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# Impact of Inorganic Chemicals on Growth and Yield Potential of *Pleurotus sajor-caju*

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## ABSTRACT

The experiments on Impact of Inorganic Chemicals on Growth and Yield Potential of *Pleurotus sajor-caju* were conducted during October–November 2018–2019 and 2019–2020 in Completely Randomized Design at Mushroom Research and Development Centre, Department of Plant Pathology, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India. Among all the treatments, minimum 11 days required for spawn running in the combination of Wheat straw+NPK 5 mg+$CaCO_3$ 6 mg. Similarly, the minimum number of days required for pin head formation and harvesting days were also noticed in $T_5$ treatment (wheat straw+5 g NPK+6 g $CaCO_3$), representing 15 and 20 days respectively. The treatment $T_5$ produced maximum number of fruiting bodies where combinations were given as wheat straw+5 g NPK+6 g $CaCO_3$.The maximum stipe length and width of pileus were also recorded maximum in treatment $T_5$, showing 7.9 cm and 13.5 cm against 2.8 cm and 6.6 cm respectively in case of control. Yield potential, total yield and biological efficiency of *Pleurotus sajor-caju* were also found maximum in treatment $T_5$, representing the values 500, 450, 370, 300 and 250 g yield $bag^{-1}$ at 1st , 2nd, 3rd, 4th and 5th flushing stages, respectively. On the other hand, the maximum biological efficiency was recorded in $T_5$ (wheat straw+5 g NPK+6 g $CaCO_3$) treatment, showing 37.40% against 25.68% in case of treatment $T_1$ (Control). Result showing that treatment $T_5$ (wheat straw+5 g NPK+6 g $CaCO_3$) performed better than all treatments.

**KEYWORDS:** Biological efficiency, growth parameter, inorganic chemical, mushroom, yield potential

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***Data Availability Statement:*** Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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## 1. INTRODUCTION

*Pleurotus* mushroom, generally referred to as 'Oyster mushroom or Dhingri' in India is relatively new to the mushroom industry but has gained popularity at a tremendous pace and today it is cultivated in about 25 countries of East Asia, Europe and America. In India, total production of Oyster mushroom 21272 tons (Sharma et al., 2017). *Pleurotus* mushroom cultivation is most suitable and profitable in all three climatic conditions like tropical, subtropical, and temperate regions (Raman et al., 2020). *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 compound than any other Oyster mushroom. Nowadays, functional food is of great interest, which, apart from providing the basic nutritional benefits, has a positive impact on human health. Mushrooms are also currently considered as functional food due to their natural ability to accumulate various types of substances that allow improving their health promoting properties and can supplement the human diet (Gasecka et al., 2016; Kała et al., 2016; Poniedziałek et al., 2017). It is considered as a potential substitute of muscles protein on account of their high digestibility (Powel, 2009). It has rich nutritional value with high content of proteins, vitamins, minerals, fibers, trace elements and low number of calories and cholesterol (Agrahar and Subbulakshmi, 2005; Wani et al., 2010). In addition to protein, mushrooms are a source of antioxidants, anticancer, prebiotic, immunomodulating, anti-inflammatory, cardiovascular, anti-microbial, and hypoglycemic, and so on (Elkhateeb et al., 2018). Adebayo and Oloke (2017) added that *P. ostreatus* extract can reduce the high blood glucose levels in hyperglycemic rats, although lesser than treatment with amaryl. The spent substrate left after harvesting the mushrooms, which is entangled with innumerable mushroom threads (collectively referred to as mycelia), can also be used as animal feed (more palatable), bio-fertilizer for soil fertility enrichment and biogas (Alice and Kustudia, 2004). The fungus can grow wide range of agricultural and industrial wastes which are made up by cellulose hemicelluloses and lignin. These wastes can be classified into different branches such as wood residues, waste paper, grasses, agricultural residues (including straw, stalks, and bagasse), domestic wastes (lignocellulosic garbage and sewage) and municipal solid wastes (Rodriguez et al., 2008). 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 (Orts et al., 2008; Saber et al., 2010). Fermented moso bamboo sawdust having potential as an alternative substrate for the cultivation of *Pleurotus ostreatus* (Yamauchi et al., 2018). Substrate supplementation to the nutrient can improve the nutrient requirements for an efficient production of mushroom. Both carbon concentration and the C/N ratios of the substrate have significant effect on mushroom production gap, whereas, it has been well documented that C/N ratio is more effective than carbon concentration (Gao et al., 2007). Substrate source is one of the important factors in mushroom production because it supports mycelia growth and development into mushroom fruit bodies. Keeping the above point in view, the study was undertaken to study the impact of inorganic chemicals on growth and yield potential of *Pleurotus sajor-caju*.

