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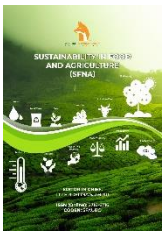

RESEARCH ARTICLE

EVALUATION OF THE EFFECT OF DIFFERENT DOSES OF GIBBERELLIC ACID ON THE GROWTH AND YIELD PERFORMANCE OF OYSTER MUSHROOM *(Pleurotus ostreatus)*

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ABSTRACT

An experiment was conducted at Dang, Nepal in 2021 to scrutinize the effect of different doses of gibberellic acid on the growth and yield performance of oyster mushrooms *(Pleurotus ostreatus)*. From February to April, seven different dosages of Gibberellic acid (0, 5, 10, 15, 20, 25, and 30 ppm) were tested in Completely Randomized Design (CRD), replicated 4 times with an average daily temperature of 15-28^{0}C and relative humidity ranging from 75-90 %. The oyster mushroom cultivation was undertaken under aseptic conditions, and the growth and development of mushrooms were recorded. Results of the study revealed that the highest yield (2.55 kg/ball), number of fruiting bodies (47), and effective primordia (11), better stipe length (5.132 cm) were found in 10 ppm of GA3 application. The result suggested that GA3 at 10 ppm/packet would be the best possible concentration for the production of Oyster mushrooms.

KEYWORDS

Fruiting Body, Gibberellic Acid, Oyster Mushroom, Yield

1. INTRODUCTION

Mushroom is a macro fungus with a particular plant organ, which may be either epigeous or hypogeous and enormous enough to determine with naked eyes and to be picked by hand (Chang and Miles, 1991). Mushrooms are edible fungi belonging to the Basidiomycetes class and genus Pleurotus (Mondal et al., 2010). It bears spores that function as a seed that germinates to grow mycelium. The term mushroom belongs to those species that have a stem (stipe), cap (pileus), hymenium (lamellae), and spore on the underside of the cap (Masarirambi et al., 2011). Mushrooms are saprophytic but also parasitic and mycorrhizal and can't synthesize their food and heterotrophic mode of nutrition (Rajbhandari, 1999). Mushrooms can degrade cellulose, hemicelluloses, and lignin, and turns edible fruiting bodies filled with characteristic flavor and aroma (Pandey and Ghos, 1996). Mushrooms lack chlorophyll, root, and leaves and they don't photosynthesize like green plants.

There are 1150 species of mushroom among which 147 are said to be edible, while 100 species are poisonous and 73 have medicinal values (Adhikari, 2014). There are 40 species of oyster mushroom within the Pleurotus (Jayakumar, 2011). In Nepal, artificial mushroom farming started in 1974 on a commercial scale in Kathmandu valley (Singh, 2007). Nepal has a diverse climate, where the year-round mushroom is produced from which year-round income is generated. Locally available agricultural wastes are also utilized as a technique of employment opportunity for people with low landholding and particularly women of terai are confined to indoor activities for economic betterment reforming the weak sections of the community (Raut, 2019). Mushrooms are a sweet source of protein (19-40%), fat (2-5%), sugars (17-47%), mycocellulose (7-38%) minerals (potassium, phosphorus, calcium, sodium) of about 38% (Kurtzman, 1975). Mushrooms are a source of vitamins like niacin, riboflavin, vitamin D, C, B1, B5, and B6 (Ahmed et al., 2009). Oyster mushrooms have much medicinal and industrial importance due to their antioxidant, antimicrobial, antihypertensive, anti-inflammatory, antitumor, and additive properties (Chang, 2007).

Considering the importance of plant hormones on the yield of mushrooms, the experiment was carried out to find out the optimum concentration of GA3 for maximizing the growth and yield of mushrooms. Mushrooms are the fruiting bodies of the fungus comprising the reproductive part while mycelium is the vegetative part. This study will help local farmers to get to know about the hormonal implementation to improve Oyster mushroom production. This experiment is to study the effectiveness of the optimum concentration of GA3 on Oyster mushrooms.

2. MATERIALS AND METHODOLOGY

The experiment was conducted at Lamahi-3, Dang from February 3rd, 2021 to April 17th, 2021. The experimental research site has a tropical climate type with three distinct seasons in a year. Among them, this research was carried out during the winter season, which is considered favorable for mushroom cultivation. The temperature ranges from 15-28^0 C and humidity ranges from 75-90%. Materials used for this research are rice straw as substrate, spawn, plastic sheet, chopper, weighing balance, sprayer, sprit, gibberellin, thermometer, rope, metallic drum plastic bags, vernier scale, yellow sticky trap, fuel, and scale. Oyster mushroom i.e. *Pleurotus ostreatus* was used in our experiment, the most common mushroom cultivated in Nepal. The experiment was conducted in a

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mushroom tunnel. Sterilization of the room was done by spraying 4% formalin. For fumigation of the room formalin and potassium permanganate were used.

