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Effect of biostimulants on growth and yield of rice

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Abstract
The field experiment was planned to assess the impact of this fertilizer on growth and yield of paddy during *Kharif* 2022-23 at Jawahar Lal Nehru Krishi Vishwavidyalaya, Jabalpur to evaluate the efficacy of AGMA-foliar Biostimulant on growth and yield of rice. The maximum grain yield of was recorded with application of AGMA BIOSTIMULANT GRANULE + 100% (T3) compared to all the remaining treatments and control and it was statistically at par with AGMA Biostimulant Granule + 100% NPK At the time of transplanting. The highest straw yield was recorded AGMA Biostimulant Granule + 100% NPK At the time of transplanting. benefit cost (B:C) ratio was higher in the application AGMA Biostimulant Granule + 100% NPK At the time of transplanting followed by AGMA Biostimulant Granule + 80% NPKat 30 days after transplanting over other treatment.

Keywords: Biostimulants, growth, yield, rice

Introduction
Rice (*Oryzae sativa* L.) belongs to family Poaceae and genus "*Oryzae*". It contains 28.6% carbohydrate, 2.7% protein, 0.3% fat, and considerable proportion of Vitamin B6, Magnesium, Calcium, Iron. It is the primary staple for more than half of the world's population. Rice is grown globally on an area of about 164.84 million ha with the production of 755.5 million tones and productivity of 4.59 tonnes ha^{-1}. In India rice is grown in 45 million ha area, with a production of 122.27 million tones and productivity of 4.08 tonnes ha^{-1}. Madhya Pradesh contributes nearly 2.04 million ha and 6.19 million tonnes to the total area and production of rice in the country respectively. But the productivity (3.04 tonnes ha^{-1}) is far below the yield potential i.e. 5.0 tonnes ha^{-1}. Various agricultural practices have been employed to enhance paddy yields, including the use of fertilizers, irrigation systems, and crop protection measures. However, these conventional methods often have limitations, such as high costs, negative environmental impacts, and potential risks to human health. Raghuwanshi *et al*., 2023a; Yadav *et al*., 2023a [44, 47, 48, 23]. In recent years, there has been growing interest in the utilization of foliar biostimulants as a sustainable alternative for enhancing crop performance. 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. This research study aims to comprehensively review the existing literature on the effects of AGMA-foliar biostimulants on paddy growth and yield.

Materials and Methods
In view of this a sponsored trial is planned to assess the impact of this fertilizer on growth and yield of paddy during *Kharif* 2022-23 at Jawahar Lal Nehru Krishi Vishwavidyalaya, Jabalpur to evaluate the efficacy of AGMA-foliar Biostimulant on growth and yield of rice. The field experiment was carried out at the Breeder seed production unit of JNKVV, Jabalpur, Madhya Pradesh (India). It is situated between 23º90′North latitude and 79º58′East longitude at an altitude of 411.78 meters above mean sea level and classified as "Kymore plateau and Satpura hills agro-climatic zone". The experimental plot was provided with assured irrigation facility having uniform topography and proper drainage.

The crop variety "JR-206" recommended for cultivation in Madhya Pradesh which was used in the experimental The major plant nutrients i.e. nitrogen, phosphorus and potash were given by urea, DAP and MOP respectively. The dose of fertilizer viz. 120 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} was applied in accordance to the treatments given in Table 1. Half of total nitrogen and full dose of phosphorus, and potassium were applied as basal application before sowing according to the treatments. Treatments were arranged in randomized block design with three replications. Remaining half dose of nitrogen in the form of urea was applied as top dressing in two equal splits, at the active tillering and panicle initiation stage. Harvesting of individual plots was done manually with the use of a sickle when the grains in panicles had fully matured. The data collected from both the stover and grain analyses were meticulously compiled and interpreted to glean valuable insights into the effects of the different treatments on nutrient uptake and crop yield