## 2. MATERIALS AND METHODS

The experiments on Impact of Inorganic Chemicals on Growth and Yield Potential of *Pleurotus sajor-caju* were conducted during October–November 2018–2019 and 2019–2020 in Completely Randomized Design at Mushroom Research and Development Centre, Department of Plant Pathology, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India. The spawn of *Pleurotus sajor-caju*, empty glucose bottles, polythene bags, grains of cereal (Wheat) and other chemicals, viz., fungicides, insecticides, formalin etc. were procured from the Mushroom Research and Development Centre, Department of Plant Pathology. Wheat straw and inorganic chemicals were obtained from the Student Farm and Soil Science Laboratory Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (208002).

### *2.1. Preparation and chemical sterilization of substrate*

For the preparation of wheat substrate, wheat straw was chopped (3–5 cm size) in to small pieces, and then chemically treated by soaking in solution of formalin (2%) for 18–20 hrs. Next day, the wet substrate was separated from water and excess water was removed properly. The substrate was kept on the concrete floor, which was previous sterilized by formalin @ 2%. The substrate was thus ready to be used in mushroom cultivation.

### *2.2. Treatment details*

$T_1$- Wheat straw (Control), $T_2$- Wheat straw+NPK 5 mg, $T_3$- Wheat straw+NPK 5 mg+$CaCO_3$ 2 mg, $T_4$- Wheat straw+NPK 5 mg+$CaCO_3$ 4 mg, $T_5$- Wheat straw+NPK 5 mg+$CaCO_3$ 6 mg, $T_6$- Wheat straw+NPK 5 mg+$ZnSO_4$ 2 mg, $T_7$- Wheat straw+NPK 5 mg+$ZnSO_4$ 4 mg, $T_8$- Wheat straw+NPK 5 mg+$ZnSO_4$ 6 mg, $T_9$- Wheat straw+NPK 5 mg+$FeSO_4$ 2 mg, $T_{10}$- Wheat straw+NPK 5 mg+$FeSO_4$ 4 mg, $T_{11}$- Wheat straw+NPK 5 mg+$FeSO_4$ 6 mg, $T_{12}$- Wheat straw+NPK 5 mg+$CuSO_4$ 2 mg, $T_{13}$- Wheat straw+NPK 5 mg+$CuSO_4$ 4 mg, $T_{14}$- Wheat straw+NPK 5 mg+$CuSO_4$ 6 mg.

### *2.3. Quantity of supplements*

These were 5 g NPK (2:1:1)+2 g or 4 g or 6 g other supplements $bag^{-1}$, substrate- wheat straw, quantity of

substrate bag$^{-1}$ - 5 kg dry substrate, rate of spawning - 10% dry weight basis. The observations were recorded on days taken for spawn running, days taken for pin head formation, size of pileus, and stripe, crop yield and biological efficacy.

*2.4. Spawning*

Polybag method are used for cultivation of oyster mushroom, polypropylene bag of about 75×45 cm$^2$ were fill at first a layer with a prepared substrate of about 6-8 cm thickness. At first, a layer and then about 50g of previously prepared spawn was spread on or outer side of substrate with cautions. This spawn process was repeated several times in the same manner until bag is completely full. But last layer of spawn was covered with less amount of substrate. Then the bags were packed tightly and kept on iron rack, and each bag 8-10 hole, required for running of mycelium.

*2.5. Crop room management*

After spawning, bags were shifted in to the cropping room. However, before shifting the cropping room was cleaned and sterilized by fumigation with formalin to avoid micro-organisms infestation and contamination. The formalin (2%) was sprayed in the room and the room was air tightly closed for 48 hours. Then all the doors and windows are opened and put on fans to remove the trace of formalin.

The bags were then kept on iron rakes for 10–15 days to complete the vegetative stages of mushroom were maintained as Temperature- 22±2°C, Relative humidity- 85–90%, Unit bags$^{-1}$ are look like a covered with white mycelia mat.

