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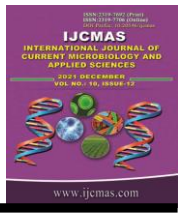

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Effect of Growth Regulators and Micronutrients on Growth and Yield of *Pleurotus sajor-caju*

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A B S T R A C T

The present investigation was conducted to study the effect of various growth regulators and micronutrients on growth and yield of *Pleurotus sajor-caju*. Results of the research explicitly indicated that the growth regulators and micronutrients experimented at different concentrations, targeting at stimulating growth and sporophore yield of *Pleurotus sajor-caju*, displayed significantly diverse response to *in vitro* colony diameter of the fungus, days required for spawn run, pinhead formation, first harvest of sporophores, yield of sporophores and biological efficiency. However, among the growth regulators used, gibberellic acid (GA) @ 20 and 15 ppm significantly improved the colony diameter (90 and 89.98 mm) in *in vitro* study; reduced the period required for spawn running (13 and 13.5 days), pinhead formation (16 and 16.5), and first harvest (18.5 and 19); augmented the total sporophore yield (858.25 and 855 g/kg dry substrate) and biological efficiency (85.83 and 85.5%). Mixture of micronutrients was ineffective in augmenting the foregoing traits. From the present investigation it is concluded that, spraying of gibberellic acid at 20 and 15 ppm concentrations on cultivation substrate, at the time of spawning, is highly beneficial for obtaining maximum yield of *Pleurotus sajor-caju*.

Introduction

In India, three mushrooms are commercially cultivated: *Agaricus bisporus* (white button mushroom), *Pleurotus* spp. (oyster mushroom), and *Volvariella* spp. (tropical mushroom) (Chadha, 1992). Mushrooms are popular because of their excellent flavour, low calorie count, high protein content, B vitamins and minerals. Mushrooms are high in non-starchy carbohydrates, dietary fibre, protein, minerals, and vitamins (Kulshreshtha *et al*., 2009).

In India, mushrooms are cultivated in different states amongst which, Punjab is the largest producer of *Agaricus*, followed by Tamil Nadu which produces *Agaricus*, *Pleurotus*, *Volvariella* and *Calocybe* mushrooms and, Rajasthan produces *Agaricus* and *Pleurotus* mushrooms (Singh and Prasad, 2012). Mushroom production in India was 441 tonnes

in 2016-17, and it climbed to 487 tonnes in 2017-18 (Anonymous, 2018).

Pleurotus spp., also known as "oyster mushroom" or "dhingri," presently rank second among the world's farmed mushrooms. These mushrooms are highly effective in lowering dangerous plasma lipids, lowering the risk of atherosclerosis and other cardiovascular and artery problems. *Pleurotus* spp. belongs to the Agaricomycetes class, the Agaricales order, and the Pleurotaceae family. *Pleurotus florida* (Mont.) Singer, *Pleurotus eous* (Berk) Sacc., *Pleurotus ostreatus* (Jacq.) Kummer, *Pleurotus sajor-caju* (Fr.) Singer, *Pleurotus flabellatus* Sacc., *Pleurotus pulmonarius* (Fr.) Quel., *Pleurotus cystidiosus* O. K. Mill., have been examined by numerous scientists for their antioxidant, antimicrobial and nutritional profile because of the excellent medicinal and culinary properties of this genus. *Pleurotus* spp. have a large quantity of moisture (90.8 per cent), whereas fresh as well as dry oyster mushrooms are rich in carbohydrates (57.6 per cent), proteins (30.4 per cent), fibre (8.7 per cent), fat (2.2 per cent) and ash (9.8 per cent) with 345 kcal energy value on 100 g dry weight basis; while they contain vitamins such as niacin (108.7 mg), thiamin (4.8 mg) and riboflavin (4.7 mg) and minerals like calcium (98 mg), phosphorous (476 mg), ferrous (8.5 mg) and sodium (61 mg) on 100 g dry weight basis (Pandey and Ghosh, 1996).

Improvement in cultivation technology of mushroom is anincessant process. Researchers working in the field of mushrooms attempt to augment yield of mushrooms by using innovative ideas and techniques. Use of plant growth regulators for mushroom production is one of them. Plant growth regulators, also known as phytohormones, are organic chemical molecules that, when given in small amounts, influence the growth of plants (Prajapati *et al.*, 2015). Different concentrations of growth regulators affect mushroom size and yield (Charles, 1986). Growers would gain benefit from fewer but larger fruiting bodies or fewer but more numerous fruiting bodies, resulting in higher yield.

