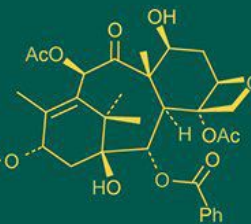
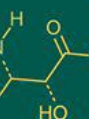
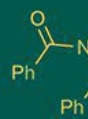
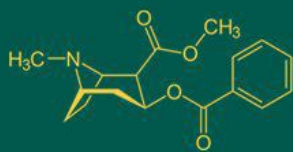


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Effect of different biostimulants on nutrient uptake and yield of rice

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Abstract

A field experiment entitled "Effect of different biostimulants on nutrient uptake and yield of rice" was conducted during *kharif* 2022 at Agricultural and Horticultural Research Station, Kathalagere (Karnataka). The experiment was laid out in RCBD design consisting of ten treatments replicated thrice. The treatments consist of control (T_1), soil application of humic acid at 5 kg ha^{-1} (T_2), soil application of humic acid @ 10 kg ha^{-1} (T_3), foliar application of humic acid @ 0.2 per cent (T_4), soil application of seaweed extract @ 5 kg ha^{-1} (T_5), soil application of seaweed extract @ 10 kg ha^{-1} (T_6), foliar application of seaweed extract @ 0.2 per cent (T_7), soil application of both humic acid @ 5 kg ha^{-1} and seaweed extract @ 5 kg ha^{-1} (T_8), foliar application of both humic acid @ 0.2 per cent and seaweed extract @ 0.2 per cent (T_9) and foliar application of jeevamrutha @ 3 per cent (T_{10}). Among the different treatments tried, foliar application of humic acid @ 0.2 per cent, and seaweed extract at 0.2 per cent along with RDF at tillering and panicle initiation stage has recorded significantly higher grain yield (5678 kg ha^{-1}) and straw yield (7483 kg ha^{-1}) compared to other treatments. Also, recorded significantly higher total nutrient uptake of nitrogen ($134.64 \text{ kg ha}^{-1}$), phosphorous (39.30 kg ha^{-1}) and potassium (93.66 kg ha^{-1}) compared to other treatment combinations.

Keywords: Biostimulant, rice, humic acid, sea weed, nutrient uptake, yield

Introduction

Rice (*Oryza sativa* L.) is the staple food crop for more than half of the world's population and it's cultivation secure livelihood for more than two billion people. Rice is said to be on the fore front in the fight against the world's hunger and poverty. India occupies a prime position in rice production among the food crops cultivated in the world. It is the major staple food crop of India and occupies the largest cropped area of 46.27 m ha with an annual production 129.47 million tones with a productivity of 2798 kg ha^{-1} [2]. Rice (*Oryza sativa* L.) is the primary food source for more than one-half of the world's population and is key for global food security (15). To cope up with the food demands of growing population and to maintain the present level of self-sufficiency, there is a need to increase the productivity of rice to 4.03 t ha^{-1} by 2030. Rice is being majorly cultivated in the states of West Bengal, Andhra Pradesh, Chhattisgarh, Tamil Nadu, Karnataka, Assam, Maharashtra, Orissa, Punjab and Gujarat. In Karnataka, rice occupies an area of 14 lakh ha with an annual production of 43.18 lakh tones and productivity 3089 kg ha^{-1} [2].

Biostimulants are organic compounds or mixtures of natural origin that show great promise as tools for improving crop production in current agricultural practices. They enhance plant growth and increase nutrient uptake efficiency, yield, quality and stress tolerance. Biostimulants include botanical extracts, protein hydrolysates, amino acids, vitamins, microbial products, antioxidants, anti-transpirants and various derivatives of humic and fulvic acid. They have shown significant yield increases, up to 17.9 per cent in cereals, legumes, fruits and vegetables in addition they reduce greenhouse gas emissions by reducing fertilizer usage. Biostimulants have gained significant attention in rice cultivation due to their potential to enhance crop productivity and improve plant resilience to various environmental stresses. In the context of rice production, biostimulants offer promising solutions to address challenges such as nutrient deficiencies, sub optimal soil conditions and the need for sustainable agricultural practices. They also play a crucial role in promoting root development and nutrient uptake in rice plants. These act as a messenger in signal transduction resembling phytohormones and other chemical compounds and their cross-talk

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in various abiotic stresses help us design future crop management under changing climate thus, sustaining food security with finite natural resources.