*2.6. Opening of the bags*

After the spawn run period is completed, the bags were cut and polypropylene portion will be removed. The bags look like cylinder shape structure which were stored in cage and sprayed with water daily once or twice depending on the crop room condition season. The spraying of water should be stopped a day before harvesting and again continued. During fruiting, the conditions of rooms were maintained as temperature 18-20°C, relative humidity- 85%, ventilation- 0.1 to 0.5%, visible light in the range- 360 to 420 nm. Frequent spraying of water was done in the cropping room depending upon the atmospheric humidity.$CO_2$ concentration during cropping should be less than 0.6%.

*2.7. Harvesting and yield*

After 6-7 days after spawn running, small pin head like structure were observed and the right shape for picking can be judged by the shape and size of fruit body. The fruit bodies should be harvested before spore release. It is advisable to pick all the mushrooms at one time from a cube and the next flush will appear at one time.

Biological efficiency of substrate was calculated by using following formula-

Biological efficiency=(Fresh weight of fruit body-Dry weight of substrate)×100

The statistical analysis was done using Completely Randomized Design.

## 3. RESULT AND DISCUSSION

*3.1. Effect of various combinations of organic chemicals on spawn running, pin head formation and number of days require for harvesting.*

*3.1.1. Spawn running*

The data presented in the Table 1, showed the different combinations of inorganic chemicals give variable response

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

| Treatments | Average no. of days for spawn running | Average no. of days for pin head initiation | No. of days require for harvesting |
|---|---|---|---|
| $T_1$ | 21 | 26 | 32 |
| $T_2$ | 14 | 19 | 24 |
| $T_3$ | 17 | 22 | 27 |
| $T_4$ | 13 | 18 | 23 |
| $T_5$ | 11 | 15 | 20 |
| $T_6$ | 15 | 20 | 25 |
| $T_7$ | 19 | 24 | 30 |
| $T_8$ | 20 | 25 | 31 |
| $T_9$ | 18 | 23 | 28 |
| $T_{10}$ | 16 | 21 | 26 |
| $T_{11}$ | 12 | 17 | 22 |
| $T_{12}$ | 22 | 27 | 34 |
| $T_{13}$ | 23 | 28 | 36 |
| $T_{14}$ | 25 | 30 | 38 |
| CD ($p$=0.05) | 1.789 | 2.236 | 2.683 |
| SEm± | 0.618 | 0.772 | 0.926 |
| SEd± | 0.873 | 1.091 | 1.309 |

$T_1$: Wheat straw (Control), $T_2$: Wheat straw+NPK 5 mg, $T_3$: Wheat straw+NPK 5 mg+$CaCO_3$ 2 mg, $T_4$: Wheat straw+NPK 5 mg+$CaCO_3$ 4 mg, $T_5$: Wheat straw+NPK 5 mg+$CaCO_3$ 6 mg, $T_6$: Wheat straw+NPK 5 mg+$ZnSO_4$ 2 mg, $T_7$: Wheat straw+NPK 5 mg+$ZnSO_4$ 4 mg, $T_8$: Wheat straw+NPK 5 mg+$ZnSO_4$ 6 mg, $T_9$: Wheat straw+NPK 5 mg+$FeSO_4$ 2 mg, $T_{10}$: Wheat straw+NPK 5 mg+$FeSO_4$ 4 mg, $T_{11}$: Wheat straw+NPK 5 mg+$FeSO_4$ 6 mg, $T_{12}$: Wheat straw+NPK 5 mg+$CuSO_4$ 2 mg, $T_{13}$: Wheat straw+NPK 5 mg+$CuSO_4$ 4 mg, $T_{14}$: Wheat straw+NPK 5 mg+$CuSO_4$ 6 mg

on spawn running, pin head formation and harvesting days of *Pleurotus sajor-caju*. Among the all treatment as $T_5$ treatment require minimum days as 11 for spawn running stage, which was followed by $T_{11}$ treatment as 13 days. From the table, it is also cleared that the maximum days require for spawn running stages in the treatment $T_{14}$, in comparison to $T_1$where only wheat straw is used as substrates (Table 1). Zerihun tsegaye (2015) found that oyster mushroom mycelia growth was very fast on the mixture of cotton waste and coffee pulp compare to the mixture of wood chips and Teff straw. Nirdesh et al. (2019) found that the different combinations of substrates, as wheat straw+mustard straw+wheat bran give variable response on spawn running, pin head formation and harvesting days of *Pleurotus sajor-caju.* Biswas et al. (2013) stated that different species *of Pleurotus* mushroom completed spawn running in 15–20 days on different substrates and Girmay et al., (2016) reported time for pinhead formation was noted as 17–33 days.

