + WB 600 (g), T_{14} = WS + Molasses 400 ml + WB 800 (g), T_{15} = Control (Wheat straw) where, WS = Wheat straw, WB= Wheat bran.

Spawning

Spawning was done by freshly prepared spawn, generally 15-20 days old spawn which considered the best for spawning. Old spawn (3-6 months) stored at room temperature (at 20-30 ^oC) forms a very thick mat like structure due to mycelium aggregation. The spawning was done in a pre-fumigated room (36 hrs. with 2% formaldehyde). The supplemented substrate was mix with sterilized wheat substrate and filled in 45×75 cm polythene bag, spawning was done by layering method and then bags were transfer in to the cropping room. The crop room was maintained as temperature 23 °C and relative humidity >85% with proper ventilation.

Results and Discussion

Effect of organic growth supplements on mycelium growth initiation, spawn running, pin head formation and harvesting days

Two organic growth supplements *viz*., Molasses and WB alone or in combinations with different doses were evaluated to observe their effect on days required for mycelium growth initiation in *P. florida* and *P. sajor-caju*. The result presented in table 1 showed that the treatment T_{14} as Molasses 400 ml + WB 800 g documented superior in *P. sajor-caju* has taken lesser number of days for mycelium growth initiation (2.33) followed by treatment T_{12} and T_{13} also documented statistically at par with treatment T_{14} While *P. florida* required 2.67 days followed by treatment T_{13} and T_{12} have taken 3 days in each for initiation of mycelium growth. On the other hand observation on spawn running days revealed that the minimum 13 days required in case of *P. florida* and *P sajor-caju* where treatment was given as molasses 400 ml + wheat bran 800 g against 20 and 23 days, respectively in case of control. The treatment T_{11} (molasses 400 ml + wheat bran 200 g) showing 3.33 days for mycelium growth initiation and 13 days to complete spawn running for *P. florida* and 3.00 days for mycelium growth initiation and 14 days to complete spawn running for *P. sajor-caju*, respectively which is also statistically at par with T_{14}, T_{12} and T_{13} in case of pin head formation highest among the treatments. These findings accordance with Ashraf *et al*. (2013) [1] found that *P. florida* showed faster spawn run period along with early pin head initiation than in *P. sajor-caju*. Thulasi *et al.* (2010) [19] also founded that *P. florida* took 16 days in sorghum and 19 days in coffee husk medium for 100% colonization.

Pin head Initiation

Scrutiny of mean data concerning the effect of different combinations of wheat bran and molasses on pin head formation of *P. florida* presented in table 1 showed that the treatment T_{14} (Molasses 400 ml + Wheat bran 800 g) registered superior in terms of minimum days (17) required for pin head initiation than other treatments. The treatments like T_{13} (Molasses 400 ml+ Wheat bran 600 g) T_{12} (Molasses 400 ml + Wheat bran 400 g) and T_{11} (Molasses 400 ml + Wheat bran 200 g) also recorded superior in terms of days required for pin head initiation, while in case of *P. sajor-caju* also required maximum number of days (17) when treated with T_{14} (Molasses 400 ml + Wheat bran 800 g) for the pin head initiation for control showing 27 days. The rest of treatments were also able to minimize the number of days for pin head initiation over control. From the table 1it is also cleared that mycelial growth initiation is faster in *P. sajor-*

caju but pin head formation is faster in *P. florida*. The present findings are lined with the result reported by Nirdesh *et al.* (2019) found that *P. sajor-caju* has been taken 16 days for pin head initiation and 21 days for first harvesting in treatment T_5 (3/4 wheat straw+1/4 mustard straw+100 g wheat bran). Khan *et al.* (2012) [11] also found that after spawn inoculation average time taken for pin head initiation and fruiting bodies formation on cotton waste, wheat straw, paddy straw, corn cobs, Corn stovers, sugarcane bagasse and mungbean straw were 23.50, 21.50, 22.0, 27.50, 16.00, 21.00 and 17.00 days respectively.

Harvesting days

The effect of different combinations of wheat bran and molasses on number of days required for first harvesting, the data presented in table 1 showed that the lesser number of days (21.67) required for harvesting of first flush when substrate was prepare as molasses 400 ml + wheat bran 600 g (T_{13}). The treatment as molasses 200 ml + Wheat bran 800 g for cultivation of the *P. florida* also documented average 22.33 days each, representing second lowest among all the treatments which are also statistically at par with treatment T_{14}. On the other hand in case of *P. sajor-caju*, the treatment T_{14} (Molasses 400 ml + Wheat bran 800 g) and T_{13} (Molasses 400 ml + Wheat bran 600 g) taken 22 days each for harvesting of first flush which is minimum among all the treatments. The treatment T_{12} (Molasses 400 ml + Wheat bran 400 g) taking 23 days for harvesting of first flush representing 2nd lowest among the treatment. Raman *et al.* (2020) [17] reported that when different species of *Pleurotus* mushroom cultivated on various substrate *viz*., paddy straw, wheat straw, barley straw, soybean straw, sorghum straw, maize stem residue, cotton waste, maize stems, maize cob shells, pseudobanana stems, oak sawdust, were required 20-31 days for harvesting of first flush. Chaurasiya *et al.* (2019) also reported that when substrate treated with solution of GA_3 with 10 ppm concentration on *P. florida* it required 24 days for harvesting of first flush.

