E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(9): 704-708
Received: 04-07-2025
Accepted: 05-08-2025

Effect of plant growth regulators and biostimulants on growth characters and yield of transplanted rice

Soyam Parvathi, Ashwani Kumar Thakur, Shri Narendra Kumar, Tejpal Chandrakar, Shri Vikas Ramteke, Purnima Janghel and Nikki Rani Toppo

Soyam Parvathi
Postgraduate Scholar, Agronomy Section, S. G. College of Agriculture and Research Station, Jagdalpur, IGKV, Raipur, Chhattisgarh, India

Ashwani Kumar Thakur
Principal Scientist, Agronomy Section, S. G. College of Agriculture and Research Station, IGKV, Jagdalpur, Chhattisgarh, India

Shri Narendra Kumar
Scientist, Agronomy Section, S. G. College of Agriculture and Research Station, IGKV, Jagdalpur, Chhattisgarh, India

Tejpal Chandrakar
Research Scientist, Soil Science and Agricultural Chemistry Section, S. G. College of Agriculture and Research Station, IGKV, Jagdalpur, Chhattisgarh, India

Shri Vikas Ramteke
Scientist, Horticulture Section, S. G. College of Agriculture and Research Station, IGKV, Jagdalpur, Chhattisgarh, India

Purnima Janghel
Postgraduate Scholar, Agronomy Section, S. G. College of Agriculture and Research Station, Jagdalpur, IGKV, Raipur, Chhattisgarh, India

Nikki Rani Toppo
Postgraduate Scholar, Agronomy Section, S. G. College of Agriculture and Research Station, Jagdalpur, IGKV, Raipur, Chhattisgarh, India

Corresponding Author:
Soyam Parvathi
Postgraduate Scholar, Agronomy Section, S. G. College of Agriculture and Research Station, Jagdalpur, IGKV, Raipur, Chhattisgarh, India

DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i9j.3840

Abstract
A field trial was conducted during the *Kharif*- 2024 at the Research cum Instructional Farm of Shaheed Gundadhur College of Agriculture and Research Station, IGKV, Jagdalpur, Chhattisgarh, to evaluate the effectiveness of various plant growth regulators and biostimulants on growth and yield performance of transplanted rice. The study was laid out in a Randomized Complete Block Design (RCBD) with eleven treatments, it was replicated three times. The findings of the study indicated that application of Paclobutrazol @ 0.5 ml L^{-1} (T_{10}) recorded highest number of effective tillers at 60, 90, and 120 DAT, while treatment T_{11} (control) showed the lowest. Dry matter accumulation was recorded highest in treatment T_{10} (Paclobutrazol @ 0.5ml L^{-1}) which was on par with T_4 (Humic acid @ 8ml L^{-1}) and T_8 (Triacontanol @ 2ml L^{-1}). Crop growth rate was highest in T_{10} (Paclobutrazol @ 0.5 ml L^{-1}) at 60 DAT and in T_7 (Triacontanol @ 1 ml L^{-1}) at 90 and 120 DAT. Relative growth rate was highest in T_4 (Humic acid @ 8ml L^{-1}) during 90-120 DAT. NAR peaked in T_{10} (Paclobutrazol @ 0.5 ml L^{-1}) at 30-60 DAT, T_7 (Triacontanol @ 1 ml L^{-1}) at 60-90 DAT and T_9 (Paclobutrazol @ 0.25ml L^{-1}) at 90-120 DAT. Yield attributes (grains panicle^{-1}, grain and straw yield, harvest index) were significantly highest in T_2 (*Ascophyllum nodosum* @ 6 ml L^{-1}).

Keywords: *Ascophyllum nodosum*, triacontanol, paclobutrazol

Introduction
Rice (*Oryza sativa* L.) belongs to the family Gramineae (Poaceae). Rice is the leading cereal crop of the world and more than half of the human race depend on rice for their daily sustenance (Chauhan and Johnson, 2011). Almost 90% of the world's rice is produced and consumed in Asia (Solunke *et al.*, 2006) [22]. Rice provides 50-80% daily calorie intake to the consumer (Choudhary *et al.*, 2011) [5]. Rice is an important cereal crop in developing countries and also the staple food for over half of the world's population, ranking second to wheat in terms of area and production (Nandi *et al.*, 1990) [14].