*3.1.2. Pin head formation*

On the other hands, the minimum days require for pin head initiation is noted in $T_5$ treatment (wheat straw+5 g NPK+6 g $CaCO_3$) which is only 15 days against 26 day in case of $T_1$ treatment where only wheat straw is used as substrates. The treatment, $T_{11}$ (NPK 5 g+$FeSO_4$ 6 g) require 17 days for pin head initiation, which was followed by $T_4$ treatment, where combination was given as wheat straw+NPK 5 g+$CaCO_3$ 4 g. Among the treatments, the maximum days required for pin head initiation in $T_{14}$ (30 days) where combination was given as +NPK 5 g+$CuSO_4$ 6 g. Rangaswami et al., (1975) reported pin-heads of *P. sajor-caju is* appeared in 20–25 days after inoculation. Khan et al. (2001) reported that after spawn running, primordial formations took 7–8 days but took different durations for primordial emergence in coir fiber, soybean Stover and cotton stalk substrate. Khan et al., (2001) too reported that fruiting bodies appear 3–4 weeks after inoculation of spawn while Shah et al., (2004) stated that pinheads appear 27–34 days after inoculation at 17–20 °C.

*3.1.3. Harvesting days*

Similarly, the minimum with 20 days require for ready to harvest the crop is found in $T_5$ treatment where combination was given as wheat straw+5 g NPK+6 g $CaCO_3$ which was followed by $T_{11}$ treatment (wheat straw+5 g NPK+6 g $FeSO_4$) as 22 days require for ready to harvest the crops. Among the various combinations, the maximum days require for ready to harvest the crop is found in $T_{14}$ treatment (wheat straw+5 g NPK+6 g $CuSO_4$) in which 38 days against $T_1$ treatment (Wheat straw) in which 32 days required to harvest. Chaurasia, et al. (2019) found that the minimum with 24 days require for ready to harvest of the crop is found in $T_5$ treatment (spraying on straw with $GA_3$ @ 10 ppm) followed by $T_6$ (spraying on straw with $GA_3$ @ 15 ppm) among various treatments. Khan et al., (2001) also reported that after spawn running to pin head formation took 7–8 days and fruiting body formed after 3–5 days, sporocarps may be harvested after 10–12 days. Nirdesh et al. (2019) found that the 21–36 days was required for ready to harvest the crop in various combinations of substrates.

*3.2. Effect of various combinations of inorganic chemicals on growth characteristics and fruiting bodies of Oyster Mushroom*

*3.2.1 Number of fruiting bodies*

Growth is important parameter for higher yield of any crops and mushrooms is not exception from them. The data presented in the (Table 2) showed that the maximum number of fruiting bodies is produced in $T_5$ treatment where combinations is given as wheat straw+5 g NPK+6 g $CaCO_3$ with the value 30 per bags against 14 fruiting bodies in case of $T_1$ treatment where only wheat straw is used as substrates. The treatment $T_{11}$ (wheat straw+5 g NPK+6 g $FeSO_4$) showing 27 fruiting bodies per bag representing second highest among the treatment. The minimum number of fruiting bodies is produced by $T_{14}$ which is 11 where combination was given as of WS+NPK 5 g+$CuSO_4$ 6 g. Khan et al. (2013) found the highest number of fruiting

Table 2: Effect of different combination of inorganic chemicals on growth parameters of *Pleurotus sajor-caju*

| Treatments | No. of fruiting bodies | Stipe length(cm) | Pileus width(cm) |
|---|---|---|---|
| $T_1$ | 14 | 2.8 | 6.6 |
| $T_2$ | 23 | 5.6 | 10.0 |
| $T_3$ | 18 | 4.5 | 8.0 |
| $T_4$ | 25 | 6.5 | 11.0 |
| $T_5$ | 30 | 7.9 | 13.5 |
| $T_6$ | 21 | 5.0 | 9.0 |
| $T_7$ | 16 | 3.5 | 6.9 |
| $T_8$ | 15 | 3.0 | 6.8 |
| $T_9$ | 17 | 4.0 | 7.1 |
| $T_{10}$ | 20 | 4.7 | 8.5 |
| $T_{11}$ | 27 | 7.0 | 11.5 |
| $T_{12}$ | 13 | 2.5 | 6.5 |
| $T_{13}$ | 12 | 2.2 | 6.2 |
| $T_{14}$ | 11 | 1.8 | 6.0 |
| CD ($p$=0.05) | 2.208 | 0.671 | 1.163 |
| SEm± | 0.762 | 0.232 | 0.401 |
| SEd± | 1.078 | 0.328 | 0.567 |

bodies 28 in *Pleurotus* mushroom Treated with 2% lime. Zerihun tsegaye (2015) found that the number of fruiting bodies formation is related to their mycelial colonization. According to him, the mixture of cotton waste and coffee pulp yielded the highest number of fruit bodies.