The substrate was collected from a local farmer's field near Prithu technical college. After collection and selection, the straw was chopped into 2-5 cm long bits and soaked in clean water for 12 hours to achieve 65 to 70 % moisture. After that, all of these wet substrates were removed from the water and kept under shade to drain excess water out. For substrate sterilization, steam sterilization was preferred over other methods and after sterilization, transparent polythene bags of diameter 16''X24'' were used for inoculation of spawn and were tied with rope in such a way to get a cylindrical shape after filling. Each of these bags was filled with a 6 kg substrate making 5 strata. The grain spawn of *Pleurotus ostreatus* was used and spawning was carried out aseptically. The experimental design was a single factor experiment that out was carried in a Completely Randomized Design (CRD) with seven treatments which were replicated 4 times thus making a total of 28 bags.

During primordial initiation, the substrate was sprayed with various doses of gibberellic acid as mentioned in the research treatment. Various ppm of gibberellic acid was prepared by making a stock solution of 1000ppm that was diluted to the required concentration and reasonable volume by dilution formula i.e. N1*V1= N2*V2. For statistical and data analysis of MS-Excel and Genstat Eighteenth Edition was used. And the means were separated using Duncan's Multiple Range Test (DMRT).

3. Results and Discussion

3.1 Pileus Diameter

A significant effect of gibberellic acid was observed in the first harvest with maximum and minimum pileus diameter at 30 ppm (6.05 cm) and 5 ppm (4.1 cm) respectively (Table 1). Similarly, during the second harvest maximum and minimum diameter were observed at 0 ppm (6.02) and 20 ppm (4.48) respectively (Table 2). During the third harvest, a slightly insignificant result was obtained (Table 3). By observing the overall result of the first and second harvest greater fluctuation in pileus diameter was found with no conclusive evidence for the effect of gibberellic acid.

3.2 Stalk Diameter

The second harvest showed only a significant result (Table 2). The highest value for the stalk diameter was obtained at 0 ppm (1.71cm) and the

minimum was obtained at 20 ppm (0.91 cm). The first and third harvests showed non-significant results (Tables 1 and 3).

3.3 Number of Primordia

A highly significant result was obtained in all three harvests for the number of effective primordia. The maximum number of effective primordia was obtained in 10 ppm (14), (13), and (6) of GA3 for the first, second, and third harvest respectively (Tables 1, 2, and 3). The minimum result was obtained in 5 ppm (5), 0 ppm (7), and 0 ppm (2) respectively for the first, second, and third harvests respectively.

3.4 Number of Effective Fruiting Bodies

A highly significant result was obtained in all three harvests for the number of fruiting bodies. The maximum number of fruiting bodies was obtained at 10 ppm (64), (50), and (28) for the first harvest, second harvest, and third harvest respectively (Tables 1, 2, and 3). The minimum number of fruiting bodies was observed at 5ppm (33), 15 ppm (25), and 0 ppm (13) for the first second and third harvest respectively.

3.5 Stipe Length

A significant result was obtained in all three harvests with maximum stipe length obtained at 10 ppm (6.22cm) and (5cm) respectively for the first and third harvest (Table 1 and 3). However, for the second harvest maximum length of stipe was obtained at 30 ppm (5.7cm) (Table 2). Similarly, minimum stipe lengths were obtained at 25 ppm (4.69cm), 20 (3.88), and 20 ppm (2.63) for the first, second, and third harvest respectively (Table 1). GA3 application was found to have a positive effect on stipe length which may be due to the elongation of the cell caused by GA3.

3.6 Thickness of Pileus

For the second and third harvests, the maximum thickness of pileus was recorded at 30 ppm (0.62 cm) and 0 ppm (0.51 cm). Similarly, the minimum thickness was recorded at 15 ppm (0.44cm) and 5 ppm (0.28cm) respectively (Tables 2 and 3). The first harvest was non-significant (Table 1). Similar results were obtained from (Sarker and Chowdhury, 2014; Dey et al., 2007; Ashrafuz zaman et al., 2005; Xavier et al., 2001).