In world total rice grown in area 165.65 million hectares with the production of 523.5 million metric tonnes and productivity of 4.62 metric tonnes per hectare during *Kharif* 2022-23 (Anonymous, 2022a) [1]. India is the second largest producer and consumer of rice in the world. Rice breeding in India has made significant impact in the socioeconomic spheres by simultaneously ensuring food security as well as commerce. In India total rice grown in area 46.38 million hectares with the production of rice during 2022-23 is estimated at record 130.29 million tones and productivity of 28.09 q ha^{-1}(Anonymous, 2022b) [2].

Plant growth regulators have a vital role to play in improving important growth parameters and characterizing yields. Genetic expression control has been demonstrated, at transcriptional and translational levels by plant growth regulators. Growth regulators regulate the place of growth of individual parts, integrate them into the form that we recognize as plant, the metabolism provides power and building blocks for plant life. Deficiency of growth regulators (PGRs) at any stage of the plant may create a barrier to achieve high yield of grain. The application of small amount of PGR affects physiological activities and helps to absorb applied nutrients leading to increased yield and quality (Prasad *et al.*, 1991) [17].

Foliar biostimulants are substances that, when applied to plant leaves, promote physiological processes, nutrient absorption and overall plant growth. They are typically composed of natural compounds such as seaweed extracts, amino acids, humic substances, and plant growth promoting substances. Bio stimulants are products that reduce the need for fertilizers and increase plant growth, resistance to water and abiotic stresses. In small concentrations, these substances are efficient, favouring the good performance of the plant's vital processes and allowing high yields and good quality products (Jha *et al*., 2024) [9].

Material and Methods

A field experiment was conducted during *Kharif* season 2024 of Research cum Instructional Farm, S.G. College of Agriculture and Research Station, Kumhrawand, Jagdalpur, Chhattisgarh. The experiment was laid out in a Randomized Complete Block Design (RCBD) with eleven treatments which are T_1 *(Ascophyllum nodosum* @ 3ml L^{-1}),T_2 *(Ascophyllum nodosum* @ 6ml L^{-1}), T_3 (Humic acid @ 4ml L^{-1}), T_4 (Humic acid @ 8ml L^{-1}), T_5 (Nitrobenzene @ 1ml L^{-1}), T_6 (Nitrobenzene @ 2ml L^{-1}), T_7 (Triacontanol @ 1ml L^{-1}), T_8 (Triacontanol @ 2ml L^{-1}), T_9 (Paclobutrazol @ 0.25ml L^{-1}), T_{10} (Paclobutrazol @ 0.5ml L^{-1}), T_{11} (Control). The rice variety 'Vikram TCR' was transplanted on July 09 and harvested on November 15, 2024. The crop was established with a spacing of 20 cm between rows and 15 cm between plants within each row. The gross plot size was 6 m × 3.5 m (21 m²). Hormones applications were carried out using a knapsack sprayer fitted with a flat fan nozzle, utilizing 500 L ha^{-1} of water as the spray volume for both plant growth regulators and biostimulants treatments. Fertilizers were applied at a recommended dose of 100 kg N, 50 kg P, and 25 kg K ha^{-1}. Nitrogen was applied in two equal splits half as a basal dose at transplanting and the remaining half as top dressing at 35 and 55 DAS. The entire quantity of phosphorus and potassium was applied at the time of transplanting.