*3.2.2. Length of stipe*

Similarly, the maximum stipe length was found in $T_5$ treatment (wheat straw+5 g NPK+6 g $CaCO_3$) which is 7.9 cm at the time of harvesting against $T_1$ treatment where only wheat straw is used as substrates representing the value 2.8 cm. Among the treatments second highest was found in case of $T_{11}$ treatment (wheat straw+5 g NPK+6 g $FeSO_4$) followed by $T_4$ treatment (wheat straw+5 g NPK+4 g $CaCO_3$) and $T_2$ (wheat straw+5 g NPK) treatment, representing value 7.0, 6.5 and 5.6 cm, respectively. 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 tsegaye (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. Nirdesh et al., 2019 reported that the maximum number of stripe length with 4 cm in diameter was found in combination with ¾ wheat straw+1/4 mustard straw+100 g wheat bran at the time of harvesting against 1.5 cm in case of control.

*3.2.3. Width of pileus*

The result presented in the table 2 showed that the maximum width of pileus was found in $T_5$ treatment (wheat straw+5 g NPK+6 g $CaCO_3$) representing the value 13.5 cm against 6.6 cm in case of control, which was followed by $T_{11}$ (wheat straw+5 g NPK+6 g $FeSO_4$) and $T_4$ (wheat straw+5 g NPK+4 g $CaCO_3$) treatments indicating 11.5 and 11.0 cm, respectively. From the table, it is cleared that length and width of pileus where increased due to effect of inorganic chemicals. Gunde and Cinerman (1995) reported that oyster mushroom has a cap spanning diameter of 5 to 25 cm at maturity and the results of this work are within the range they reported. Girmay et al., (2016) stated that *Pleurotus ostreatus* completed spawn running in 17–20 days on different substrates and time for pinheads formation was noted as 23–27 days with variable length of stripe.

*3.3. Effect of various combinations of inorganic chemicals on yield potential, total yield and biological efficiency of Pleurotus sajor-caju*

*3.3.1. Yield potential*

The crop of *Pleurotus sajor-caju* was harvested in 5 flushes and the data presented in the Table 3 showed that the maximum yield was obtained in the first flush, than the second, third, fourth and fifth flushes. It is evident from Table 3 that the maximum amount of total fresh weight of *P. sajor-caju* was obtained from $T_5$ treatment where substrate combinations were given as wheat straw +5 g NPK+6 g $CaCO_3$, representing the values 500, 450, 370, 300 and 250 g $bag^{-1}$ at $1^{st}$ , $2^{nd}$ , $3^{rd}$, $4^{th}$ and $5^{th}$ flushing stages, respectively. The treatment $T_{11}$ (wheat straw+5 g NPK+6 g $FeSO_4$) showing 450, 390, 320, 270 and 235 g fresh weight of mushroom $bag^{-1}$ at $1^{st}$, $2^{nd}$, $3^{rd}$, $4^{th}$ and $5^{th}$ flushing stages, respectively, which is second highest among the treatments. The treatment $T_1$, where only wheat straw is used as substrates representing 328, 291, 250, 220 and 195 g fresh weight of mushroom $bag^{-1}$ were obtained at $1^{st}$, $2^{nd}$, $3^{rd}$, $4^{th}$ and $5^{th}$ flushing stages, respectively, which is superior to $T_{12}$, $T_{13}$ and $T_{14}$ and inferior to most of the combinations. From the table, it is also cleared that the maximum amount of fresh mushroom was obtained from $1^{st}$ flushing stages which is gradually decrease from $2^{nd}$ to $3^{rd}$, $4^{th}$ and $5^{th}$ flushing. Abate (1995) observed the cotton stalks+eucalyptus wood chips (1:1 ratio) supplemented with 1% wheat bran gave total yield of 2.5 kg $pot^{-1}$ equivalent to 0.36 FW $kg^{-1}$ dry substrate in all the treatments. Nirdesh et al., (2019) found that *Pleurotus sajor caju* was harvested in 5 flushes, the maximum yield was obtained in the first flush, then the second and third flushes in all combinations. According to them, the maximum yield was obtained from $T_5$ treatment where combination of substrates were given as (3/4 wheat straw+1/4 mustard straw+100 g wheat bran) representing the value 1483 g $bag^{-1}$.

