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Effect of bio-fertilizer and green leaf manure on growth attributes of black aromatic rice (*Oryza sativa* L. *indica*)

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Abstract

The present investigation was carried out during the *Kharif* season of 2024 at Himalayan University, Jullang, Itanagar, to evaluate the effect of bio-fertilizers and green leaf manures on the growth attributes of black aromatic rice (*Oryza sativa* L. *indica*). The experiment was laid out in a Randomized Block Design (RBD) with seven treatments and three replications. The treatments included combinations of two biofertilizers (Seaweed and Bio Green) and three green manures (*Vigna unguiculata*, *Lantana camara*, and *Leucaena leucocephala*). The study recorded significant differences among treatments in terms of plant height, number of tillers, dry weight and CGR of plant at 20,40,60 and 80 DAS. Maximum plant height and tiller numbers were observed in the treatment T₄ (Biogreen + *Vigna unguiculata*), indicating the synergistic effect of bio green biofertilizer and leguminous green manure and gave the highest net return of 94880 INR ha⁻¹ under the treatment T₄ (bio green + *Vigna unguiculata*) with highest B:C ratio i.e. 5.5. The results demonstrated the potential of integrating bio-fertilizers and green manures in enhancing the growth performance of black aromatic rice in soil of Arunachal Pradesh.

Keywords: Bio-fertilizer, green leaf manure, black aromatic rice, growth attributes, seaweed, bio green

Introduction

Rice (*Oryza sativa*) is a dietary staple foods and one of the most important cereal crops, especially for people in Asia, but the consumption outside Asia has increased, recently (Orthofer, 2005).^[13] In India, it is cultivated over an area of 43.86 million hectares with 117.47 million tones of production (DAC&FW, 2019-20)^[7]. China ranks 1st in black rice production and it alone constitute 62% of the total global production which is followed by India, Indonessia, Sri Lanka, Thailand. Also, Thailand ranks 5th position in the global black rice cultivation (Amagliani *et al.*, 2016)^[1].

Rice (*Oryza sativa* L.) is a staple crop globally, particularly in Asia. Among various rice types, black aromatic rice is known for its high nutritional content and health benefits due to its anthocyanin-rich pigmentation China is the richest country in the black rice resources (62%) followed by Srilanka (8.6%), Indonesia (7.2%), India (5.1%), Bangladesh (4.1%) and few in Malaysia (Chaudhary, 2003)^[4]. Black rice can also increase immunity, improve liver function, prevent impaired kidney function, clean cholesterol in the blood, etc. It prevents hardening of the arteries and formation of uric acid in the body (Yuniarti *et al.*, 2019)^[20]. The name 'black rice' is related to the accumulation of anthocyanins, mainly cyanidin-3-glucoside (Bailón *et al.*, 2004)^[3]. Black rice has the highest content of total anthocyanins (327.60 mg 100 g⁻¹) among all of the studied colored grains (Abdel *et. al.* (2006)^[2], Anthocyanins (cyanidin-3-O-β-glucoside and peonidin-3-O-β-glucoside) and tocals were identified in black rice which proved that they have aldose reductase inhibitory activity (Yawadio *et al.*, 2007)^[19].

However, its productivity is constrained by declining soil fertility and reliance on chemical fertilizers. The integration of bio-fertilizers and green leaf manures offers an eco-friendly approach to improve yield and soil health. Sea weed bio-fertilizer is a natural bio fertilizer, has gained attention in recent years for its rich nutrient profile. Sea weed bio- fertilizer are beneficial for rice and other crops due to their ability to improve germination rates, increase nutrient uptake, and boost stress tolerance (Craigie, 2011)^[5] Seaweed extract contains growth-promoting hormones and enhances chlorophyll content and yield in rice crops (Craigie, 2011)^[5].

The Bio Green, is another bio-based bio-fertilizer with its main ingredient being fish amino acids and natural hormones recently been discovered by combodian researcher, Sun *et.al*, (2020) ^[16] showed that application of these amino acids bio green, as growth stimulants, has practical implications in the production of rice crops due to enhancement of chlorophyll content, photosynthetic rate, stomatal conductance, and transpiration rate for plant growth.

Green manure refers to crops grown specifically to be plowed into the soil to improve its fertility and structure. *lantana* biomass has potential for utilization as organic manure, has antimicrobial, insecticidal and medicinal properties (Dashti *et. al.*, (2014) ^[8] and another green leaf manure Cowpea can convert atmospheric nitrogen into a form usable by plants, enriching the soil and reducing the need for synthetic nitrogen fertilizers. (Carsky, 1998) ^[6] and lastly Xuan *et al.* (2006) ^[18] showed that incorporation of leucaena leaves into cultivated soils may be helpful for the biological control of weeds because of its mimosine content.

