Influence of Granular Biostimulants on Growth and Yield Characteristics of Rice (*Oryza Sativa*) in New Alluvial Zone of West Bengal

ABSTRACT

Rice (Oryza sativa), the primary food source for over half of the global population, is critical to food security but faces productivity challenges from suboptimal fertilizer use and associated environmental degradation in India. Addressing these issues necessitates innovative strategies that enhance crop performance while maintaining ecological balance. Biostimulants, known for their role in enhancing nutrient efficiency and crop resilience, offer a promising solution for optimizing fertilizer use and improving soil health. This study evaluates the efficacy of AGMA Bio Stimulant Granules on the growth, yield, and soil health of rice during the kharif season of 2023 at Bidhan Chandra Krishi Vishwavidyalaya, Kalyani, West Bengal. A randomized block design with eight treatments and three replications was employed, including combinations of AGMA granules with 100% and 80% recommended NPK doses. Results demonstrated significant improvements in growth parameters, yield attributes, and soil nutrient availability with AGMA application. Treatments T2 and T5, integrating AGMA granules with 100% and 80% NPK, respectively, achieved the highest grain yields, with T5 showing a 19% yield increase over the control. Soil health indicators, including organic carbon and available nitrogen, phosphorus, and potassium, improved significantly, while electrical conductivity decreased. The study concludes that AGMA Bio Stimulant Granules enable a 20% reduction in NPK fertilizer use without compromising yields, underscoring their potential to support sustainable and environmentally friendly agricultural practices.

Keywords: 1.Biostimulants; 2.Rice; 3.Yield; 4.Soil health; 5.Fertilizer Optimization; 6. Protein Hydrolysate

1. Introduction:

The escalating global demand for food, driven by population growth, has raised significant concerns about the sustainability of agricultural practices. 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 **(Tarang et al., 2020).** Globally, rice was cultivated on 164.2 million hectares, with a total production of 756.7 million tons in 2020–21. In South Asia, where it serves as a staple food for

1.7 billion people, rice is a crucial agricultural commodity, with over 90% of global production and consumption occurring in Asia **(Rahman et al., 2023).**However, the intensification of rice cultivation to meet these demands has often been achieved at the expense of environmental and human health. Excessive use of inputs, such as chemical fertilizers and pesticides in the intensive rice bowls, will likely result in resource degradation and environmental pollution will have adverse effects on human health. Despite its critical importance, the use efficiency of chemical fertilizers in Indian soils remains suboptimal, with nitrogen (N) use efficiency ranging from 35–40%, phosphorus (P) at 15–20%, and potassium (K) at 50–60% **(Singh et al., 2020).** Overreliance on chemical fertilizers has led to declining soil fertility, groundwater contamination, and increasing greenhouse gas (GHG) emissions, particularly methane and nitrous oxide, which exacerbate climate change **(Lal, 2020; IPCC, 2019)**. The excessive use of synthetic inputs not only contributes to environmental degradation but also raises serious health concerns due to the bioaccumulation of harmful residues in food chains **(Sharma et al., 2021).** These issues necessitate a paradigm shift toward sustainable farming practices that enhance productivity while mitigating adverse environmental impacts.

Biostimulants are substance or microorganism that stimulates natural plant processes to improve plant characteristics, such as nutrient use efficiency, tolerance to abiotic stress, quality traits, and availability of nutrients in the rhizosphere. The impact of foliar biostimulants on solanaceous crops such as potato and tomato has been remarkable, with widespread adoption across India. These eco-friendly inputs have significantly improved crop growth, yield and quality by enhancing nutrient use efficiency and stimulating plant physiological processes **(Karak et al., 2023**). Biostimulants, particularly granular formulations such as AGMA biostimulant granule formulations (K Max Super, AgroPower Gold, Gallant Gold, and Krishi Value), have emerged as promising alternatives to synthetic fertilizers in rice crop. These products, composed of protein hydrolysates (PHs) and amino acids, enhance the quality and yield of crops by improving the use efficiency of P and K through the utilization of native reserves. The Protein hydrolysates and Physico activator compounds help in promoting plant growth, enhance productivity, and mitigate abiotic stresses, including salinity, heavy metals, and water stress by modulating the physiological and molecular processes of plants **(Colla et al., 2015).** In the context of the New Alluvial Zone of West Bengal, characterized by fertile yet increasingly stressed soils, the use of granular biostimulants could be a transformative strategy to sustainably boost rice yields while addressing the twin challenges of climate change and food security.