In view of importance of biostimulants for rice crop, the investigation was planned with following objective to study the effect of bio stimulants on grain yield and nutrient uptake of rice.

Materials and Methods

A field experiment was conducted at Agricultural and Horticultural Research Station, Kathalagere, which comes under Southern Transitional Zone of Karnataka in the Bhadra command area. KSNUAHS, Shivamogga (Karnataka) under irrigated condition during Kharif 2022. Experimental site was situated between 14°16'11" N latitude and 75°49'31" E longitude with an altitude of 665 meters above mean sea level. The station was located 4.5 km away towards south of Kathalagere village and 30 km from south of Davanagere city (Karnataka).

Physical and chemical properties of experimental site

A composite soil sample at 30 cm depth was collected from the experimental site before start of the experiment and analyzed for its physical and chemical properties. Data pertaining to physical and chemical properties of experimental site are as follows.

The soil of the experimental site was sandy loam in texture with acidic in reaction (6.05), Ec (dsm-1), organic carbon (5.32 g/kg), medium available nitrogen (312.25 kg/ha), medium available phosphorus (56.80 kg/ha) and medium in available potassium (292.75 kg/ha).

Normal climatic condition of experimental site

The average annual precipitation was 407.43 mm distributed from August to December with maximum temperature range of 28.63 °C and 30.69 °C, While, minimum temperature ranges of 18.20 °C and 20.50 °C. The average normal relative humidity was 74.00 per cent to 85 per cent.

Actual climatic condition during cropping period of 2022

The rainfall of 388.28 mm received during crop growth period (August to December, 2022) and highest monthly rain fall of 127.7 mm was recorded in the month of September 2022. The mean monthly maximum temperature varied from 27.19 °C to 29.20 °C., monthly minimum temperature range of 17.00 to 20.22. The maximum and minimum temperature was recorded in the month of September (29.20 °C) and November (17.00 °C), respectively. Relatively humidity ranged from 73.00 to 88.00%.

Jeevamrutha is prepared by mixing 10 kg local cow dung (Cow dung is good only for 21 days, store it by keeping moist, sprinkle water) with 10 litres cow urine, add 2 kg local jaggery, 2 kg pulse flour and handful of garden soil and the volume made up to 200 litres. Keep the drum in shade for 48 hrs covering with wet gunny bag and stir the mixture clockwise thrice a day and incubate.

Grain yield: From the net plot marked for each plot, panicles from the border rows and net plot area were harvested separately and sun dried for one day in threshing yard. Later panicles from net plot were threshed and grain weight was recorded in kilogram and later converted to kilo gram per hectare.

Straw yield: From the net plot area recorded after sun drying to 2-3 days after harvesting. The straw yield of rice crop was recorded after complete sun drying the stalks from each net plot and expressed in kilo gram per hectare

Harvest index: Is the ratio of grain yield to the total biological yield expressed in per cent. It was suggested by [4].

Chemical analysis of soil samples

Soil analysis

During the field experimentation, a composite soil sample was collected from the experimental plot before transplanting and after harvest of crop, soil sample were collected from each plot were analysed with respect to N, P and K status. The collected soil samples were shade dried powdered using pestle and mortar and passed through 2 mm sieve and preserved for analysis. For organic carbon analysis, the 2 mm sieved soil samples were subjected for further grinding and passed through 0.2 mm sieve.