Result and Discussion

Plant height

Effect of different plant growth regulators (PGRs) and biostimulants on plant height of transplanted rice was recorded at different plant growth stages and it is presented in Table 1. Plant height increased steadily up to 120 DAT. Treatment T_4 (Humic acid @ 8 ml L^{-1}) produced the tallest plants at most stages, except at 30 DAT. At 60 DAT, T_4 (Humic acid @ 8 ml L^{-1}) was statistically similar to T_3 (Humic acid @ 4ml L^{-1}), T_2 (*Ascophyllum nodosum* @ 6ml L^{-1}) and T_1 (*Ascophyllum nodosum* @ 3ml L^{-1}) at 90 DAT and at 120 DAT, T_4 (Humic acid @ 8 ml L^{-1}) remained at par with T_3 (Humic acid @ 4 ml L^{-1}) and T_2 (*Ascophyllum nodosum* @ 6ml L^{-1}). The shortest plants were recorded in treatment T_{10} (Paclobutrazol @ 0.5 ml L^{-1}), was on par with T_4 (Humic acid @ 8 ml L^{-1}) only at 60 DAT. These findings are in accordance with those of Naik *et al.* (2020) [12], who reported that humic acid and seaweed extract significantly enhanced plant height in rice. The stimulating effect of humic acid may be attributed to enhanced cell elongation and increased nutrient uptake (Rose *et al.*, 2014) [18].

Number of effective tillers

The number of effective tillers per plant in transplanted rice was significantly influenced by the application of different plant growth regulators (PGRs) and biostimulants at 60, 90, and 120 DAT presented in Table 1. Treatment T_{10} (Paclobutrazol @ 0.5 ml L^{-1}) recorded the highest number of effective tillers at all growth stages except at 30 DAT, where it was on par with T_9 (Paclobutrazol @ 0.25ml L^{-1}), T_8 (Triacontanol @ 2ml L^{-1}) and T_7 (Triacontanol @ 1 ml L^{-1}) at 60 DAT. Treatments with paclobutrazol and triacontanol showed superior tillering performance, which may be attributed to their effect on apical dominance suppression and enhanced lateral bud development (Ghosh *et al*., 2015) [7]. The results suggest that paclobutrazol significantly improved tillering, possibly by modifying endogenous hormone levels and improving sink strength (Thakur *et al.*, 2018) [24].

Dry matter accumulation

Dry matter accumulation (DMA) is an important physiological parameter that directly reflects the photosynthetic efficiency and overall growth performance of the crop. The data presented in Table 1 reveals that significant variation among the different treatments due to application of plant growth regulators and biostimulants. Treatment T_{10} (Paclobutrazol @ 0.5 ml L^{-1}) showed the highest dry matter accumulation at all growth stages which was at par with T_9 (Paclobutrazol @ 0.25ml L^{-1}), T_8 (Triacontanol @ 2ml L^{-1}) and T_7 (Triacontanol @ 1ml L^{-1}). Treatment T_{11} (Control) recorded the lowest dry matter accumulation throughout. The improvement in (DMA) may be attributed to enhanced cell division, expansion, and chlorophyll content due to application of plant growth regulators and biostimulants (Jeyakumar *et al.*, 2008; Patil and Deore, 2014) [8, 16]. Paclobutrazol, being a growth retardant, alters hormonal balance and favors partitioning of assimilates towards storage tissues, which leads to higher dry matter accumulation. Triacontanol and Nitrobenzene treatments also showed increased biomass due to stimulation of photosynthetic activities and protein synthesis (Naruka and Singh, 2012) [15].

Leaf area index (LAI)

Leaf Area Index (LAI) is an important physiological parameter associated with the plant's photosynthetic efficiency and biomass production. The application of biostimulants and plant growth regulators (PGRs) significantly influenced LAI values, particularly during the mid to later growth stages are presented in Table 2. Treatment T_2 (*Ascophyllum nodosum* @ 6ml L^{-1}) recorded significantly higher leaf area index at 60 and 90 DAT, which was observed significantly at par with T_1 (*Ascophyllum nodosum* @ 3ml L^{-1}), T_4 (Humic acid @ 8ml L^{-1}) and T_9 (Paclobutrazol at 0.25 ml L^{-1}) at 60 DAT and at 90 DAT, treatment T_1 (*Ascophyllum nodosum* @ 3ml L^{-1}) was found significantly at par, whereas at 120 DAT treatment T_2 (*Ascophyllum nodosum* @ 6ml L^{-1}), T_1 (*Ascophyllum nodosum* @ 3ml L^{-1}), T_6 (Nitrobenzene @ 2ml L^{-1}), T_{10} (Paclobutrazol @ 0.5ml L^{-1}) and T_4 (Humic acid @ 8ml L^{-1}) was recorded on par with treatment T_2 (*Ascophyllum nodosum* @ 6ml L^{-1}) however, significantly lower leaf area index was recorded under treatment T_{11} (Control). The superior performance of T_2 (*Ascophyllum nodosum* @ 6ml L^{-1}) may be attributed to its content of cytokinin's, auxins, and trace elements which enhance cell division and expansion, resulting in greater leaf area (Zodape *et al.*, 2011) [26].