2. MATERIALS AND METHODS

The experimental site (22.89º N, 88.45º E and 9.75m AMSL) was selected at C-block farm, Bidhan Chandra Krishi Vishwavidyalaya, Kalyani, West Bengal **(Fig-1)** during the kharif season of 2023. The experiment was laid out in a randomized complete block design with three replications comprising eight treatments of soil application of AGMA biostimulant granules (K Max Super / AgroPower Gold / Gallant Gold / Krishi Value) along with recommended doses of fertilizers (100% RDF) and 80% RDF (20% reduced NPK). The treatment details for the experiment are summarized in **Table 2**.The recommended package & practices of rice crop for West Bengal condition were followed to raise the crop. The major objective of study is to find out the effect of AGMA Biostimulant granule with optimized the dose of NPK on crop yield and soil health. The data on Root fresh weight, Root dry weight, Plant height, No. of effective tillers, No. of Grains/panicle, Panicle length, No. of chaffy grains, 1000 grain weight, Grain Yield (kg/ha), Straw Yields (kg/ha) and soil health parameters were recorded as per standard agronomic practices. Soil samples were collected at harvest of rice crop and analyzed for soil pH, soil electrical conductivity (EC), organic carbon, available nitrogen, available phosphorous and available potassium. The laboratory work was carried out at the "Department of Vegetable Science" and the "Quality Control Laboratory," Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia. The climatic parameters of the experimental site during the Kharif season of 2023 are presented in **Figure 2**.The soil at the experimental site was characterized as sandy clay loam, with a pH of 7.06 and an organic carbon content of 0.44%. The soil texture analysis revealed the proportions of sand, silt, and clay to be 55.8%, 20.75%, and 23.1%, respectively. Additionally, the soil exhibited low levels of available nitrogen (N), phosphorus (P), and potassium (K). The methods employed for soil analysis are summarized in **Table 1**.