Earlier investigators have reported significant role of growth regulators in mushroom cultivation. Mukhopadhyay *et al.*, (2005) investigated that the plant growth regulators such as gibberellic acid (GA), indole-3-acetic acid (IAA) and kin boosted the biomass production of *Pleurotus sajor-caju* by 15-26 per cent, while also increasing the protein content of the mycelia at varied doses. Some researchers reported that *in vitro* mushroom mycelial colony multiplication is also aided by plant growth regulators and medium (Maniruzzaman, 2004; Shukla, 1995; Chodchoi, 1986). Moreover, some researchers also have investigated effects of micronutrients on growth and yield of mushrooms. Atri and Guleria (2013) documented the highest vegetative growth (7.46 mg/ml) of *Lentinus cladopus* at a 1 ppm iron concentration. Bearing in mind the importance of plant growth regulators and micronutrients on mushroom yield, the present experiment was conducted to determine the influence of growth regulators and micronutrients at different dosages on the growth and yield of *Pleurotus sajor-caju*.

Materials and Methods

The present investigation was conducted at the All India Coordinated Mushroom Improvement Project, College of Agriculture, Pune. Pure culture required for spawn production of *Pleurotus sajor-caju* was obtained from the Mycologist, All India Coordinated Mushroom Improvement Project, College of Agriculture, Pune. Various growth regulators *viz*., gibberellic acid (GA), indole-3-acetic acid (IAA) and indole-3-butyric acid

(IBA) and, mixture of micronutrients consisting of iron (Fe) 2.5% EDTA, manganese (Mn) 1% EDTA, zinc (Zn) 3% EDTA, copper (Cu) 1% EDTA, molybdenum (Mo) 0.1% and boron (B) 0.5% at different dosages were appraised in the present experimentation in order to find out the most effective growth regulator and micronutrient mixture and their dosages for augmenting the mycelial growth, sporocarp growth and yield of *Pleurotus sajor-caju.*

Preparation of solutions of growth regulators and micronutrients

For preparation of solutions of growth regulators *viz.,* gibberellic acid (GA), indole-3-acetic acid (IAA) and indole-3-butyric acid (IBA) of 10, 15 and 20 ppm concentrations, 1.2 mg, 1.8 mg and 2.4 mg of each of the growth regulator, respectively, were added separately in 5 ml of 1N NaOH solution. These solutions were further added separately to 120 ml sterilized water.

For preparation of solutions of mixture of micronutrients of 1, 2 and 5 ppm concentrations, 0.12 mg, 0.24 mg and 0.6 mg of mixture of micronutrients, respectively, were added separately in 5 ml of 1N NaOH solution. These solutions were further added separately to 120 ml sterilized water. For preparation of the solutions sterile glasswares were utilized and all the procedures were performed under aseptic conditions.

Influence of growth regulators and micronutrients on *in vitro* colony diameter of *Pleurotus sajor-caju*

To assess the effect of growth regulators and micronutrients on mycelial growth of *Pleurotus sajor-caju,* a basal medium (malt extract medium) was prepared and 50 ml of it was placed in each of the conical flasks of 250 ml capacity. The medium was sterilized for 15 minutes in an autoclave at 15 lb pressure (121^0C). The sterilized flasks were then transferred to laminar air flow cabinet. After the medium was cooled to 40-45^0C and mixed well by steady stirring, 5 ml of each stock solution of the growth regulators *viz.,* gibberellic acid (GA), indole-3-acetic acid (IAA) and indole-3-butyric acid (IBA) of 10, 15, and 20 ppm concentrations was introduced with the use of a sterile pipette into two flasks for individual treatment.

Further, for each treatment, 20 ml of the medium was placed into each sterilized Petri plates and allowed to solidify. Then, using a sterilized cork borer, standard mycelial bits of 5 mm diameter were removed from the peripheral growth of a pure culture of *Pleurotus sajor-caju*.

The bits were aseptically transferred to culture plates, with the mycelial growth side of the bit touching the media in the sterilized Petri plates. The Petri plates were then incubated at 25 ± 2°C for 9 days and observations on mycelial growth were recorded. The diameter of the colony was measured using a measuring scale, and the average diameter was estimated for statistical analysis.