Crop growth rate (CGR)

The crop growth rate (CGR) is an important indicator of plant vigor and photosynthetic efficiency during the vegetative and reproductive phases are presented in Table 2. At 30-60 DAT, T_9 (Paclobutrazol @ 0.25 ml L^{-1}) recorded the highest CGR which was statistically on par with T_{10} (Paclobutrazol 0.5 ml L^{-1}) and T_8 (Triacontanol @ 2 ml L^{-1}), while T_3 (Humic acid @ 4 ml L^{-1}) showed the lowest. At 60-90 DAT, T_7 (Triacontanol @ 1 ml L^{-1}) showed the highest CGR, comparable with T_2, T_5, T_6, T_8, T_9, and

T_{10}, whereas T_{11} (Control) had the lowest. During at 90-120 DAT, treatment T_{10} had the highest CGR, which was at par with T_2, T_5, T_6, T_7, T_8, and T_9, while T_4 (Humic acid @ 8 ml L^{-1}) recorded the lowest. These findings are consistent with earlier reports by El-Sayed *et al.* (2016) and Kumari *et al.* (2021) [6, 12], who emphasized the role of foliar applied plant growth regulators (PGRs) in maintaining higher physiological activity and dry matter accumulation throughout the crop duration.

Relative growth rate (RGR)
The declining trend in RGR from early to later stages of crop growth aligns with the natural growth dynamics of rice plants, where the relative increase in biomass slows as the plant matures are presented Table 2. The data reveals that treatment T_4 (Humic acid @ 8ml L^{-1}) recorded significantly higher RGR compare to all treatments at 60-90 DAT which was at par with treatments T_2 (*Ascophyllum nodosum* @ 6ml L^{-1}), T_3 (Humic acid @ 4ml L^{-1}), T_7 (Triacontanol @1ml L^{-1}), T_1 (*Ascophyllum nodosum* @ 3ml L^{-1}), T_5 (Nitrobenzene @ 1ml L^{-1}), T_6 (Nitrobenzene @ 2ml L^{-1}) and T_{11} (Control) at 60-90 DAT. Treatment T_7 (Triacontanol @ 1ml L^{-1}) recorded significantly higher RGR among all other treatments, which was at par with all the treatments except T_4 (Humic acid @ 8ml L^{-1}) at 90-120 DAT. During early stages (30-60 DAT), cell division and elongation are rapid, resulting in higher RGR. However, as the crop advances towards maturity, metabolic activities such as photosynthesis decrease and respiration increases, contributing to reduced RGR values (Salisbury and Ross, 1992) [19]. Paclobutrazol is known to inhibit gibberellin biosynthesis, resulting in compact growth and enhanced assimilate accumulation, which indirectly supports a steady relative growth rate at later stages (Wani *et al.*, 2017) [25]

Number of grains panicle^{-1}
The data on number of grains per panicle is presented in Table 3. Treatment T_2 (*Ascophyllum nodosum* @ 6 ml L^{-1}) recorded the highest values which was at par with T_1 (*Ascophyllum nodosum* @ 3 ml L^{-1}), T_{10} (Paclobutrazol @ 0.5ml L^{-1}), and T_9 (Paclobutrazol @ 0.25ml L^{-1}), while the lowest was observed in T_{11} (Control). Similar result was also recorded by Sharma *et al.* (2017) [21]. The increase in number of grains per panicle and grain yield due to the application of *Ascophyllum nodosum* may be attributed to its high content of natural plant growth hormones like cytokinin's, auxins, and gibberellins, which enhance panicle development and grain filling efficiency (Sridhar and Rengasamy, 2010; Kumar *et al.*, 2021) [23, 11].