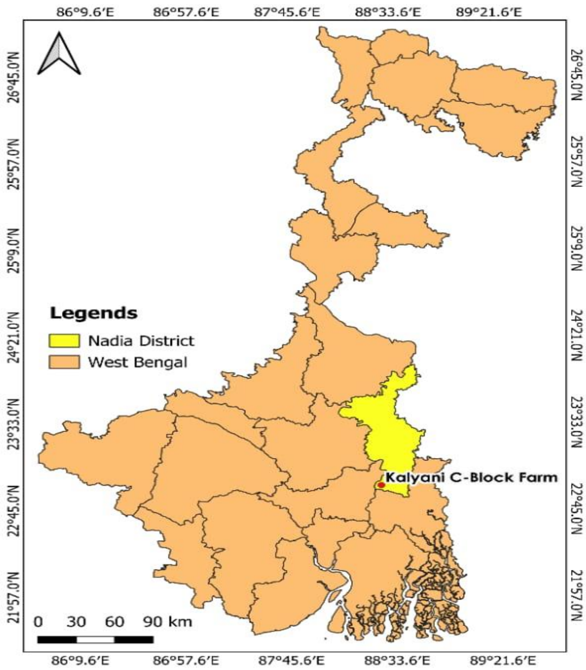

Fig 1: Experimental Site

Climate parameters of the experimental site during the Kharif season of 2023

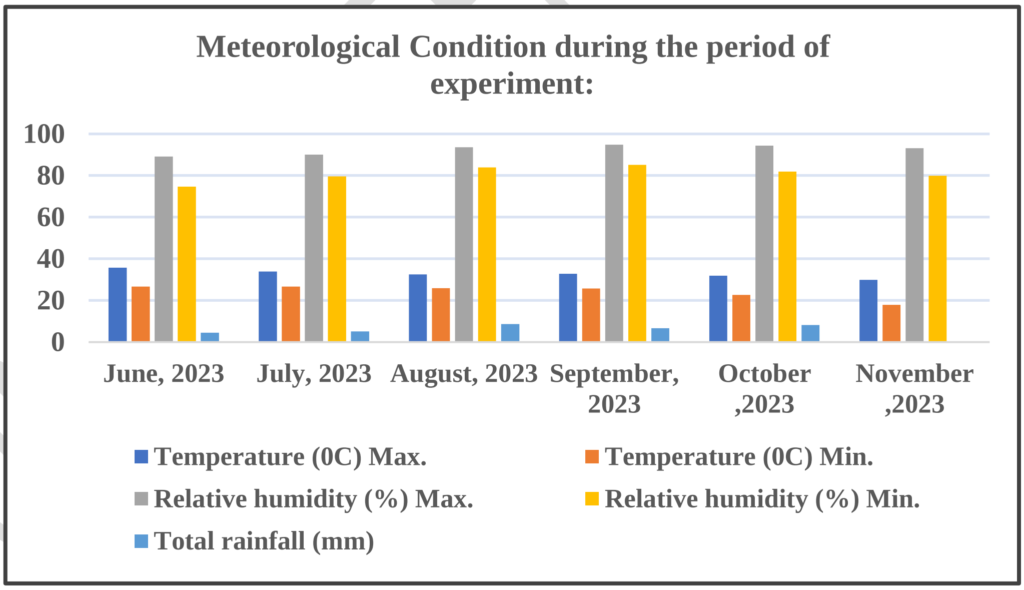

Fig 2: Meteorological Conditions of the Experimental Site

(**Source**: Department of Agril. Meteorology and Physics, B.C.K.V., Nadia, W.B.)

Table-1: Methods employed for analysis of soil properties

Sl.No	Soil properties	Using Analytical methods
01	Electrical conductivity of EC (ds/m)	Conductivity bridge method
02.	Soil pH	Beckman's pH meter method
03.	Organic carbon	Walkley and black's titration method
04.	Available N (kg/ha)	Macro - kjeldahl
05.	Available P (kg/ha)	Olsen's method
06.	Available K (kg/ha)	Flame photometer method

Table-2: Treatments Details

TREATMENTS	PRODUCTS	DOSE/ACRE	NO. OF APPLICATION	TIMEOFAPPLICATION
T1	AGMA BIOSTIMULANT GRANULE+100% NPK	4 Kg	1	At the time of transplanting
T2	AGMA BIOSTIMULANT GRANULE+100% NPK	4 Kg	1	15 days after transplanting
T3	AGMA BIOSTIMULANT GRANULE+100% NPK	4 Kg	1	30 days after transplanting
T4	AGMA BIOSTIMULANT GRANULE+100% NPK	4 Kg	1	40 days after transplanting
T5	AGMA BIOSTIMULANT GRANULE+80% NPK	4 Kg	1	15 days after transplanting
T6	AGMA BIOSTIMULANT GRANULE+80% NPK	4 kg	1	30 days after transplanting
T7	CONTROL+100% NPK	-	-	-
T8	CONTROL+80% NPK	-	-	-

3. RESULTS AND DISCUSSION

3.1. Growth attributes

3.1.1. Plant height (cm)

Plant height was recorded at 30, 60 days after transplanting and at harvest (**Table-3 & Figure-3**). The maximum plant height was observed in treatment T_2 and T_3 (101.89 cm) where recommended dose of NPK was applied along with 4 kg AGMA Bio stimulant granule (K Max Super, AgroPower Gold, Gallant Gold, Krishi Value) at 15 DAT and 30. Though the difference in plant heights was not much in the treatments. The minimum plant height was observed in the control (T_7 and T_8) treatment. Data revealed that there was no significant increment in the plant height at all crop growth stages in all the treatments **(Kundu et al., 2023)**

3.1.2. SPAD Value

SPAD value was recorded at 60 and 75 days (Table-3 & Figure-4). The maximum SPAD value at 75 DAT was observed in (41.84) T_2 where recommended dose of NPK was applied along with 4 kg AGMA Bio stimulant granule at 15 DAT **(Jha *et al.,* 2024)**. The minimum was observed in the control (T_7 and T_8) treatment.