Soil pH was determined in 1:2.5 soil: water suspension using digital pH meter having the glass electrode developed by [9]. The electric conductivity of soil was measured in 1:2 soil:water extract using conductivity bridge by (9). Expressed in dsm-1. For OC (%), a known weight (0.5 g) of 0.2 mm sieved soil was treated with a known excess volume of chromic acid (K₂Cr₂O₇+H₂SO₄). After oxidation of organic carbon, the unreacted K₂Cr₂O₇ left in the content was back titrated against standard ferrous ammonium sulphate solution using diphenylamine indicator. The result expressed in percentage [18].

The alkaline potassium permanganate method developed by [14] was used for the estimation of available N content in the soil. The result expressed in kilo gram per hectare. The soil available phosphorus was determined by chloromolybdate blue colour method using Bray's-1 extractant as described by [3]. The intensity of blue colour was determined by 660 nm using Spectrophotometer. The available P was computed and expressed in kilo gram per hectare. Available potassium content was extracted using neutral N NH₄ OAC as described by [9]. The concentration of K in the extractant was determined by Flame photometer. The available K content was computed and expressed in kilo gram per hectare [9].

Collection and preparation of plant sample for analysis

Grain and straw sample are collected at the time of harvest were dried at 65 °C in a hot air oven and powdered using grinder fitted with stainless steel blades and preserved in polythene bags for further analysis [9].

Total nitrogen (%) was determined by Kjeldal's method of nitrogen determination as described by (9). In this method, a powdered sample of 0.5 g was digested with concentrated H₂SO₄ in presence of digestion mixture (K₂SO₄:CuSO₄.5H₂O:Se in the proportion of 100:20:1) and distilled under alkaline medium. NH₃ liberated was trapped in boric acid containing mixed indicator and titrated against standard H₂SO₄.

Digestion of plant sample with di-acid mixture

For analyses of phosphorus and potassium, plant samples were pre-digested with tri-acid mixture (HNO₃: HClO₄: H₂SO₄ at 9:4:1) which was used for digestion of composite plant samples. Phosphorus content in samples was

determined by Vanadomolybdate phosphoric yellow colour method by using Spectrophotometer at 470 nm ^[9].

Total phosphorus

Total phosphorus (%) was determined by taking a known volume of the digested materials by adopting the Vanadomolybdate phosphoric acid yellow colour method as described by ^[9].

Total potassium

Using the respected di-acid digested extract, potassium (%) was estimated using Flame photometer as described by ^[9].

Estimation of nutrient uptake

Estimation of nitrogen uptake

$$\text{Nitrogen uptake (kg ha}^{-1}\text{)} = \frac{\text{N concentration (\%)} \times \text{Dry matter (kg ha}^{-1}\text{)}}{100}$$

Estimation of phosphorus uptake

$$\text{Phosphorus uptake (kg ha}^{-1}\text{)} = \frac{\text{P concentration (\%)} \times \text{Dry matter (kg ha}^{-1}\text{)}}{100}$$

Estimation of potassium uptake

$$\text{Estimation of potassium uptake} = \frac{\text{K concentration (\%)} \times \text{Dry matter (kg ha}^{-1}\text{)}}{100}$$

Statistical analysis

The data recorded on various observations were subjected to analysis of variance (ANOVA) as outlined by ^[5]. The level of significance used in 'F' test was at 5 per cent. The critical difference (CD) values were given in the table at 5 per cent level of significance, wherever the "F" test was significant. Otherwise against CD values abbreviation NS (Non-significant) was indicated.

Results

The result of the experiment is presented in this chapter.