Test weight
Effect of different treatments on test weight is presented in Table 3. Recorded numerically higher in treatment T_2 (*Ascophyllum nodosum* @ 6ml L^{-1}) and numerically lower in controlled treatment.

Grain yield
Grain yield is presented in Table 3. Highest in treatment T_2 (*Ascophyllum nodosum* @ 6 ml L^{-1}) which was at par with T_1, T_6, T_5, T_4, T_3, and T_8, while T_{11} (Control) recorded the lowest yield. The comparatively lower performance of paclobutrazol treatments in terms of grain yield despite having higher straw yield may be due to its known growth-retarding effects and altered source-sink relationship, where assimilates may have been diverted more towards vegetative growth and storage in stem rather than reproductive structures (Sarkar *et al*., 2014) [20].

Straw yield (q ha-1)
The data on straw yield is presented in Table 3. The data shows that straw yield was significantly high under treatment T_2 (*Ascophyllum nodosum* @ 6ml L^{-1}) which was at par with T_1 (*Ascophyllum nodosum* @ 3ml L^{-1}), T_{10} (Paclobutrazol @ 0.5ml L^{-1}), T_9 (Paclobutrazol @ 0.25ml L^{-1}), T_6 (Nitrobenzene @ 2ml L^{-1}), T_5 (Nitrobenzene @ 1ml L^{-1}) and T_4 (Humic acid @ 8ml L^{-1}). And T_{11} (Control) was significantly low in straw yield.

Harvest index
The partitioning behaviour of grain and straw yield of the rice as influenced by different plant growth regulators and biostimulants under the study of harvest index value for treatments were calculated in Table 3. The highest harvest index was recorded in treatment T_2 (*Ascophyllum nodosum* @ 6 ml L^{-1}), at par with all treatments except T_{11} (Control), which had the lowest harvest index. The increased harvest index under this treatment further corroborates the fact that more assimilates were effectively translocated towards economic yield. Similarly, Nitrobenzene @ 2 ml L^{-1} (T_6) also improved grain yield (59.26 q ha^{-1}) and harvest index (43.38%) due to its role in enhancing flowering, fruit setting, and photosynthetic activity (Karthikeyan *et al.*, 2009) [10].

Table 1: Effect of different plant growth regulators and biostimulants on various growth parameters of transplanted rice

Treatment	Plant height (cm)				Number of Effective tillers (plant^{-1})				Dry matter accumulation (hill^{-1})			
	At 30 DAT	At 60 DAT	At 90 DAT	At 120 DAT	At 30 DAT	At 60 DAT	At 90 DAT	At 120 DAT	At 0-30 DAT	At 30-60 DAT	At 60-90 DAT	At 90-120 DAT
T_1: *Ascophyllum nodosum* @ 3ml L^{-1}	29.32	71.23	90.66	93.19	1.69	3.08	3.74	4.63	6.45	15.46	26.04	38.48
T_2: *Ascophyllum nodosum* @ 6ml L^{-1}	29.53	75.37	96.02	99.91	1.84	3.10	3.75	4.86	6.26	15.88	28.44	41.96
T_3: Humic acid @ 4ml L^{-1}	31.23	77.28	98.09	101.45	1.49	2.76	3.43	4.21	5.73	13.45	23.97	32.05
T_4: Humic acid @ 8ml L^{-1}	31.83	77.45	100.97	102.73	1.54	3.05	3.60	4.49	6.04	14.44	25.97	32.10
T_5: Nitrobenzene @ 1ml L^{-1}	27.72	67.44	84.93	88.80	1.85	3.17	3.84	4.95	7.76	17.88	29.87	43.41
T_6: Nitrobenzene @ 2ml L^{-1}	28.38	68.95	86.68	89.26	1.96	3.59	4.26	5.14	7.93	18.04	30.10	43.71
T_7: Triacontanol @ 1ml L^{-1}	25.73	66.50	82.90	85.19	2.08	4.15	4.93	5.15	8.46	18.28	31.94	46.31
T_8: Triacontanol @ 2ml L^{-1}	25.39	66.72	83.52	87.80	2.15	4.26	5.04	5.41	9.48	21.35	34.64	48.42
T_9: Paclobutrazol @ 0.25ml L^{-1}	23.41	65.10	80.21	84.25	2.31	4.40	5.07	6.12	10.06	22.48	35.47	50.16
T_{10}: Paclobutrazol @ 0.5ml L^{-1}	20.79	64.75	79.99	82.93	2.32	4.44	6.10	6.23	10.39	22.68	36.27	51.67
T_{11}: Control	24.14	65.40	80.31	84.43	1.46	2.70	3.13	3.58	5.09	13.12	21.98	31.58
SE(m±)	2.54	2.64	2.81	3.14	0.24	0.24	0.39	0.36	1.22	1.49	1.78	2.06
CD at 5%	NS	7.86	8.36	9.34	NS	0.71	1.14	1.08	NS	4.42	5.27	6.11
CV%	16.29	6.58	5.56	5.99	22.32	11.84	15.63	12.62	13.83	14.67	10.42	8.52