Spawn production

Wheat grain based spawn of *Pleurotus sajor-caju* was prepared by the method given by Garcha and Kalra (1979).

Substrate preparation and sterilization

For cultivation of *Pleurotus sajor-caju*, wheat straw was used as substrate. The wheat straw was filled in gunny bags and soaked into 100 l aqueous solution containing appropriate quantity of bavistin (7.5 g) and formalin (125 ml) for 16-18 hours. After soaking for whole night, the next morning excess water was drained off.

Disinfection of mushroom house

The spawning, spawn running, and cropping rooms were cleaned properly and washed with clean tap water. The rooms were subsequently sprayed with bavistin at a 10% dosage on a daily basis for four days. The rooms were also fumigated for 48 hours with 2% formaldehyde.

Preparation of mushroom beds

The spawning was carried out in a room that had been pre-fumigated (48 h with 2 % formaldehyde). The first layer of the substrate (approximately of 5 cm thick) was given at the base of the polythene bags of size 45 cm x 55 cm (100 gauge) and the spawning was done uniformly over this layer. A second layer (approximately of 5 cm thickness) was given over this and solution of growth regulator/micronutrients was sprayed uniformly on surface of the substrate layer with the help of hand-sprayer, as per the treatments. After application of growth regulators/micronutrients, a next layer of the substrate (approximately 5 cm thick) was given and spawning was done. In this manner, rest of the layers of the substrate were given and finally the mouths of bags were closed with thread. There were 25-30 pinhole perforations all over the bag for substrate ventilation. At the same time, a few pinholes were made in the bottom of the bag for drainage. Each bag held 3.5 kg of wet straw (one kg dry straw). After spawning, the bags were placed in a permanent mushroom house and incubated in the dark at a temperature of 24-28°C. During the spawn run, no light or cross ventilation were permitted.

Crop management

The polythene bags were removed after the spawn had fully impregnated the substrate with the fungal mycelium, exposing the substrate surface for the initiation of sporophores. These were then hanged on hangers in the mushroom house's cropping room to fruit. Water was sprayed on the compact cylinder mass of the substrate twice a day to keep them moist. During the experiment, the temperature in the cropping room varied between 22 - 28°C. The cropping room's humidity was kept at 85-90 per cent by spraying water on the walls and floor on a regular basis. Two to three hours of light (supplied by a fluorescent lamp of 40 watts) and 2-3 hours of cross ventilation per 24 hours (given by opening doors and windows) were provided for cropping.

Harvesting

A day before harvesting, watering was stopped and the sporophores were harvested before spore shedding. The weight of sporophores was noted soon after harvesting.

Observations

Data recorded included the days required for spawn run, days required for pinhead formation, days required for first harvest, sporophore yield and biological efficiency.

Statistical analysis

The data obtained from the trial were statistically analysed in Completely Randomized Design as per the procedure described by Panse and Sukhatme (1985).

Results and Discussion

Influence of growth regulators and micronutrients on *in vitro* colony diameter of *Pleurotus sajor-caju*

Data pertaining to *in vitro* effect of different growth regulators and micronutrients on mycelial growth of *Pleurotus sajor-caju,*

recorded at 9 days after inoculation (DAI), clearly indicated that gibberellic acid (GA) 20 ppm had the highest mycelial colony diameter of 90.00 mm, followed by GA 15 ppm, which had the colony diameter of 89.98 mm (Table 1). However, colony diameter recorded with both the treatments differed non-significantly, which clearly substantiated that GA at 20 and 15 ppm had identical effect in augmenting the mycelial growth of *P. sajor-caju*. Thus, GA at these two concentrations was found to be significantly superior over the rest growth regulators and micronutrients tried in the investigation in improving mycelial growth of *P. sajor-caju*. The next treatments in order of efficacy were indole-3-acetic acid (IAA) 20 ppm, indole-3-butyric acid (IBA) 20 ppm, IBA 15 ppm, GA 10 ppm, micronutrient mixture 1 ppm and IBA 10 ppm, which recorded colony diameter of 80.70, 80.60, 80.45, 80.32, 80 and 70.95 mm, respectively. Significantly least colony diameter of 50 mm was observed in control plates.

Results of the present experimentation evidently showed that gibberellic acid had the first-rated effect in influencing mycelial growth of *P. sajor-caju.* These results are in agreement with those of Pal *et al.,* (2013) who found the highest mycelial growth in GA incorporated medium and the least in 2, 4-D incorporated medium.