Treatment details

Treatments	NPK Application Dose	AMF Dose/acre	No. of application	Time of Application of AMF
T_1	AGMA Biostimulant Granule + 100% NPK	4 Kg	1	At the time of transplanting
T_2	AGMA Biostimulant Granule + 100% NPK	4 Kg	1	15 days after transplanting
T_3	AGMA Biostimulant Granule + 100% NPK	4Kg	1	30 days after transplanting
T_4	AGMA Biostimulant Granule + 100% NPK	4Kg	1	40 days after transplanting
T_5	AGMA Biostimulant Granule + 80% NPK	4 Kg	1	15 days after transplanting
T_6	AGMA Biostimulant Granule + 80% NPK	4 kg	1	30 days after transplanting
T_7	Control + 100% NPK	-	-	-
T_8	Control + 80% NPK	-	-	-

*Fertilizer application to be applied at recommended application window

Results

On Growth parameters

Plant population m-2 remained significant with application of biostimulant treatments at harvest whereas, non-significant at 20 DAS. The data presented in Table 1 and Table 2 revealed that all the characters were influenced significantly by the given treatments. The highest height of plant at time of harvest (85.3 cm) was recorded in the treatment T_3 followed by T_2 and T_1. The Highest number of tillers per plant was recorded in T_3 followed by T_2 and T_1 as compared to control.

Table 1: Efficacy of Biostimulant on growth and yield parameters of rice

Treatments	Plant Height cm	Effective tillers m^{-2}	Panicle length	Panicle weight	Grainspanicle^{-1}
T_1	80.3	385	22.05	1.73	80
T_2	84.3	395	22.8	1.77	83
T_3	85.3	336	21.4	1.72	80
T_4	81.8	353	21.52	1.79	83
T_5	79.9	345	22.01	1.65	77
T_6	78.8	330	19.7	1.39	70
T_7	73.6	328	21.37	1.45	73
T_8	77	283	19.3	1.47	67
S.E.m +	0.12	1.14	0.14	0.02	1.32
C.D at 5%	0.36	3.78	0.46	0.06	3.54

Table 2: Effect of Biostimulant on, yield and quality of Rice

S. No.	Treatments			Yield		
				Grain yield ha^{-1}	Straw yield ha^{-1}	Harvest index (%)
T_1	AGMA Biostimulant Granule + 100% NPK	At the time of transplanting	4 Kg	6288	9431	0.40
T_2	AGMA Biostimulant Granule + 100% NPK	15 days after transplanting	4 Kg	5480	8561	0.38
T_3	AGMA Biostimulant Granule + 100% NPK	30 days after transplanting	4Kg	5793	8751	0.39
T_4	AGMA Biostimulant Granule + 100% NPK	40 days after transplanting	4Kg	6332	9496	0.41
T_5	AGMA Biostimulant Granule + 80% NPK	15 days after transplanting	4 Kg	5680	8528	0.38
T_6	AGMA Biostimulant Granule + 80% NPK	30 days after transplanting	4 kg	4934	7658	0.37
T_7	Control + 100% NPK	At the time of transplanting	-	4637	7412	0.37
T_8	Control L + 80% NPK	15 days after transplanting	-	4065	6903	0.36
SEm +				92.71	35.98	0.005
CD (P=0.05)				277.6	107.7	0.014

Effect on crop yield

Among all the treatment combined application AGMA BIOSTIMULANT GRANULE + 100% NPK at the 15 days after transplanting showed higher plant population at harvest, plant height, leaf area index, tillers per meter row length and crop dry weight compared to other treatments as well as 100% RDF and control. The treatment AGMA BIOSTIMULANT GRANULE + 100% NPK was however at par to the treatment given.

Yield attributes viz., effective tillers m-2, length of panicle, weight of panicle, grains panicle-1 and test weight were significantly influenced by integrated application. Among the various nutrient management treatments, application of AGMA BIOSTIMULANT GRANULE + 100% (T_3) showed significantly higher effective tillers m-2, panicle length, panicle weight, grains panicle-1 and test weight, over the control plot as well as the plot given recommended fertilizer dose.