Influence on grain yield, straw yield and harvest index

Grain yield of rice as influenced by application of different biostimulants is presented in Table 1. Biostimulant application significantly influenced the grain yield of rice. Among the different biostimulants, foliar application of 0.2 per cent humic acid + 0.2 per cent seaweed extract along with RDF (T₉) recorded significantly higher grain yield (5678 kg ha⁻¹) and was on par with soil application of humic acid @ 5 kg ha⁻¹ + seaweed extract @ 5 kg ha⁻¹ along with RDF (5473 kg ha⁻¹). Significantly lower grain yield was observed in control (4848 kg ha⁻¹) which was applied with RDF alone. Straw yield at harvest of rice as influenced by application of different bio-stimulants presented in Table 1. Among the application of different bio-stimulants, there was a significant difference in straw yield at harvest. 0.2 per cent humic acid + 0.2 per cent seaweed extract along with the RDF (T₉) recorded significantly higher straw yield (7483 kg ha⁻¹) and this was at par with the soil application of humic acid @ 5 kg ha⁻¹ + seaweed extract @ 5 kg ha⁻¹ along with RDF (7308 kg ha⁻¹). Significantly lower straw yield was observed in control (5993 kg ha⁻¹) which applied with RDF alone. No significant difference with respect to harvest index was observed among the treatments in the Table.1. But

numerically higher harvest index was recorded in foliar application of 0.2 per cent humic acid + 0.2 per cent seaweed extract along with RDF (0.43) -T₉ and numerically lowest harvest index (0.42) was recorded in control.

Influence on Nutrient uptake

Nitrogen uptake (kg ha⁻¹)

Nitrogen uptake at harvest as influenced by application of different biostimulants is furnished in Table 2. With respect to application of different biostimulants, nitrogen uptake significantly differed at harvest. Foliar application of 0.2 per cent humic acid + 0.2 per cent of seaweed extract along with RDF (T₉) recorded significantly higher nitrogen uptake (98.15 kg ha⁻¹ by grain and 36.33 kg ha⁻¹ by straw) and was followed by soil application of humic acid @ 5 kg ha⁻¹ + seaweed extract @ 5 kg ha⁻¹ (94.31 kg ha⁻¹ by grain and 34.33 kg ha⁻¹ by straw). Significantly the lowest nitrogen uptake was recorded in control (46.58 kg ha⁻¹ by grain and 14.34 kg ha⁻¹ by straw) which was supplied with RDF alone.

Phosphorous uptake (kg ha⁻¹)

Phosphorous uptake at harvest as influenced by application of different biostimulants is furnished in Table 3. Phosphorus uptake of rice varied significantly with application of different biostimulants. Foliar application of 0.2 per cent humic acid + 0.2 per cent of seaweed extract along with RDF (T₉) recorded significantly greater phosphorous uptake (25.05 kg ha⁻¹ by grain and 25.05 kg ha⁻¹ by straw). This was on par with soil application of humic acid @ 5 kg ha⁻¹ + seaweed extract @ 5 kg ha⁻¹ (24.10 kg ha⁻¹ by grain and 13.61 kg ha⁻¹ by straw). Significantly lower phosphorous uptake was recorded in control (11.03 kg ha⁻¹ by grain and 6.38 kg ha⁻¹ by straw) which was supplied with only RDF.

Potassium uptake (kg ha⁻¹)

Potassium uptake at harvest as influenced by application of different bio stimulants is furnished in Table 4. Foliar application of 0.2 per cent humic acid + 0.2 per cent of seaweed extract along with RDF (T₉) recorded significantly higher potassium uptake (27.43 kg ha⁻¹ by grain and 66.23 kg ha⁻¹ by straw) followed by soil application of humic acid @ 5 kg ha⁻¹ + seaweed extract @ 5 kg ha⁻¹ (25.33 kg ha⁻¹ by grain and 63.06 kg ha⁻¹ by straw). Application of RDF alone resulted in significantly minimum potassium uptake (10.36 kg ha⁻¹ by grain and 30.26 kg ha⁻¹ by straw).