Days Required for Spawn Run

The data depicted in Table 2 regarding effect of various growth regulators and micronutrients on days required for completion of spawn run noticeably showed significant variation in days required for spawn run.

The days required for completion of spawn run with different treatments of growth regulators and micronutrients ranged between 13.00 and 18.50 days in all beds of *Pleurotus sajor-caju*. However, gibberellic acid (GA) applied to the cultivation substrate at 20 ppm required the lowest period of 13 days for completion of spawn run. This was closely followed by application of GA at 15 ppm, which took 13.5 days for completion of spawn run. Nonetheless, the former treatment did not differ significantly from the latter and thus these two treatments were found to be significantly superior over the rest of treatments. Application of indole-3-acetic acid (IAA) 15 ppm, IAA 20 ppm, indole-3-butyric acid (IBA) 15 ppm and IBA 20 ppm was the subsequent best set of treatments in hastening the spawn run, which required 15 days for full spawn run. Spawn run period with the micronutrient mixture and untreated control was prolonged considerably. Micronutrients at all the concentrations of 1, 2 and 5 ppm took 18 days for completion of spawn run, whereas untreated control took 18.5 days. Days required for completion of spawn run with various treatments of micronutrient and control differed non-significantly from each other. Thus, micronutrients evidently proved to be ineffective in lowering the spawn run period.

Pal *et al.,* (2013) found that gibberellic acid treated substrate required less (10.83 days) period for spawn run in *P. eous*. Furthermore, earlier scientists also have reported the role of growth regulators in enhancing mycelial growth of range of edible mushrooms (Shukla, 1995; Bhardwaj, 2004; Guo *et al.,* 2009; Pani, 2011; Uddin *et al.,* 2012; Atri *et al.,* 2013; Atri and Guleria, 2013). Thus, results of the present study are in agreement with those of these investigators.

Days required for pinhead formation

Data in respect of effect of various growth regulators and micronutrients on days required for pinhead formation in *Pleurotus sajor-caju*, portrayed in Table 2, indicated significantly

varied response of growth regulators and micronutrients, tried at different concentrations.

Number of days required for pinhead formation with different treatments of growth regulators and micronutrients varied from 16 to 21.5 days. However, amongst the various treatments of growth regulators and micronutrients, application of gibberellic acid (GA) at the concentration of 20 ppm conspicuously showed its effectiveness over the other treatments, as this treatment significantly shortened the period for pinhead formation. Pinheads in this treatment appeared on 16.00 days after spawning. This treatment was followed non-significantly by GA 15 ppm, which took 16.5 days for pinhead appearance. Consequently, these two treatments were statistically at par with each other and were found significantly superior over the rest of the treatments. Indole-3-acetic acid (IAA) 15 ppm, IAA 20 ppm, indole-3-butyric acid (IBA) 15 ppm and IBA 20 ppm were the next best treatments, which took 18 days for pinhead formation. Pinhead appearance was prolonged considerably with micronutrients and untreated control. Micronutrients at 1, 2 and 5 ppm concentrations required 21 days for pinhead formation, whereas untreated control treatment took 21.5 days. However, days taken for pinhead formation in micronutrient treatments differed non-significantly from those in control. Thus, micronutrient at all the three concentrations evidently was found to be ineffective in hastening pinhead formation.

In the present investigation, gibberellic acid at 20 as well as at 15 ppm hastened the spawn run, which might have reflected in speeding the pinhead appearance. Mohpatra and Behera (2013) obtained early pinning with IAA @ 200 ppm in *Volvariella volvacea*. Furthermore, Dey *et al*., (2011) reported that the least number of days (13.6) were required from casing to primordial initiation in the treatment of 100 ppm GA_3 in button mushroom. These results validate results of the present investigation.

Days required for first harvest

Results abridged in Table 2 relating to days required for first harvest of sporophores of *Pleurotus sajor-caju*, evidently suggested that the growth regulators and micronutrients, sprayed at different concentrations, had significant influence on the period required for first harvest of sporophores. Days required for first harvest of sporophores with various treatments varied significantly from 18.5 to 23.5 days.