Materials and Methods

The field experiment was conducted during the Kharif season of 2024 at the Research Farm of Himalayan University, Jullang, Itanagar, Arunachal Pradesh. The black aromatic rice variety used was Bora Saul. The experiment was laid out in a

Randomized Block Design (RBD) with seven treatments and three replications. The plot size was 3 m × 3 m with a spacing of 25 cm × 25 cm. The treatments were as follows:

T₀: Control

T₁: Seaweed + *Vigna unguiculata*

T₂: Seaweed + *Lantana camara*

T₃: Seaweed + *Leucaena leucocephala*

T₄: Bio Green + *Vigna unguiculata*

T₅: Bio Green + *Lantana camara*

T₆: Bio Green + *Leucaena leucocephala*

Growth parameters such as plant height, number of tillers per hill, dry weight were recorded at different intervals of 20, 40, 60, and 80 days after sowing (DAS).

Results and Discussion

The data pertaining to growth attributes such as plant height, number of tillers, and dry weight are presented in the following tables. Significant variation was observed among the treatments. The treatment T₄ (biogreen + *Vigna unguiculata*) consistently outperformed other treatments in plant height and tiller number at all stages. These findings are consistent with the results reported by Sharma *et al.* (2017) ^[15], who found that the combination of bio-fertilizer and leguminous green manure significantly enhanced rice growth.

Table 1: Effect of treatments on plant height (cm) at different DAS

Treatment	20- 40 DAS	40-60 DAS	60-80 DAS	80 DAS
T0 Control	28.9	58.3	99.8	112.4
T1 Seaweed + vigna unguiculata	30.1	65.1	108.6	129.4
T2 Seaweed + lantana camara	31.5	65.5	112.7	136.2
T3 Seaweed + leucaena leucocephala	31.4	69.5	113.5	138.6
T4 Bio green + vigna unguiculata	32.8	70	121.2	148.7
T5 Bio green + Lantana camara	30.1	70.3	120.3	137
T6 Bio green + Leucaena leucocephala	31.9	66.7	117.2	126.7
F test	NS	S	S	S
S.Ed(±)		1.89	2.52	7.45
CD		4.06	5.4	16.2
(P= 0.05)				

A. Effect of treatments on plant height (cm) at different DAS

The maximum increase in plant height was found to be statistically significant in treatment T₄ (Bio green + *vigna unguiculata*) where 5 ml of bio green is mixed in 500 ml of water and *vigna unguiculata* added 2 g in 1m². The probable reason could be increase soil fertility and microbial activity because biofertilizer (bio green) combined with green manure crops significantly increased plant height and biomass in rice due to improved nitrogen availability and microbial stimulation reported by kumar *et. al.* (2015) ^[9] but at 40 DAS the maximum increase in plant height was found to be statistically significant in treatment T₅ (Bio green + *lantana camara*) i.e 70.4 where 5ml of bio green mixed in 500ml of water and *lantana camara* 2g at per m² was added. The reason could be application of biogreen and *Lantana camara* as green manure which decomposes fast and work as good source of nutrient, nitrogen = 0.88%, K=0.90% and Calcium = 0.61%. addition to it biogreen stimulates nitrogen increase microbial activitie thus the treatment combination promotes over all functionality, stability and fertility of the crop as well the soil. (Munir, 1996; Mullar and Touraine,1992) ^[10, 11].and lowest height recorded in T₀ (Control) because of no external inputs added.

Table 2: Effect of treatments on number of tillers per hill at different DAS

Treatment combination	20 DAS	40 DAS	60 DAS	80 DAS
T ₀ Control	5.2	7.9	10.6	13.2
T ₁ Seaweed + vigna unguiculata	6.2	8.7	13.4	17.2
T ₂ Seaweed + lantana camara	7.1	10.2	13.8	16.9
T ₃ Seaweed + leucaena leucocephala	6.9	9.5	14.3	17.8
T ₄ Bio green + vigna unguiculata	7.3	12	16.2	20.1
T ₅ Bio green + Lantana camara	6.6	10.6	14.9	18.9
T ₆ Bio green + Leucaena leucocephala	6.8	10.4	15.2	19.2
F test	NS	S	S	S
S.Ed(±)		0.6	0.8	0.5
CD		1.4	1.9	1.26
(P= 0.05)				

B. Effect of treatments on number of tillers per hill at different DAS

The maximum Number of tiller was found to be statistically significant under the treatment T₄ (Bio green + *vigna unguiculata*) where 5ml of bio green was added in 500 ml of water and 2 g/m² of green leaf manure was added. The reason for increase in accumulation N in higher rate as the leguminous crops as green manure increase the rate of N and also bio green

plant tonic made of amino acid can be used as bio-stimulants to stimulate plant over all growth including tillering of rice (Madende & Hayes, 2020) ^[12] and the minimum number of tillers

at 20, 40, 60 and 80 DAS was recorded in T₀ (Control) the reason is the plants under T₀ (control) grown without any supplementary bio fertilizer or green leaf manure.