3.7 Yield

A significant result was obtained for the total yield of Oyster mushrooms treated with gibberellic acid. The maximum yield was observed at 10 ppm (2.55kg/ball), followed by 15 ppm (2.14kg/ball), 20 ppm (2.13kg/ball), and least yield (1.67kg/ball) was observed on the treatment with control (0 ppm of GA3) (Table 4). For other treatments average yield of 15 ppm (2.14kg), 20 ppm (2.12 kg), and 30 ppm (1.87 kg) was obtained. Overall, there was an increase in total yield with the application of GA3 in different treatments when compared to control. The obtained result was statistically significant and similar to the findings (Dey et al., 2007; Sarker and Chowdhury, 2014; Dey, 1996; Ashrafuzzaman et al., 2005).

Table 1: Effect of Different Doses of Gibberellic Acid on the Growth and Yield Attributes of Oyster Mushroom at First Harvest.

Treatments	Pileus Diameter	Stalk Diameter	Number of Fruiting Bodies	Stipe Length	Thickness of Pileus	Number of Primordia
5 ppm	4.09 ^{b}	1.16 ^{ab}	33.00 ^{c}	5.64 ^{ab}	0.48 ^{ab}	5.50 ^{b}
10 ppm	4.96 ^{ab}	1.36 ^{ab}	63.75 ^{a}	6.22 ^{a}	0.53 ^{ab}	14.00 ^{a}
15 ppm	4.93 ^{ab}	1.12 ^{ab}	56.00 ^{ab}	4.72 ^{bc}	0.44 ^{b}	10.50 ^{ab}
20 ppm	4.97 ^{ab}	1.14 ^{ab}	52.75 ^{abc}	5.83 ^{ab}	0.45 ^{b}	7.50 ^{b}
25 ppm	5.51 ^{a}	1.09 ^{b}	40.25 ^{bc}	4.69 ^{bc}	0.50 ^{ab}	5.25 ^{b}
30 ppm	6.05 ^{a}	1.49 ^{a}	39.00 ^{bc}	5.37 ^{ab}	0.49 ^{ab}	7.25 ^{b}
Control	5.84 ^{a}	1.21 ^{ab}	43.50 ^{bc}	4.30 ^{c}	0.58 ^{a}	6.75 ^{b}
Grand Mean	5.20	1.23	46.89	5.25	0.50	8.11
SEM (±)	0.376	0.115	6.254	0.391	0.035	1.705
LSD	1.117	0.341	18.581	1.161	0.105	5.067
F-test	*	NS	*	*	NS	*
CV (%)	14.5	18.7	26.7	14.9	14.2	42.1

Table 2: Effect of Different Doses of Gibberellic Acid on the Growth and Yield Attributes of Oyster Mushroom at Second Harvest.

Treatments	Pileus Diameter	Stalk Diameter	Number of Fruiting Bodies	Stipe Length	Thickness of Pileus	Number of Primordia
5 ppm	4.50 ^{c}	1.23 ^{bc}	25.25 ^{b}	4.52 ^{b}	0.43 ^{c}	8.00 ^{bc}
10 ppm	4.80 ^{bc}	1.12 ^{bc}	49.75 ^{a}	4.17 ^{b}	0.49 ^{bc}	13.50 ^{a}
15 ppm	4.95 ^{bc}	1.27 ^{bc}	22.50 ^{b}	4.27 ^{b}	0.48 ^{bc}	8.25 ^{bc}
20 ppm	4.47 ^{c}	0.92 ^{c}	36.00 ^{ab}	3.87 ^{b}	0.52 ^{abc}	11.50 ^{ab}
25 ppm	5.50 ^{ab}	1.03 ^{bc}	24.50 ^{b}	4.52 ^{b}	0.45 ^{bc}	9.00 ^{bc}
30 ppm	5.46 ^{ab}	1.40 ^{ab}	33.25 ^{b}	5.7 ^{a}	0.62 ^{a}	10.00 ^{bc}
Control	6.02 ^{a}	1.71 ^{a}	24.50 ^{b}	4.90 ^{ab}	0.57 ^{ab}	7.25 ^{c}
Grand Mean	5.11	1.24	30.82	4.57	0.51	9.64
SEM (±)	0.233	0.130	4.737	0.332	0.037	1.083
LSD	0.693	0.385	14.074	0.985	0.111	3.219
F-test	***	**	**	*	*	**
CV (%)	9.1	20.8	30.7	14.5	14.6	22.5

Table 3: Effect of Different Doses of Gibberellic Acid on the Growth and Yield Attributes of Oyster Mushroom at Third Harvest