Growth regulators and micronutrients, tried at different concentrations, showed considerable variation in their effectiveness to hasten the first harvest of sporophores. Amongst the various growth regulators and micronutrients tried in the present study, application of gibberellic acid (GA) at the concentration of 20 ppm significantly required the lowest number of days (18.5) for the first flush of sporophores. This treatment was followed non-significantly by application of GA at 15 ppm, which required 19 days for the first harvest. However, the latter treatment differed non-significantly from the former and thus, these treatments were found to be statistically at par with each other and significantly superior over the rest of treatments in reducing the period required for the first harvest of sporophores. Indole-3-acetic acid (IAA) 15 ppm, IAA 20 ppm, indole-3-butyric acid (IBA) 15 ppm and IBA 20 ppm were the next best treatments, which required 20.5 days for the first harvest of sporophores. However, the first crop of sporophores was prolonged substantially with the treatments of micronutrients and untreated control. Micronutrients at 1, 2 and 5 ppm concentrations and untreated control treatment

took 23.5 days for the first harvest. The results, thus, clearly substantiated the ineffectiveness of micronutrients in reducing period required for the first crop of sporophores.

Total yield of sporophores

Data presented in Table 3 in regard to total yield of sporophores of *Pleurotus sajor-caju* per 1000 g dry weight of substrate, revealed significantly varying response of growth regulators and micronutrients experimented at different concentrations.

Growth regulators and micronutrients appraised at different concentrations showed clear variation in total yield of sporophores of *P. sajor-caju*. However, spraying of gibberellic acid (GA) 20 ppm gave significantly highest yield of sporophores to the extent of 858.25 g. Thus, spraying of GA 20 ppm was the most effective treatment, which yielded 20.30 % increase in yield over untreated control. GA @ 15 ppm was the next best treatment in improving total yield of sporophores, which produced 855.00 g sporophores. However, total sporophore yield obtained in these two treatments differed non-significantly from each other, which clearly indicated that these two treatments had equality in their efficiency in enhancing sporophore yield of *Pleurotus sajor-caju*. Thus, application of GA at 20 and 15 ppm were the superior treatments in augmenting the yield. Indole -3-acetic acid (IAA) 20 ppm, IAA 15 ppm and indole -3- butyric acid (IBA) 20 ppm were the next best treatments, in order of efficacy, in enhancing the sporophore yield. The least sporophore yield was obtained in untreated control beds. However, yield obtained with micronutrients, at all the concentrations of 1, 2 and 5 ppm, differed non-significantly from that obtained in control. Thus, micronutrients at all the concentrations proved ineffective in enhancing the sporophore yield.

Biological Efficiency

Data presented in Table 3 in regard to per cent biological efficiency (BE) of *Pleurotus sajor-caju*, revealed significantly varying response of plant growth regulators and micronutrients experimented at different concentrations.

Growth regulators and micronutrients appraised at different concentrations showed clear variation in BE of *P. sajor-caju*. However, spraying of gibberellic acid (GA) 20 ppm recorded significantly highest BE to the extent of 85.83%. GA @ 15 ppm was the next best treatment in improving BE, which was to the tune of 85.50%. Nevertheless, BE noted with these two treatments differed non-significantly from each other, which clearly indicated that these two treatments had equality in their efficiency in enhancing BE. Thus, application of GA at 20 and 15 ppm were the superior treatments, in comparison to the rest, in augmenting BE. Indole -3-acetic acid (IAA) 20 ppm, IAA 15 ppm and indole -3- butyric acid (IBA) 20 ppm were the next best treatments, in order of efficacy, in enhancing BE. The least BE was obtained in untreated control treatment. However, BE estimated with micronutrients, at all the concentrations of 1, 2 and 5 ppm, differed non-significantly from that obtained in control. Thus, micronutrients at all the concentrations proved ineffective in enhancing BE.

Table.1 Influence of growth regulators and micronutrients on *in vitro* colony diameter of *P. sajor-caju*

Treatment details	Colony diameter (mm)
T1: Gibberellic Acid (GA) 10 ppm	80.32
T2: Gibberellic Acid (GA) 15 ppm	89.98
T3: Gibberellic Acid (GA) 20ppm	90.00
T4: Indole-3-Acetic Acid (IAA) 10 ppm	60.50
T5: Indole-3-Acetic Acid (IAA) 15 ppm	70.90
T6: Indole-3-Acetic Acid (IAA) 20 ppm	80.70
T7: Indole-3-Butyric Acid (IBA) 10 ppm	70.95
T8: Indole-3-Butyric Acid (IBA) 15 ppm	80.45
T9: Indole-3-Butyric Acid (IBA) 20 ppm	80.60
T10: Micronutrient Mixture 1 ppm	80.00
T11: Micronutrient Mixture 2 ppm	70.80
T12: Micronutrient Mixture 5 ppm	70.90
T13: Control	50.00
S.E. (m) ±	0.01
CD at 1%	0.04