*3.3.2. Total crop yield*

Yield is important parameter for increasing production and productivity of any crops. The data presented on the table -5 shown maximum yield was obtained from $T_5$ treatment where combination of substrate was given as wheat straw+5 g NPK+6 g $CaCO_3$ representing the value 1870 g per bag, which was followed by $T_{11}$ treatment (wheat straw+5 g NPK+6 g $FeSO_4$) 1665 g and $T_4$ treatment (wheat straw+5 g NPK+4 g $CaCO_3$) 1530 g per bag .The treatment $T_1$ where only wheat straw is used as substrate representing the value 1284 g per bag which is superior to $T_{12}$ (1088 g), $T_{13}$ (1049 g) and $T_{14}$ (965 g) treatment, but inferior to rest of the combinations, indicating that integrated effect has good response on increasing crop yield as compare to sole treatments. Zerihun tsegaye (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 of fruit bodies. Ajay et al. (2019) found that IAA and gibberalic acid have ability to increased crop growth and yield of mushroom. Sarker et al. (2007) also found the performance of different substrates on yield and nutrient content of *Pleurotuos treatus.*

Table 3: Effect of different combinations of inorganic chemicals on yield potential in different flushes, total yield and biological efficacy of *Pleurotus sajor-caju*

| Treatments | Weight of flushes of *Pleurotus sajor-caju* | | | | | Total yield (g) | Yield increase/ decrease over Wheat straw (%) | Biological efficacy (%) |
|---|---|---|---|---|---|---|---|---|
| | 1st Harvest (g) | 2nd Harvest (g) | 3rd Harvest (g) | 4th Harvest (g) | 5th Harvest (g) | | | |
| $T_1$ | 328 | 291 | 250 | 220 | 195 | 1284 | - | 25.68 |
| $T_2$ | 380 | 355 | 325 | 260 | 205 | 1525 | +18.77 | 30.50 |
| $T_3$ | 374 | 340 | 268 | 245 | 216 | 1443 | +12.38 | 28.86 |
| $T_4$ | 400 | 350 | 290 | 260 | 230 | 1530 | +19.16 | 30.60 |
| $T_5$ | 500 | 450 | 370 | 300 | 250 | 1870 | +45.64 | 37.40 |
| $T_6$ | 385 | 352 | 282 | 257 | 225 | 1501 | +16.90 | 30.02 |
| $T_7$ | 322 | 300 | 275 | 224 | 204 | 1325 | +03.19 | 26.50 |
| $T_8$ | 219 | 289 | 273 | 218 | 189 | 1290 | +0.47 | 25.80 |
| $T_9$ | 350 | 315 | 290 | 255 | 215 | 1425 | +10.98 | 28.50 |
| $T_{10}$ | 380 | 348 | 278 | 256 | 221 | 1483 | +15.49 | 29.66 |
| $T_{11}$ | 450 | 390 | 320 | 270 | 235 | 1665 | +29.67 | 33.30 |
| $T_{12}$ | 278 | 250 | 215 | 195 | 150 | 1088 | -15.26 | 21.76 |
| $T_{13}$ | 272 | 245 | 205 | 185 | 142 | 1049 | -18.30 | 20.98 |
| $T_{14}$ | 260 | 230 | 190 | 150 | 135 | 965 | -24.84 | 19.30 |
| CD ($p$=0.05) | 16.991 | 13.861 | 22.356 | 20.121 | 15.649 | 89.416 | 1.549 | 1.789 |
| SEm± | 5.864 | 4.783 | 7.715 | 6.944 | 5.401 | 30.858 | 0.535 | 0.617 |
| SEd± | 8.291 | 6.764 | 10.909 | 9.818 | 7.637 | 43.633 | 0.756 | 0.873 |

*3.3.3. Biological efficiency*

The suitability of different combinations of inorganic chemicals for mushroom cultivation was also confirmed by the average biological efficiency which was variable among the treatments due to variable combinations of substrates. The maximum biological efficiency was found in $T_5$ (wheat straw+5 g NPK+6g $CaCO_3$) treatment, showing 37.40 % against 25.68 % in case of treatment $T_1$, where only wheat straw was given as substrates.