Table 3: Effect of treatments on Dry weight at different DAS

Treatment combination	20 DAS	40 DAS	60 DAS	80 DAS
T0 Control	0.6	2.6	4.1	6.6
T1 Seaweed + <i>vigna unguiculata</i>	1.5	3	5	8
T2 Seaweed + <i>lantana camara</i>	2	3	5.9	7.2
T3 Seaweed + <i>leucaena leucocephala</i>	1.5	2.7	5.6	7.3
T4 Bio green + <i>vigna unguiculata</i>	1.4	4.4	7.1	10.4
T5 Bio green + <i>Lantana camara</i>	1.1	2.9	6.8	9.3
T6 Bio green + <i>Leucaena leucocephala</i>	1.2	4.4	6.8	10.2
F test	NS	S	S	S
S.Ed(±)		0.5	0.5	0.4
CD		1.2	1.1	0.8
(P= 0.05)				

C. Effect of treatments on Dry weight at different DAS

At 20 DAS, the highest dry matter accumulation was recorded under treatment T₃ (Seaweed + *leucaena leucocephala*) i.e 1.52 g which was statistically non significant treatment while at 40, 60 and 80 DAS the highest dry matter accumulation was recorded under treatment T₄ (Biogreen + *Vigna unguiculata*) which is statistically significant treatment. The reason could be application of bio green 5ml at 500ml of water and *vigna*

unguiculata 2 g/m² as green manure, stimulates the nitrogen accumulation and increase the microbial activity also increases soil fertility. (Valenzuela and Smith, 2002) ^[17]. And the lowest dry matter production was observed in the control treatment T₀ (Control) i.e 0.2, 2.6, 4.1 and 8.6, which might be due to the lack of external nutrient inputs, resulting in restricted vegetative growth and reducing assimilate translocation.

Table 4: Effect of treatments on CGR of black aromatic rice at different DAS.

Treatment	0- 20DAS	20-40 DAS	40-60 DAS	60-80 DAS
T0 Control	0.01	0.09	0.04	0.31
T1 Seaweed + <i>vigna unguiculata</i>	0.01	0.06	0.09	0.23
T2 Seaweed + <i>lantana camara</i>	0.03	0.03	0.24	0.08
T3 Seaweed + <i>leucaena leucocephala</i>	0.03	0.03	0.30	0.06
T4 Bio green + <i>vigna unguiculata</i>	0.05	0.21	0.36	0.09
T5 Bio green + <i>Lantana camara</i>	0.08	0.08	0.39	0.15
T6 Bio green + <i>Leucaena leucocephala</i>	0.12	0.23	0.09	0.32
F test	NS	S	S	S
S.Ed(±)		0.02	0.02	0.02
CD		0.04	0.04	0.05
(P= 0.05)				

D. Effect of treatments on CGR of black aromatic rice at different DAS

The highest CGR recorded under T₄ at 20-40 and 40-60 DAS i.e 0.21 and 0.39 respectively which is due to application of these amino acids bio green, as growth stimulants, has practical implications in the production of rice crops due to enhancement of plant growth Sun *et.al*, (2020) ^[16] and at 60-80 DAS it is recorded that highest CGR is under T₆ (Bio green + *Leucaena leucocephala*) the probable reason could be application of bio green and *leucaena* leaves which subsequent increase in availability of nutrients which increased the overall fertility, stability and functionality of the soil, thus leading to boost in plant growth (Pandey *et. al* 2008) ^[14].

Conclusion

Based on the comprehensive study conducted it can be concluded that the utilizing of Biogreen + *Vigna unguiculata* evident that the treatment shows the most favourable outcomes across growth of black aromatic rice i.e highest plant height (148.7 cm), highest tiller number (20.1), highest dry weight (10.4) at 80 DAS and highest CGR found to be statistically significant at T₄ (Biogreen + *Vigna unguiculata*) at 20- 40 DAS and 40 - 60 DAS

and at 60 - 80 DAS it is shown that highest CGR is at T₆ (Biogreen + *Leucaena leucocephala*) i.e. 0.32. moreover, it is seen that under T₄ (bio green + *Vigna unguiculata*) highest net return was found i.e 94880 INR ha⁻¹ with highest B:C ratio i.e. 5.5. The approach of bio-fertilizer and green leaf manure not only boosts productivity but also improves soil health, supporting sustainable agriculture in soils of Northeast India. T₄ demonstrated superior performance, showcasing optimal growth parameters proved to be the most effective treatment among all the mentioned treatments.

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