Treatments	Pileus Diameter	Stalk Diameter	Number of Fruiting Bodies	Stipe Length	Thickness of Pileus	Number of Primordia
5 ppm	5.01 ^{ab}	0.80 ^{b}	19.50 ^{ab}	4.12 ^{ab}	0.28 ^{c}	4.00 ^{bc}
10 ppm	4.19 ^{b}	0.88 ^{ab}	28.00 ^{a}	5.00 ^{a}	0.41 ^{abc}	6.00 ^{a}
15 ppm	4.87 ^{ab}	1.38 ^{a}	27.50 ^{a}	3.04 ^{bc}	0.35 ^{bc}	5.00 ^{ab}
20 ppm	4.10 ^{b}	1.02 ^{ab}	24.00 ^{ab}	2.62 ^{c}	0.46 ^{ab}	4.25 ^{bc}
25 ppm	5.18 ^{ab}	0.97 ^{ab}	16.50 ^{b}	3.33 ^{bc}	0.31 ^{c}	3.50 ^{bc}
30 ppm	5.62 ^{a}	1.13 ^{ab}	19.00 ^{ab}	3.94 ^{ab}	0.36 ^{bc}	3.75 ^{bc}
Control	4.52 ^{ab}	1.23 ^{ab}	13.50 ^{b}	3.74 ^{bc}	0.51 ^{a}	3.25 ^{c}
Grand Mean	4.79	1.06	21.14	3.68	0.38	4.25
SEM (±)	0.341	0.162	3.254	0.356	0.045	0.459
LSD	1.014	0.480	9.669	1.059	0.134	1.363
F-test	NS	NS	*	**	*	**
CV (%)	14.3	30.5	30.8	19.4	23.4	21.6

Treatments means are separated by Duncan's multiple range test (DMRT) and the means in the column represented by the same letter(s) are not significantly different from each other at a 5% level of significance.

* = significant

** = highly significant

*** = very highly significant SEM = Standard Error of Mean CV = Coefficient of Variation

Table 4: Effect of Different Doses of Gibberellic Acids on Yield of Oyster Mushroom

Treatments (GA_3 Concentration)	Yield (gm/ball)
5 ppm	1763 ^{bc}
10 ppm	2552 ^{a}
15 ppm	2136 ^{b}
20 ppm	2128 ^{b}
25 ppm	1684 ^{c}
30 ppm	1876 ^{bc}
Control	1671^{c}
Grand Mean	1973
SEM (±)	121.5
LSD	361.1
F-test	***
CV (%)	12.3

Treatments means are separated by Duncan's multiple range test (DMRT) and the means in the column represented by same letter(s) are not significantly different among each other at 5% level of significance.

*** = very highly significant.

3.8 Relation Between Stipe Length and Yield

The linear relationship between stipe length and yield was found to be positive (Figure 1). In general, if stipe length is high, then ultimately yield will be higher. The coefficient of correlation explains 5.66% (R2=0.0566) variation in yield was due to variation in stipe length. Each unit of stipe length increases the yield by 5.66 units. The remaining was due to other unknown factors.

3.9 Relation Between Numbers of Effective Primordia and Yield

The linear relationship between the number of effective primordia and yield was found to be positive (Figure 2). In general, if the number of primordia is high, then ultimately yield will be higher. The coefficient of correlation explains that 68.83% (R2=0.6883) variation in yield was due to the variations number of effective primordia. Each unit of cap diameter increases the yield by 68.83 units. The remaining was due to other unknown factors.

3.10 Relation Between Number of Fruiting Bodies and Yield

The linear relationship between the number of fruiting bodies and yield was found to be positive (Figure 3). In general, if the number of fruiting bodies is high, then ultimately yield will be higher. The coefficient of

correlation explains that 80.12%% (R2=0.8012) variation in yield was due to the variations in the number of fruiting bodies. Each unit of fruiting bodies increases the yield by 80.12 units. The remaining was due to other unknown factors.