Table 2: Effect of different plant growth regulators and biostimulants on leaf area index, crop growth rate and relative growth rate of transplanted rice

Treatment	Leaf area index (LAI)				CGR (g plant^{-1} day^{-1})				RGR (g g^{-1} day^{-1})		
	At 30 DAT	At 60 DAT	At 90 DAT	At 120 DAT	At 0-30 DAT	At 30-60 DAT	At 60-90 DAT	At 90-120 DAT	At 30-60 DAT	At 60-90 DAT	At 90-120 DAT
T_1: *Ascophyllum nodosum* @ 3ml L^{-1}	0.41	2.23	2.59	2.71	0.21	0.30	0.35	0.41	0.030	0.017	0.013
T_2: *Ascophyllum nodosum* @ 6ml L^{-1}	0.39	2.26	2.63	2.80	0.21	0.32	0.42	0.45	0.031	0.019	0.013
T_3: Humic acid @ 4ml L^{-1}	0.34	1.22	2.27	2.16	0.19	0.26	0.35	0.27	0.029	0.019	0.010
T_4: Humic acid @ 8ml L^{-1}	0.35	2.23	2.36	2.44	0.20	0.28	0.38	0.20	0.030	0.020	0.007
T5: Nitrobenzene @ 1ml L^{-1}	0.32	1.41	2.04	2.12	0.26	0.34	0.40	0.45	0.028	0.017	0.012
T_6: Nitrobenzene @ 2ml L^{-1}	0.33	1.51	2.20	2.58	0.26	0.34	0.40	0.45	0.028	0.017	0.012
T_7: Triacontanol @ 1ml L^{-1}	0.27	1.52	2.03	1.76	0.28	0.33	0.46	0.48	0.026	0.019	0.014
T_8: Triacontanol @ 2ml L^{-1}	0.30	1.55	2.16	1.79	0.32	0.40	0.44	0.46	0.028	0.016	0.011
T_9: Paclobutrazol @ 0.25ml L^{-1}	0.26	2.05	2.25	2.81	0.34	0.41	0.43	0.49	0.025	0.015	0.012
T_{10}: Paclobutrazol @ 0.5ml L^{-1}	0.29	1.75	2.20	2.53	0.35	0.41	0.45	0.51	0.026	0.016	0.013
T_{11}: Control	0.23	1.19	1.95	1.83	0.17	0.27	0.30	0.32	0.032	0.017	0.012
SE(m±)	0.03	0.12	0.07	0.18	0.041	0.022	0.019	0.029	0.004	0.001	0.001
CD at 5%	NS	0.36	0.20	0.52	NS	0.065	0.057	0.086	NS	0.003	0.003
CV%	5.62	12.32	5.19	13.11	15.864	11.386	8.355	12.274	15.7	9.983	15.527

Table 3: Effect of different plant growth regulators and biostimulants on yield attributes and yield of transplanted rice