3.1.3. Number of tillers per hill

Impact of different treatments on the total number of tillers and number of effective tillers recorded at harvesting of crop growth has been shown in Table 3, Figure-5. There was clear increment in total number of tillers and numbers of effective tillers were recorded in treatment where AGMA granules were applied. Though maximum tillers were observed in $T_{5,}$ (8.24) where NPK was reduced by 20% and applied along with AGMA granule. In case of number of tillers, T_2 is also at par with T_5. Minimum number of tillers was found in control treatment (T_7 and T_8).

3.1.4. Root mass dry weight:

The data showing the root dry weight in rice crop is represented in Table 3 & Figure-6.

It was observed that application of AGMA granule increase the root dry mass. The highest root mass dry weight was observed under T_5 treatment where 80% dose of NPK was applied along with 4 kg AGMA Bio stimulant granule at 15 DAT. Minimum root dry weight was found in absolute control treatment (T_7 and T_8) **(Calvo *et al.,*2014).**

3.2. Yield and yield attributing characters

The data illustrating the effects of AGMA biostimulant granules (K Max Super, AgroPower Gold, Gallant Gold, and Krishi Value) on grain yield, biological yield, and test weight are presented in Table 4. The results clearly indicate a significant enhancement in grain and biological yields in treatments where AGMA biostimulant granules were applied, even with a reduction in chemical fertilizer doses.

The highest grain and biological yields were recorded in treatments T_2 (53.91 & 119.71 q/ha respectively) and T_5 (53.85 & 119.40 q/ha respectively), which received 100% and 80% of the recommended dose of fertilizers (RDF) in combination with AGMA biostimulant granules. Conversely, the lowest yields were observed in the control treatments (T_7 and T_8), which did not include biostimulant applications. The similar trend was observed by **Karak et al. (2023)** in tuber yield of potato in response to the application of biostimulants. In rice also application of AGNA foliar showed the good results. (Karak et.al.2024)

A similar trend was observed for test weight, with the maximum values recorded in treatments T2 and T5, while the minimum test weight values were associated with the control plots (T7 and T8). These findings align with the observations of **Rouphael et al. (2015)**, who reported significant improvements in yield attributes and grain quality following the application of biostimulants.

3.3 Physico-chemical analysis Soil parameters

3.3.1. Soil pH

The data showing the effect of AGMA Bio stimulant granule (K Max Super, AgroPower Gold, Gallant Gold, Krishi Value) on soil pH is presented in Table 5. The effect of AGMA Bio stimulant granule showed slight increase in soil pH. However, there was no significant differences were found in relation to soil pH in all the treatments. **(Turan *et al.*, 2010).**

3.3.2. Soil EC

The data showing the Soil EC in rice crop is represented in Table- 5 The highest EC was observed under T_7 and T_8 treatment where recommended dose of NPK was applied without AGMA Bio stimulant granule. The EC was positively improved in the treatments where AGMA Bio stimulant granule were applied as decrease in the Electrical conductivity (EC) is a positively good sign in terms of nutrient availability. **(Malgorzata & Agnieszka, 2019).**

3.3.3. Organic Carbon

The effect of AGMA Bio stimulant granule (K Max Super, AgroPower Gold, Gallant Gold, Krishi Value) on organic carbon is presented in Table- 5 and Figure-7. The highest organic carbon was observed under T_2 and T_5 treatment which followed by $T_{1,}$ T_2 and $T_{3.}$ This depicted that the treatments where AGMA Bio stimulant granules were applied the organic carbon content was significantly got improved (**Du Jardin, 2015).**