Discussion

The factors that affected the growth, yield, nutrient uptake, and quality of rice have been discussed in this chapter

Among the different treatments tried, foliar application of 0.2 per cent of humic acid + 0.2 per cent of seaweed extract along with RDF gave significant improvement in grain yield (5678 kg ha⁻¹) and straw yield (7483 kg ha⁻¹). The magnitude of increase in yield with the foliar application of 0.2 per cent humic acid and 0.2 per cent seaweed extract along with RDF was to an extent of 14.61 per cent in grain yield and 19.91 per cent in straw yield over control (RDF). This may be due to application of bio-stimulants at the two important phenological stages i.e., at tillering and panicle initiation stage, which may have aided in correcting plant chlorophyll content, increase the permeability of the plant membranes, and intensify enzyme systems of plants. Biostimulants accelerate cell division, show greater root

development, and decrease stress deterioration similar observations recorded by [8]. Also, humic acid improved plant physiological processes by enhancing the availability of major and minor nutrients. Improved nutrient uptake (N, P and K) was also observed with application of seaweed extract lead to better grain and straw yield. These results are in agreement with the findings of [8], [17] and [12] in rice crop. Also, the increase in yield attributes in rice crop is due to efficient utilization of native as well as applied nutrients through roots and foliar application of seaweed biostimulants. Similar studies conducted in other crops highlighted the spraying of seaweed extract at after planting recorded higher tuber yield, improved nitrogen, total soluble solids, and protein contents of the potato tubers [6].

Effect of different biostimulants on nutrient uptake of rice: Nutrient uptake is the mechanism by which plants absorbs mineral nutrients essential for the normal growth and development of crop either through roots or through foliar application. Significantly higher uptake of nitrogen (98.15 kg ha⁻¹ by grain and 34.33 kg ha⁻¹ by straw at harvest, respectively) was recorded with foliar application of 0.2% humic acid and 0.2% seaweed extract along with RDF when compared to alone application of RDF 46.58 kg ha⁻¹ by grain and 14.34 kg ha⁻¹ by straw at harvest respectively. Increase in nitrogen uptake with foliar application of humic acid and seaweed extract was to an extent of 52.54 per cent by grain and 60.52 per cent by straw at harvest, respectively over application of only RDF. The stimulation of nitrogen uptake in the treatment that received foliar application of humic acid may be attributed to the effect of humic acid on the membrane permeability and the better developed root system [11] and also similar observation was reported by [1] that nitrogen uptake in the treatment that received foliar application of humic acid attributed to the auxin-like activity of humic substances which stimulates plasma membrane by increasing its permeability, and thereby improving the

cellular growth that leads to well-developed root system with lateral roots influencing better absorption of nutrients. Foliar application of 0.2% humic acid and 0.2% seaweed extract along with RDF recorded significantly higher phosphorus uptake (12.75 kg ha⁻¹ by grain and 6.98 kg ha⁻¹ by straw at harvest respectively) in comparison with alone application of RDF (11.03 kg ha⁻¹ by grain and 6.38 kg ha⁻¹ by straw at harvest, respectively). The magnitude of increase in phosphorus uptake with foliar application of humic acid and seaweed extract was to an extent of 13.49 per cent by grain and 8.98 per cent by straw at harvest, respectively over application of only RDF. This is mainly because humic acid increases the cell membrane permeability that results in increased nutrient uptake and accumulation in plant cells. Humic acid influenced the root growth which intern helped in better assimilation of P. [7] reported that increased P availability was due to reduced P fixation and, also due to the formation of humophosphate complexes [10] which might have increased the P uptake by rice.

Significantly higher potassium uptake (27.43 kg ha⁻¹ by grain and 66.23 kg ha⁻¹ by straw at harvest, respectively) was recorded with foliar application of 0.2% humic acid + 0.2% seaweed extract along with RDF compared to alone application of RDF (10.36 kg ha⁻¹ by grain and 30.26 kg ha⁻¹ by straw at harvest, respectively). Increased potassium uptake with foliar application of humic acid and seaweed extract was to an extent of 62.23% by grain and 54.31% by straw at harvest, respectively over application of only RDF. Increase in K content and uptake recorded in this study might be due to the reduced K fixation on addition of humic acid. According to [13] application of humic acid increased the permeability of bio membranes for electrolytes and thereby accounted for increased K uptake. Rice being a monocot, might have taken up more potassium by virtue of its high root cation exchange capacity [16].