Treatment	Yield attributing characters					
	No. of grains Panicle-^{1}	Test Weight (g)	Grain Yield (q ha^{-1})	Yield Increase over control (%)	Straw Yield (q ha^{-1})	Harvest Index (%)
T_1: *Ascophyllum nodosum* @ 3ml L^{-1}	130.80	25.31	59.80	17.68	76.00	42.69
T_2: *Ascophyllum nodosum* @ 6ml L^{-1}	152.13	25.92	60.13	18.33	76.53	45.46
T_3: Humic acid @ 4ml L^{-1}	112.53	23.23	57.28	12.73	68.97	41.79
T_4: Humic acid @ 8ml L^{-1}	114.60	23.59	58.21	14.55	71.27	44.62
T_5: Nitrobenzene @ 1ml L^{-1}	117.33	24.26	58.54	15.21	72.20	42.89
T_6: Nitrobenzene @ 2ml L^{-1}	121.47	24.46	59.26	16.62	74.33	43.38
T_7: Triacontanol @ 1ml L^{-1}	92.73	23.20	56.60	12.40	68.10	42.26
T_8: Triacontanol @ 2ml L^{-1}	103.07	23.28	57.11	11.39	68.57	42.51
T_9: Paclobutrazol @ 0.25ml L^{-1}	123.73	25.14	54.27	6.80	74.70	42.62
T_{10}: Paclobutrazol @ 0.5ml L^{-1}	124.20	25.21	56.49	11.17	75.33	42.18
T_{11}: Control	88.27	22.22	50.81	0.00	64.03	35.03
SE(m±)	9.33	1.31	1.65		2.13	1.68
CD at 5%	27.72	NS	4.91		6.33	4.98
CV%	13.87	9.43	5.01		5.14	6.86

Conclusion
The present investigation clearly demonstrated that plant growth regulators and biostimulants exerted significant influence on growth, physiological attributes, and yield of transplanted rice. Among the treatments, paclobutrazol at 0.5 ml L^{-1} (T10) was most effective in enhancing tiller production, dry matter accumulation, crop growth rate, and net assimilation rate, reflecting its role in modifying hormonal balance and improving resource partitioning. Similarly, humic acid at 8 ml L^{-1} (T4) and triacontanol at 1-2 ml L^{-1} (T7 and T8) contributed positively to growth parameters, particularly relative growth rate and biomass production. However, with respect to yield attributes such as number of grains per panicle, grain yield, straw yield, and harvest index, *Ascophyllum nodosum* at 6 ml L^{-1} (T2) outperformed all other treatments, indicating its efficiency in enhancing both vegetative and reproductive phases. The superiority of seaweed extract is likely due to the presence of natural phytohormones, trace elements, and organic compounds that stimulate physiological activities and grain filling. Overall, the results highlight that while paclobutrazol effectively enhances vegetative growth regulation, biostimulants like *Ascophyllum nodosum* ensure improved yield performance. Thus, foliar application of seaweed extract at 6 ml L^{-1} can be recommended as a promising strategy for achieving higher productivity and sustainability in transplanted rice cultivation under Chhattisgarh conditions.

Reference

1. Anonymous. Agricultural statistics report. Department of Agriculture and Farmers Welfare, Directorate of Economics and Statistics, Govt. of India, New Delhi; 2022a. p. 28.
2. Anonymous. Annual report. Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt. of India, New Delhi; 2022b. p. 8.
3. Bhagat S, Sharma N, Pathak RK. Influence of plant growth regulators on growth and yield of rice (*Oryza sativa* L.) under temperate conditions. J Pharmacogn Phytochem. 2020;9(3):2166-71.
4. Chauhan BS, Johnson DE. Row spacing and weed control timing affects yield of aerobic rice. Field Crops Res. 2011;121(1):226-31.
5. Choudhary N, Ahuja U, Jain RK, Kumari P, Batan KR. Morphological and molecular variability in weedy rice of Haryana. Asia J Agric Res. 2011;40(5):250-9.
6. El-Sayed A, Rady MM, Osman AS. Improving rice plant productivity by using plant growth regulators under saline conditions. J Plant Growth Regul. 2016;35(3):863-75.
7. Ghosh RK, Ray PK, Bhar LM. Response of rice (*Oryza sativa* L.) to plant growth regulators under new alluvial zone of West Bengal. J Crop Weed. 2015;11(2):140-4.
8. Jeyakumar P, Rajamani K, Thangaraj M, Vigneshwari R, Chidambaram ALA. Effect of triacontanol on growth and

yield of crops. Asian J Plant Sci. 2008;7(4):284-7.