The maximum grain yield of was recorded with application of AGMA BIOSTIMULANT GRANULE + 100% (T_3) compared to all the remaining treatments and control and it was statistically at par with AGMA Biostimulant Granule + 100% NPK At the time of transplanting (Singh *et al*., 2022; Jha *et al*., 2023) [30, 23]. The highest straw yield was recorded AGMA Biostimulant Granule + 100% NPK At the time of transplanting. Kantwa *et al*., 2019; Yadav *et al*., 2023c; Singh *et al*., 2013b Yadav *et al*., 2023b; Verma *et al*., 2023 [27, 47, 18, 23, 43, 44, 47, 48, 51, 52].

Effect on chemical properties of soil and nutrient uptake

Post harvest soil parameters like pH, EC, organic carbon were not significantly influenced by the integrated application of AGMA Biostimulant Granule + 100% NPK. Singh *et al*., 2013a [18]; Sahu *et al*., 2022 [49]; Patel *et al*., 2023 [33, 34, 35]. The available N, P, K in soil was significantly influenced with application of AGMA Biostimulant Granule + 100% NPK. Kumar *et al*., 2022 [30]; Raghav *et al*., 2023 [46]. The available N, P, K in soil after harvest was minimum with treatment Control L + 80% NPK (Kumar *et al*., 2023 and Shri *et al*., 2014) [35, 14]. Previous by Jha and Soni (2014) [14] and Verma *et al*. (2023) [23, 43, 44, 47, 48, 51, 52]. However, the nutrient uptake of (Nitrogen, Phosphorus, Potassium) in grain and straw (kg ha^{-1}) was highest in plots AGMA Biostimulant Granule + 100% NPK At the time of transplanting fetched higher values of gross and net returns ha^{-1}) followed by the treatment where the dose AGMA Biostimulant Granule + 100% NPK 15 days after transplanting over the control plots and RDF plots. Sanodiya *et al*. (2013) [51], Verma *et al*. (2022) [49], Kantwa *et al*. (2019) [27], Jha *et al*. (2007) [26] and Kumbhare *et al*., 2023a [33, 34, 35].