Effect of different organic supplements on production at different flushes and yield of *Pleurotus* spp

The perusal of data concerning the effect of wheat bran and molasses of yield in different flushes of *P. florida* present in the fig. 1 showed that highest production was recorded in treatment T_{14} (Molasses 400 ml + Wheat bran 800 g) with value 590 g, 430 g, 292 g and 182 g at 1st, 2nd, 3rd and 4th flushes of harvesting respectively. The treatment T_{10} comprises molasses 200 ml and WB 800 g produced 587 g, 426 g, 241 g and 118 g fresh mushroom at 1st, 2nd, 3rd and 4th flushes of harvesting representing respectively, representing second highest among the treatments. As per concerned on total production it is cleared that the T_{14} (Molasses 400 ml + Wheat bran 800 g) maximum total production as 1494 g against 973 g in case of control which is 53.54 % increased over control. From the table 1 it is cleared that all the treatments were able to increase total yield of mushroom over control similarly total weight of fruiting bodies concerning the effect of wheat bran and molasses on yield of different flush of *P. sajor-caju* in fig. 2 showed that in treatment T_{14} (Molasses 400 ml + Wheat bran 800 g) as 623, 455, 280 and 135 g respectively, at 1st, 2nd, 3rd and 4th flushes of harvesting respectively. The second highest production was recorded on treatment T_{13} as Molasses 400 ml + WB 600 g which produced 620, 398, 275 and 133 g respectively. The total yield of treatment T_{14} (Molasses 400 ml + WB 600 g) produced 1493 g which is 42.05 % increased over control. The treatment T_{13} recorded second highest production of fresh weight presenting value 1425 g which is 35.58% increased over control. From the table 1 it is cleared that the maximum total produce was harvested from first flush representing the value as 590 g and 623 g in *P. florida* and *P. sajor-caju* respectively. Tirkey *et al.* (2017) [20] reported that 498-915 g yield obtained from all flushes when using different substrate like grass card board *etc*. for production of *Pleurotus* species. The Present findings also supported by Gimenez *et al.* (2015) reported that increment of yield 34-60% over control. The substrates were used for cultivation of *Pleurotus* species. Chaurasiya *et al.* (2019) reported that 1162-1324 g yield with increment of 19-42% over control obtained from all four flushes, using growth hormones IAA and GA_3 in different concentration as a supplement.

Table 1: Effect of organic growth supplements on growth behavior of *Pleurotus florida* and *Pleurotus sajor-caju*.

Treatments	Mycelium growth initiation		Spawn running		Pin head initiation		Days required for 1st harvesting		Total production		Total production increase over control	
	P. florida	*P. sajor-caju*	*P. florida*	*P. sajor-caju*	*P. florida*	*P. sajor-caju*	*P. florida*	*P. sajor-caju*	*P. florida*	*P. sajor-caju*	*P. florida*	*P. sajor-caju*
T_1	5.33	6.00	19.00	19.00	24.00	26.00	28.33	30.00	1048	1195	+7.70	+13.70
T_2	5.33	6.00	19.00	19.00	23.00	24.00	28.00	30.00	1094	1218	+12.43	+15.88
T_3	4.67	5.33	17.00	18.00	21.00	23.00	27.67	27.00	1092	1225	+12.23	+16.55
T_4	3.33	4.67	17.00	16.00	23.00	22.00	27.00	26.00	1223	1239	+25.69	+17.88
T_5	4.67	4.00	18.00	17.00	22.00	22.00	24.33	26.00	1330	1207	+36.69	+14.84
T_6	3.67	3.67	16.00	17.00	20.00	21.00	23.67	25.00	1344	1275	+38.12	+21.31
T_7	5.00	4.33	17.00	16.00	22.00	22.00	27.00	26.00	1390	1305	+42.85	+24.16
T_8	4.33	4.00	15.00	16.00	20.00	23.00	25.67	27.00	1366	1365	+40.39	+29.87
T_9	4.33	3.33	16.00	17.00	20.00	22.00	25.00	26.00	1305	1416	+34.12	+34.72
T_{10}	3.33	3.00	14.00	16.00	20.00	19.00	22.33	24.00	1371	1413	+40.90	+34.44
T_{11}	3.33	3.00	13.00	14.00	18.00	20.00	25.00	25.00	1477	1419	+51.79	+35.01
T_{12}	3.00	2.67	14.00	14.00	19.00	19.00	24.33	23.00	1426	1402	+46.55	+33.39
T_{13}	3.00	2.67	13.00	14.00	18.00	18.00	22.33	22.00	1408	1425	+44.70	+35.58
T_{14}	2.67	2.33	13.00	13.00	17.00	17.00	21.67	22.00	1494	1493	+53.54	+42.05
T_{15}	6.67	6.67	20.00	23.00	25.00	27.00	30.67	31.00	973	1051	--------	-------
CD	0.430	0.3729	1.395	1.255	2.064	2.656	1.315	2.064	45.442	34.414	--------	-------
SEM	0.149	0.1291	0.483	0.434	0.714	0.683	0.455	0.714	15.733	11.915	--------	-------