9. Jha AK, Yadav PS, Lodhi B, Sarkar D, Sharma K, Chhaya R. Effect of biostimulants on growth and yield of rice. Int J Res Agron. 2024;7(5):282-8.
10. Karthikeyan K, Shukla AK, Ram N. Influence of nitrobenzene on growth and yield of rice. Indian J Agron. 2009;54(4):470-2.
11. Kumar R, Pandey A, Mishra R. Role of seaweed extract as plant growth regulator in sustainable crop production. J Pharmacogn Phytochem. 2021;10(5):1771-6.
12. Kumari P, Rani S, Singh B. Effect of foliar spray of seaweed extract and micronutrients on growth and yield attributes of rice (*Oryza sativa* L.). J Pharmacogn Phytochem. 2021;10(1):2534-7.
13. Naik VR, Patil SY, Jadhav S. Influence of biostimulants on growth and yield of rice (*Oryza sativa* L.). Int J Chem Stud. 2020;8(2):1832-5.
14. Nandi M, Bhattacharya S, Nanda MK, Mukherjee AK. Herbicidal impact on soil micro-flora, micronutrient and productivity of summer rice. J Crop Weed. 1990;2(1):63-6.
15. Naruka IS, Singh D. Effect of plant growth regulators on growth and yield of rice. Indian J Agric Sci. 2012;82(2):156-9.
16. Patil VR, Deore GB. Effect of foliar application of biostimulants on growth and yield of rice. Int J Agric Sci. 2014;10(2):472-4.
17. Prasad M, Prasad R, Sharma SN, Singh S. Growth and yield of wheat as influenced by plant growth regulators. Indian J Agron. 1991;36(1):32-5.
18. Rose MT, Patti AF, Little KR, Brown AL, Jackson WR, Cavagnaro TR. A meta-analysis and review of plant-growth response to humic substances: practical implications for agriculture. Adv Agron. 2014;124(1):37-89.
19. Salisbury FB, Ross CW. Plant physiology. 4th ed. USA: Wadsworth Publishing; 1992.
20. Sarkar S, Hazra GC, Mandal B. Effect of paclobutrazol on growth and productivity of rice. Bioscan. 2014;9(2):525-8.
21. Sharma L, Banerjee M, Malik GC, Gopalakrishnan VA, Zodape ST, Ghosh A, *et al*. Sustainable agro-technology for enhancement of rice production in the red and lateritic soils using seaweed based biostimulants. J Clean Prod. 2017;149(5):968-75.
22. Solunke PS, Giri DG, Rathod TH. Effect of integrated nutrient management on growth attributes, yield attributes and yield of basmati rice. Crop Res. 2006;32(2):279-82.
23. Sridhar S, Rengasamy R. Potential of seaweed liquid fertilizers (SLFs) on some agricultural crop with special reference to protein profile of seedlings. Asian J Plant Sci. 2010;9(8):411-7.
24. Thakur RS, Meena RP, Tiwari R. Role of paclobutrazol in crop improvement. J Pharmacogn Phytochem. 2018;7(3):2983-6.
25. Wani AB, Ahmad A, Hayat S. Paclobutrazol: a potent plant growth regulator. Plant Signal Behav. 2017;12(10):136-221.
26. Zodape ST, Mukhopadhyay S, Eswaran K, Reddy MP, Chikara J. Enhanced yield and nutritional quality in green gram (*Phaseolus radiata* L.) treated with seaweed (*Kappaphycus alvarezii*) extract. J Sci Ind Res. 2011;70(2):215-9.