Table 1: Grain yield, Straw yield and harvest index of rice as influenced by application of different biostimulants

Treatments	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Harvest index
T ₁ : Recommended dose of fertilizer (RDF only)	4848	5993	0.42
T ₂ : RDF + Soil application of Humic acid @ 5 kg ha ⁻¹	5323	7153	0.43
T ₃ : RDF + Soil application of Humic acid @ 10 kg ha ⁻¹	5356	7211	0.42
T ₄ : RDF + Foliar spray of Humic acid @ 0.2%	5268	7098	0.42
T ₅ : RDF + Soil application of Seaweed extract @ 5kg ha ⁻¹	5068	6673	0.43
T ₆ : RDF + Soil application of Seaweed extract @ 10 kg ha ⁻¹	5196	7016	0.42
T ₇ : RDF + Foliar spray of Seaweed extract @0.2 %	5216	7126	0.42
T ₈ : RDF + Soil application of Humic acid @ 5 kg ha ⁻¹ + Seaweed extract @ 5 kg ha ⁻¹	5473	7308	0.43
T ₉ : RDF + Foliar spray of Humic acid @ 0.2% + Seaweed extract @0.2 %	5678	7483	0.43
T ₁₀ : RDF + Foliar spray of Jeevamurutha @ 3%	4978	6696	0.43
S.E.m.±	92.43	160.70	0.62
C.D @ 5%	276.77	481.15	NS

Note: RDF only (100:50:50 kg N:P₂O₅:K₂O ha⁻¹) was commonly applied to all the treatments. DAT- Days after transplanting. NS- Non significant.

Soil application at the time of transplanting and Foliar spray at the time of tillering and panicle emergence

Table 2: Nitrogen uptake of rice as influenced by application of different biostimulants

Treatments	Uptake in grain (kg ha ⁻¹)	Uptake in straw (kg ha ⁻¹)	Total uptake (kg ha ⁻¹)
T1: Recommended dose of fertilizer (RDF only)	46.58	14.34	57.92
T2: RDF + Soil application of Humic acid @ 5 kg ha ⁻¹	86.36	31.00	117.36
T3: RDF + Soil application of Humic acid @ 10 kg ha ⁻¹	90.16	32.33	122.49
T4 : RDF + Foliar spray of Humic acid @ 0.2%	83.98	30.48	114.46
T5 : RDF + Soil application of Seaweed extract @ 5kg ha ⁻¹	62.75	18.51	81.26
T6 : RDF + Soil application of Seaweed extract @ 10 kg ha ⁻¹	70.91	23.31	94.22
T7 : RDF + Foliar spray of Seaweed extract @0.2 %	74.91	24.31	99.22
T8 : RDF + Soil application of Humic acid @ 5 kg ha ⁻¹ + Seaweed extract @ 5 kg ha ⁻¹	94.31	34.33	128.64
T9 : RDF + Foliar spray of Humic acid @ 0.2% + Seaweed extract @0.2 %	98.15	36.33	134.64
T10 : RDF + Foliar spray of Jeevamurutha @ 3%	50.16	16.01	66.17
S. Em. ±	6.63	1.08	7.71
C.D @ 5%	19.70	3.22	22.92

Note: RDF only (100:50:50 kg N:P₂O₅:K₂O ha⁻¹) was commonly applied to all the treatments. DAT- Days after transplanting. NS- Non significant. Soil application at the time of transplanting and Foliar spray at the time of tillering and panicle emergence

Table 3: Phosphorus uptake of rice as influenced by application of different biostimulants