Among the various treatments, the $T_{11}$ (wheat straw+5 g NPK+6 g $FeSO_4$) and $T_4$ (wheat straw+5 g NPK+4 g $CaCO_3$) treatments showing 2nd and 3rd best combinations on the parameters of Biological efficiency representing the values 33.30 % and 30.60 % respectively. $T_{14}$ treatment showed lowest Biological efficiency among all the treatments which is 19.30% against $T_1$ treatment, which is 25.68% where only wheat straw used as substrate. From the table 3, it is cleared that biological efficiency is different among the various combinations of treatments. Sharma et al. (2013) grows *P. ostreatus*on combination of different substrates such as rice straw, rice straw+wheat straw, rice straw+paper, sugarcane bagasse and sawdust of alder was investigated with rice straw (control) was found as a best substrate with yield (381.85 g) and biological efficiency (95.46%). Pal et al. (2014) also found that plant growth hormone has effect on growth parameter and biological efficacy of *Pleurotus eous.* Peng, Jintorng et al. (2000) reported the effect of different organic supplements with rice brawn and wheat brawn improved biological efficiency (B.E), production efficiency and fruiting behavior of Oyster mushroom.

*3.4. Effect of weight and moisture content of Pleurotus sajor-caju*

*3.4.1. Fresh and dry weight*

It is evident from the Table-4, that the variation in total amount of fresh weight of mushroom was found among the treatments. Among the treatment, the highest fresh weight of mushroom was recorded in $T_5$ (wheat straw+5 g NPK+6 g $CaCO_3$), treatment with the value of 1870 g. The treatment $T_{11}$ (wheat straw+5 g NPK+6 g $FeSO_4$) representing 1665 g fresh weight of mushroom, which is second highest among the treatments. In contrary, the lowest with 965 g Fresh weight were recorded in the treatment $T_{14}$ where treatment was given as wheat straw+5 g NPK+6 g $CuSO_4$.

The treatment $T_1$ where only wheat straw was used as substrates showing 1284 g fresh of mushroom, which is also superior to $T_{12}$, $T_{13}$ and $T_{14}$ treatments but inferior to most of the treatments. Similarly, dry weight of mushroom was found maximum on $T_5$ treatment, representing 822.80 g against 365.94 g in case of control. The $T_{11}$ treatment as wheat straw+5 g NPK+6 g $FeSo_4$ requirements 208.44 g of dry weight which as second highest among the treatment.

*3.4.2. Moisture content*

The quality of any product depends on high amount of biomass content and low content of water. The data presented in the (Table-4) showed that the minimum with 56% water content was found in $T_5$ treatment (wheat straw+5 g NPK+6 g $CaCO_3$) which was followed by $T_{11}$ treatment, representing the value 57.6 %. Among the various treatments, the maximum water content in fresh mushroom is found in $T_{14}$ treatment (wheat straw+5 g NPK+6 g $CuSO_4$) representing value 78.4 % against $T_1$ treatment, representing 71.5 % moisture content where only wheat straw is used as substrate. Elahe Kazemi Jeznabadi (2016) found that combined substrate and supplement factors indicated that the highest and the lowest mushroom fresh weight was attributed to Barley straw (BS+rice bran and rice bran+saw dust).

Stanley et al. (2011) studied the effect of supplementing corn cob substrate with rice bran on yield of *P. pulmonarius* (Fr) Quel. Un-supplemented corn cob (0% supplementation) gave the best yield in terms of the mean diameter of pileus 5.50 cm, mean fresh weight of fruiting bodies 53.2 g, mean height of stipe 3.64 cm and number of healthy fruiting bodies as 12. Khare et al. (2007) observed that the species *P. sajor caju and P. florida* grown on wheat straw substrates supplemented with grain flour, wheat bran increased yield of the mushroom as compared to control. Gautam and Ram (2007) studied the effect of wheat straw and different supplements such as wheat bran, Rice bran on growth behavior and yield potential of Oyster mushroom.

## 4. CONCLUSION

The combination of wheat straw+5 g NPK+6 g $CaCO_3$ is best regarding minimum number of days requires for pin head formation, harvesting, production of maximum number of fruiting bodies, stipe length, width of pileus, yield and biological efficiency under cropping room where all the favorable conditions were provided.

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