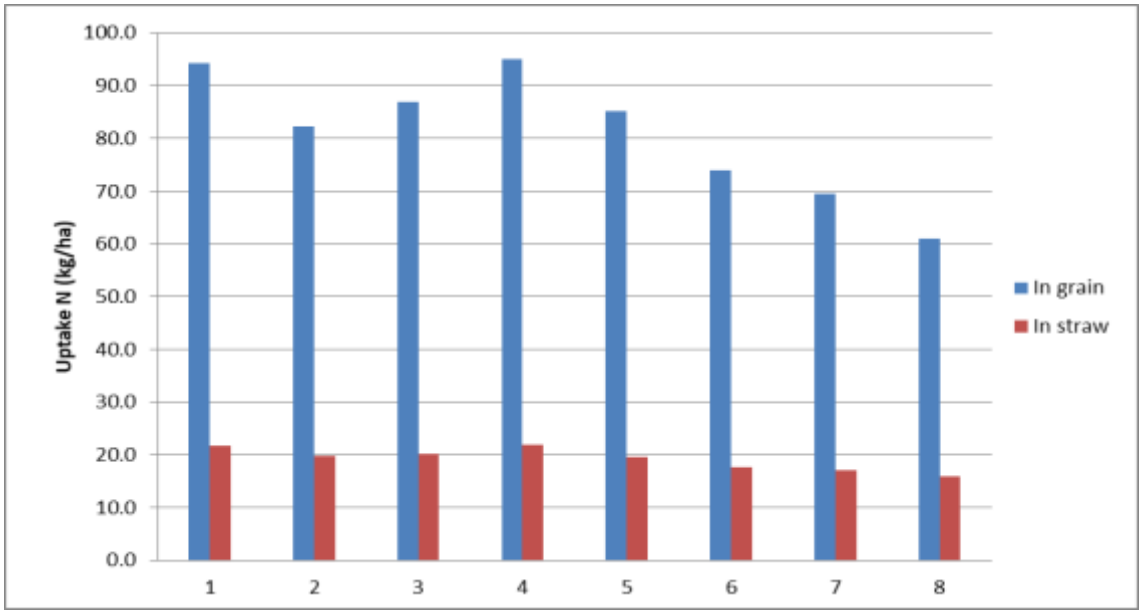

Fig 1: Uptake of N (kg/ha) influenced by treatments

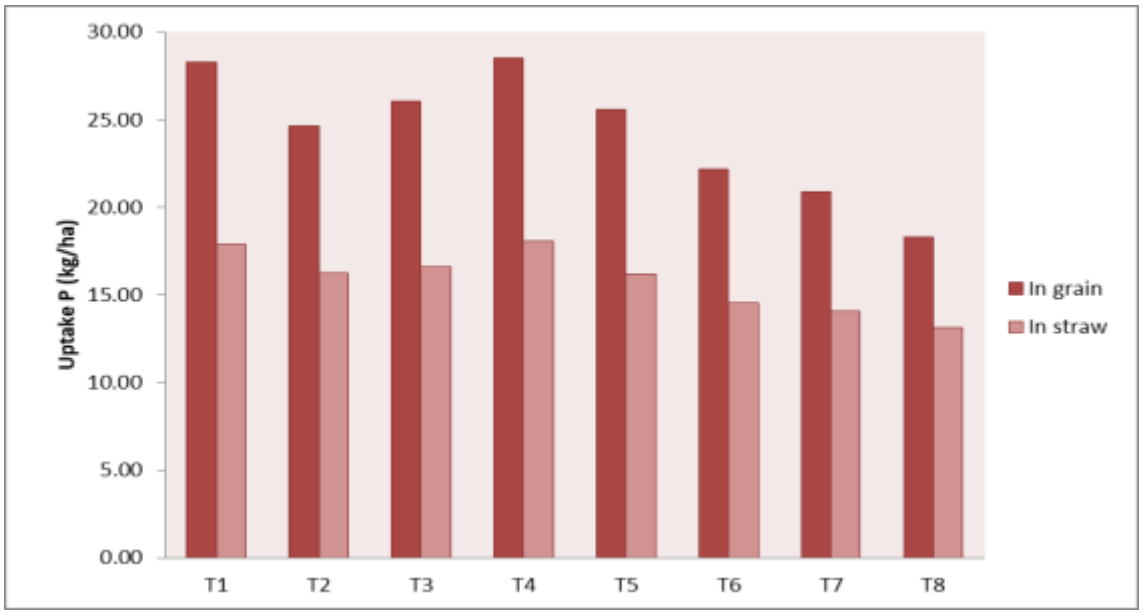

Fig 2: Uptake of P (kg/ha) influenced by treatments

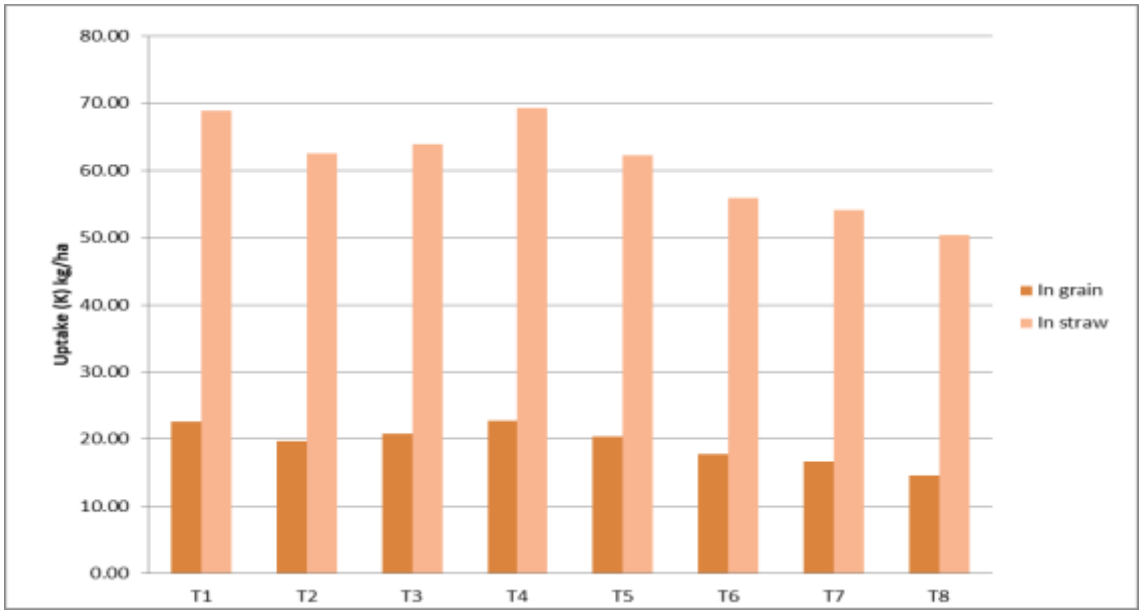

Fig 3: Uptake of K (kg/ha) influenced by treatments

Economics of treatments

Application of AGMA Biostimulant Granule + 100% NPK At the time of transplanting fetched higher values of gross and net returns ha^{-1}) followed by the treatment where the dose AGMA Biostimulant Granule + 100% NPK at 15 days after transplanting. Sahu *et al*., 2022 [49]; Verma *et al*., 2023 [23, 43, 44, 47, 48, 50, 51, 52], Verma *et al*., 2022 [49]; Malviya *et al*., 2012 [40]. Whereas, benefit cost (B:C) ratio was higher in the application AGMA Biostimulant Granule + 100% NPK At the time of transplanting followed by AGMA Biostimulant Granule + 80% NPKat 30 days after transplanting over other treatment. Mengel *et al*., 2001 [41]; Kumhar *et al*., 2022 [36]; Kumbhare *et al*., 2023 [33, 34, 35]; Sahu *et al*., 2023 [49]; Patidar *et al*., 2023 [39], Jha *et al*., 2008 [25]; Jha *et al*., 2011 [20]; Pahade *et al*., 2023 [43].

Economics of treatments

S. No.	Treatments			Economics of rice crop			