Table.2 Influence of growth regulators and micronutrients on days required for spawn run, pinhead formation and first harvest in *Pleurotus sajor-caju*

Treatment details	Number of days required for spawn run	Number of days required for pinhead formation	Number of days required for first harvest
T1: Gibberellic Acid (GA) 10 ppm	16.50	19.50	22.00
T2: Gibberellic Acid (GA) 15 ppm	13.50	16.50	19.00
T3: Gibberellic Acid (GA) 20ppm	13.00	16.00	18.50
T4: Indole-3-Acetic Acid (IAA) 10 ppm	16.50	19.50	22.00
T5: Indole-3-Acetic Acid (IAA) 15 ppm	15.00	18.00	20.50
T6: Indole-3-Acetic Acid (IAA) 20 ppm	15.00	18.00	20.50
T7: Indole-3-Butyric Acid (IBA) 10 ppm	16.50	19.50	22.00
T8: Indole-3-Butyric Acid (IBA) 15 ppm	15.00	18.00	20.50
T9: Indole-3-Butyric Acid (IBA) 20 ppm	15.00	18.00	20.50
T10: Micronutrient Mixture 1 ppm	18.00	21.00	23.50
T11: Micronutrient Mixture 2 ppm	18.00	21.00	23.50
T12: Micronutrient Mixture 5 ppm	18.00	21.00	23.50
T13: Control	18.50	21.50	23.50
S.E. (m) ±	0.47	0.48	0.49
CD at 5%	1.39	1.40	1.42

Table.3 Total yield and biological efficiency of *Pleurotus sajor-caju* as influenced by various growth regulators and micronutrients

Treatment details	Total sporophore yield (g)	Biological efficiency (%)
T1: Gibberellic Acid (GA) 10 ppm	754.22	75.42
T2: Gibberellic Acid (GA) 15 ppm	855.00	85.50
T3: Gibberellic Acid (GA) 20ppm	858.25	85.83
T4: Indole-3-Acetic Acid (IAA) 10 ppm	750.00	75.00
T5: Indole-3-Acetic Acid (IAA) 15 ppm	792.41	79.24
T6: Indole-3-Acetic Acid (IAA) 20 ppm	804.89	80.49
T7: Indole-3-Butyric Acid (IBA) 10 ppm	746.58	74.66
T8: Indole-3-Butyric Acid (IBA) 15 ppm	763.05	76.31
T9: Indole-3-Butyric Acid (IBA) 20 ppm	769.28	76.93
T10: Micronutrient Mixture 1 ppm	715.54	71.55
T11: Micronutrient Mixture 2 ppm	716.80	71.68
T12: Micronutrient Mixture 5 ppm	717.84	71.78
T13: Control	713.43	71.34
S.E. (m) ±	1.68	0.17
CD at 5%	4.91	0.48

Many researchers have observed increase in yield of mushroom owing to use of growth regulators. Shukla (1995) found that indole butyric acid @ 5 and 10 ppm induced maximum number of sporophores in *Lentinus edodes*. Eswaran and Ramabadran (2000) reported that GA at 100 ppm was the best growth regulator in enhancing the yield of *P. eous*. Increase in weight of fruiting body, total yield and biological efficiency of the *P. ostreatus* with increase in the concentration of GA_3 was recorded by Rostum (2010). Size and number of mushrooms as well as yield of *Calocybe indica* was found to be increased by spraying 50 ppm GA_3 on the emerging primordia (Pani, 2011). The highest yield of *Pleurotus eous* has been reported in gibberellic acid incorporated medium. (Pal *et al.*, 2013). Sarker and Chowdhury (2013) found that the use of GA_3 at 10 ppm had a significant effect on biological yield, economic yield and dry economic yield of oyster mushroom. Mohapatra and Behera (2013) found that IAA @ 200 ppm increased the yield in *V. volvacea* to an extent of 22.12 % in comparison to control. Krishnamoorthy and Balan (2015) found increase in yield of milky mushroom with the use of GA_3 at 40 ppm. Kaur (2016) obtained maximum yield of *C. indica* with spray of GA at pinning and at all stages. Results of the present investigations are in agreement with the results of these scientists.

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