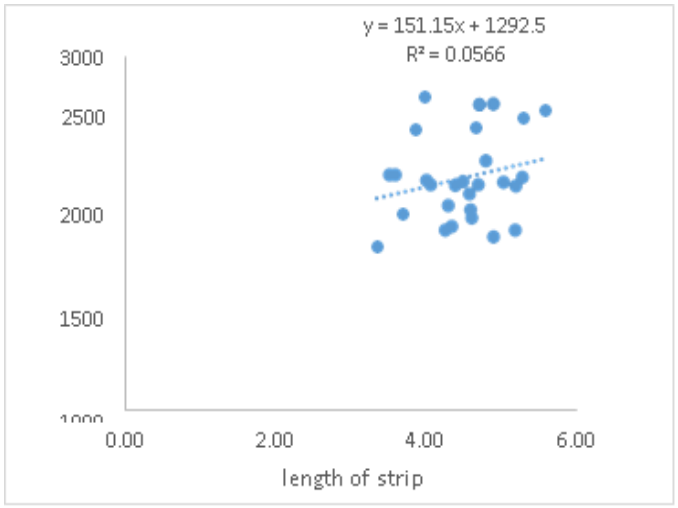

Figure 1: Relation Between Stipe Length and Yield

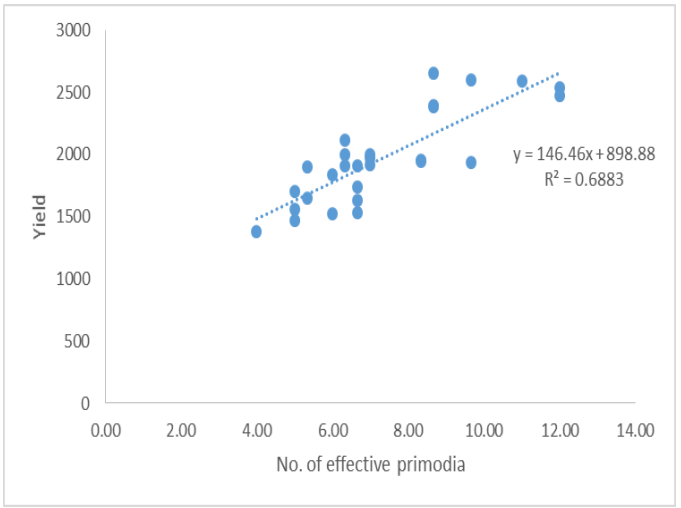

Figure 2: Relation Between Number of Effective Primordia and Yield

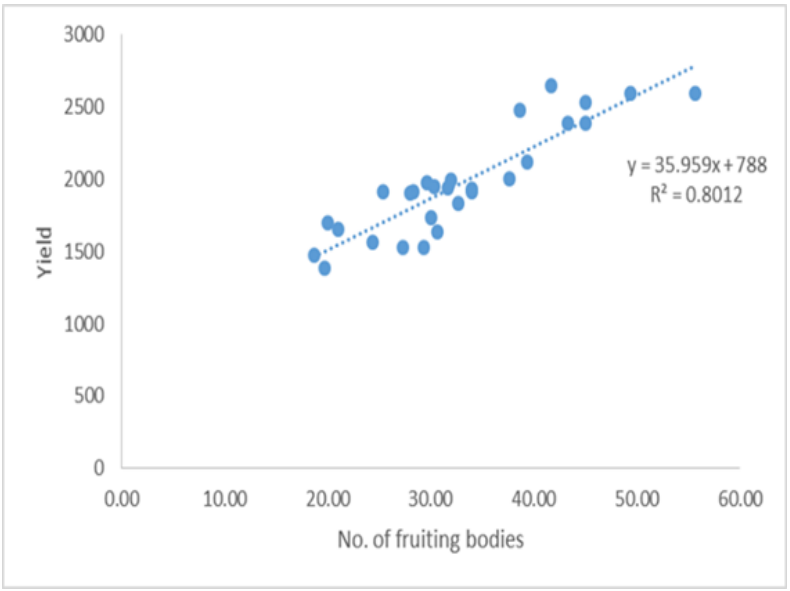

Figure 3: Relation Between Number of Fruiting Bodies and Yield

4. Conclusion

From this research, it is concluded that there is a significant effect of gibberellic acids in the growth and yield performance of oyster mushrooms which was conducted from February to April. Gibberellic acids have an effect on stalk length, stalk diameter, pileus length, effective primordia, and the number of the fruiting body. Among the seven different treatments, 10 ppm of GA3 was found effective as it gave more total yield i.e. (2.55kg) followed by 15 ppm (2.14kg), 20 ppm (2.13kg), 30 ppm (1.87 kg), 5 ppm (1.76 kg), 25 ppm (1.76 kg) and least yield was obtained from control i.e. 0 ppm (1.67kg). Gibberellic acids at 10 ppm level gave the maximum yield, effective primordia, and the number of the fruiting body. Similarly, there was no such effect of the hormone on pileus diameter.

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