				Cost of cultivation (Rs ha^{-1})	GMR (Rs ha^{-1})	NMR (Rs ha^{-1})	B:C Ratio
T_1	AGMA Biostimulant Granule + 100% NPK	At the time of transplanting	4 Kg	37760	118712	84952	3.50
T_2	AGMA Biostimulant Granule + 100% NPK	15 days after transplanting	4 Kg	37400	85664	54264	2.72
T_3	AGMA Biostimulant Granule + 100% NPK	30 days after transplanting	4Kg	37280	103486	70206	3.1
T_4	AGMA Biostimulant Granule + 100% NPK	40 days after transplanting	4Kg	37800	97436	64636	2.97
T_5	AGMA Biostimulant Granule + 80% NPK	15 days after transplanting	4 Kg	36780	121918	85138	3.31
T_6	AGMA Biostimulant Granule + 80% NPK	30 days after transplanting	4 kg	36780	131456	93676	3.47
T_7	Control + 100% NPK	At the time of transplanting	-	34300	106397	70097	2.93
T_8	Control L + 80% NPK	15 days after transplanting	-	34300	121086	83786	3.24
SEm +				92.71	35.98	0.005	
CD (P=0.05)				277.6	107.7	0.014	

Conclusion

The study conducted at JNKVV on Paddy variety JR -206 during *Kharif*, 2022-23 revealed that the application of AGMA bio-stimulant Granule gave good vegetative growth, more number of ears per plant, good size of ears and highest yield per plant as compared to control.

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