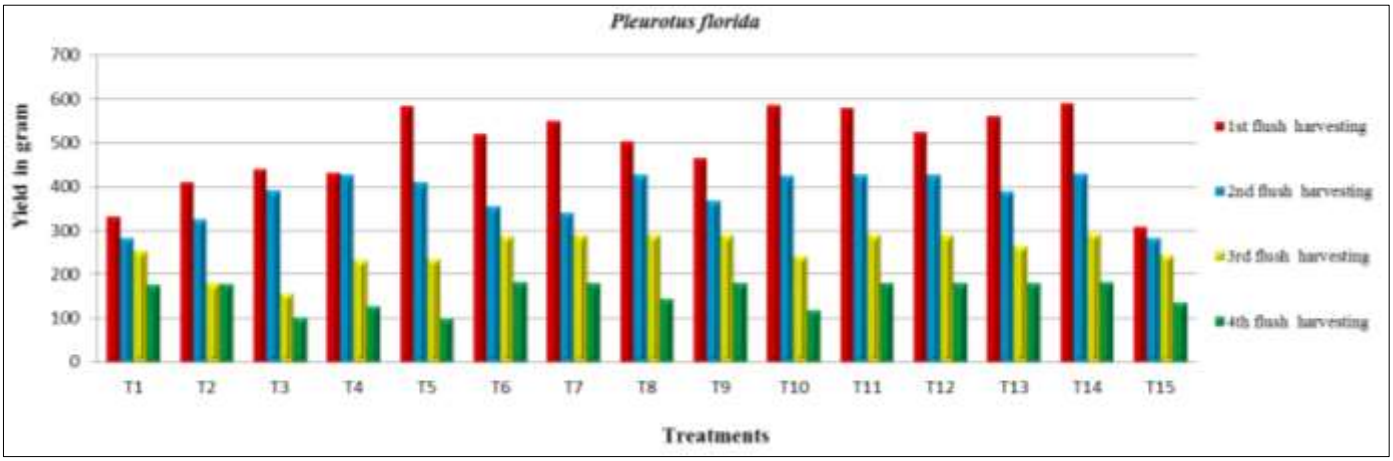

Fig 1: Effect of organic growth supplements on yield parameter at different flushes.

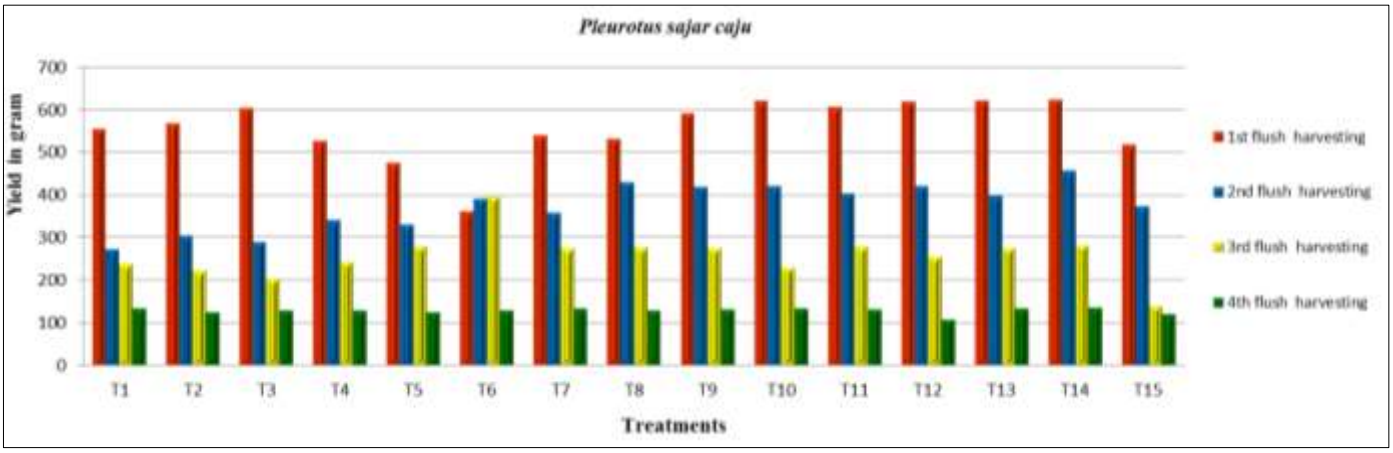

Fig 2: Harvesting at different flushes

Conclusion

It may concluded from the present finding revealed that among all the treatments, T_{14} (Molasses 400 ml + WB 800 g) considered as best treatment in terms of number of days required for mycelium growth initiation, spawn running, pin head initiation, harvesting of first flush and total yield of all flushes in both *P. florida* and *P. sajor-caju.*

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