Treatments	Uptake in grain (kg ha ⁻¹)	Uptake in straw (kg ha ⁻¹)	Total uptake (kg ha ⁻¹)
T1: Recommended dose of fertilizer (RDF only)	11.03	6.38	17.41
T2: RDF + Soil application of Humic acid @ 5 kg ha ⁻¹	21.43	12.31	33.74
T3: RDF + Soil application of Humic acid @ 10 kg ha ⁻¹	22.53	13.48	36.01
T4: RDF + Foliar spray of Humic acid @ 0.2 %	20.36	11.33	31.69
T5: RDF + Soil application of Seaweed extract @ 5 kg ha ⁻¹	14.25	7.33	21.58
T6: RDF + Soil application of Seaweed extract @ 10 kg ha ⁻¹	16.31	9.06	25.37
T7: RDF + Foliar spray of Seaweed extract @ 0.2 %	18.45	9.56	28.01
T8: RDF + Soil application of Humic acid @ 5 kg ha ⁻¹ + Seaweed extract @ 5 kg ha ⁻¹	24.10	13.61	37.71
T9: RDF + Foliar spray of Humic acid @ 0.2 % + Seaweed extract @ 0.2 %	25.05	14.25	39.30
T10: RDF + Foliar spray of Jeevamurutha @ 3 %	12.75	6.98	19.73
S. Em. ±	0.72	0.36	1.08
C.D @ 5%	2.15	1.09	3.24

Note: RDF only (100:50:50 kg N:P₂O₅:K₂O ha⁻¹) was commonly applied to all the treatments. DAT- Days after transplanting. NS- Non significant. Soil application at the time of transplanting and Foliar spray at the time of tillering and panicle emergence

Table 4: Potassium uptake of rice as influenced by application of different biostimulants

Treatments	Uptake in grain (kg ha ⁻¹)	Uptake in straw (kg ha ⁻¹)	Total uptake (kg ha ⁻¹)
T1: Recommended dose of fertilizer (RDF only)	10.36	30.26	40.62
T2: RDF + Soil application of Humic acid @ 5 kg ha ⁻¹	23.33	58.63	81.96
T3: RDF + Soil application of Humic acid @ 10 kg ha ⁻¹	24.40	60.81	85.21
T4: RDF + Foliar spray of Humic acid @ 0.2 %	22.58	57.03	79.61
T5: RDF + Soil application of Seaweed extract @ 5 kg ha ⁻¹	14.45	40.20	54.65
T6: RDF + Soil application of Seaweed extract @ 10 kg ha ⁻¹	17.45	47.96	65.41
T7: RDF + Foliar spray of Seaweed extract @ 0.2 %	18.25	50.18	68.43
T8: RDF + Soil application of Humic acid @ 5 kg ha ⁻¹ + Seaweed extract @ 5 kg ha ⁻¹	25.33	63.06	88.39
T9: RDF + Foliar spray of Humic acid @ 0.2 % + Seaweed extract @ 0.2 %	27.43	66.23	93.66
T10: RDF + Foliar spray of Jeevamurutha @ 3 %	12.60	33.66	46.26
S. Em. ±	0.63	1.53	2.16
C.D @ 5%	1.88	4.54	6.42

Note: RDF only (100:50:50 kg N:P₂O₅:K₂O ha⁻¹) was commonly applied to all the treatments. DAT- Days after transplanting. NS- Non significant. Soil application at the time of transplanting and Foliar spray at the time of tillering and panicle emergence

Conclusion

The present investigation entitled “Effect of different biostimulants on growth, yield and quality of rice” indicated that foliar application of 0.2% humic acid +0.2% seaweed extract along with RDF will increase 14.61 per cent in grain yield and 19.91 per cent in straw yield over control (RDF). Also, foliar application of 0.2% humic acid + 0.2% seaweed extract along with RDF has recorded significantly higher total nitrogen (134.64 kg ha⁻¹), total phosphorus (39.30 kg ha⁻¹) and total potassium uptake (93.66 kg ha⁻¹) over the other treatments. Thus, foliar application of 0.2% humic acid and 0.2% seaweed extract along with RDF excelled over all other treatments by recording significantly the highest yield and uptake of nutrients..

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