3.3.4 Available Nitrogen (kg/ha), Phosphorous (kg/ha) and Potassium (kg/ha)

The data showing the available nitrogen in rice crop is represented in Table 5. The data clearly showed that the nutrient availability (N, P, K) was significantly improved after application of AGMA bio stimulant granule. The maximum available nitrogen in soil was recorded under T_2 and T_5 treatment, where it was minimum in both the control plots (T_7 and T_8) There were radical change in available phosphorus in the soil where AGMA bio stimulant granule were applied. Same as best availability of potassium was observed in T_2 and T_5 treatment where as it was found minimum in both the control plots i.e. in T_7 and T_8. Thus, it was clearly evident that treatments T_2 and $T_{5\ \text{were}}$ found best in respect of available Nitrogen, Phosphorus and Potassium in all the treatments which are significantly higher in comparison to control plots (T_7 and T8) **(Colla *et al.,* 2017; Calvo *et al.,* 2014**). The graphical representation has been shown in Figure-8.

CONCLUSION

The study demonstrates the significant benefits of integrating AGMA Bio Stimulant Granules with recommended fertilizer doses for rice cultivation. Treatments T2 (100% RDF + AGMA Bio Stimulant Granule at 15 DAT) and T5 (80% RDF + AGMA Bio Stimulant Granule at 15 DAT) increased grain yield by 19% over the Recommended Dose of Fertilizers (RDF) without AGMA granules. This synergistic approach enhances plant physiological processes and growth, contributing to higher yields. Notably, the 20% reduction in chemical fertilizers (NPK) did not compromise productivity, indicating the potential for sustainable nutrient management practices. Furthermore, even a single application of AGMA Bio Stimulant Granules improved soil health, as reflected in increased organic carbon and available nutrient levels while reducing electrical conductivity. Regular use of these granules across cropping seasons could further optimize fertilizer doses and mitigate the adverse effects of excessive chemical input.

This microalgae-based technology offers a dual advantage: delivering quality yields and enhancing soil health, aligning with the principles of sustainable and green agriculture. Its adoption can support farmers in reducing dependency on chemical fertilizers while maintaining productivity, thus contributing to environmentally friendly agricultural practices and long-term soil fertility.

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Table 3: Effect of AGMA Bio stimulant granule (K Max Super, AgroPower Gold, Gallant Gold, Krishi Value) on Growth attributes (Plant height, SPAD, total no. of tillers and effective tillers at harvest, Root mass dry weight).

Sl no.	Treatments	Application Window	Plant height (cm)			SPAD Value		Total no. of tillers	Effective tillers	Root mass Dry weight (g)
			30 DAS	60 DAS	At Harvest	60 DAT	75 DAT			
T1	AGMA BIOSTIMULANT GRANULE+100% NPK	At the time of transplanting	45.87	69.56	101.51	38.84	41.59	8.19	7.47	11.37
T2	AGMA BIOSTIMULANT GRANULE+100% NPK	15DAP	45.91	69.60	101.81	38.85	41.84	8.23	7.64	11.57
T3	AGMA BIOSTIMULANT GRANULE+100% NPK	30DAP	45.91	70.06	101.89	39.43	41.07	8.15	7.30	11.04
T4	AGMA BIOSTIMULANT GRANULE+100% NPK	40DAP	45.04	69.92	101.85	38.03	41.03	7.71	6.81	10.15
T5	AGMA BIOSTIMULANT GRANULE+80% NPK	15DAP	45.82	70.17	101.73	38.26	41.56	8.24	7.74	11.72
T6	AGMA BIOSTIMULANT GRANULE+80% NPK	30DAP	45.87	69.98	100.64	38.99	41.62	8.18	7.18	11.08
T7	CONTROL+100% NPK		44.30	68.81	100.18	37.48	40.08	7.13	6.08	10.01
T8	CONTROL+80% NPK		44.12	68.70	100.28	37.03	39.49	7.07	6.04	9.19
	SE(m)		0.638	0.702	0.792	2.03	2.27	0.44	0.39	0.78
	C.D. (5%)		1.935	2.131	2.403	NS	NS	1.27	1.13	1.98

Table 4. Effect of AGMA Bio stimulant granule (K Max Super, AgroPower Gold, Gallant Gold, Krishi Value) on grain yield, biological yield and test weight.

	Treatments	Application Window	Grain yield (q/ha)	Biological yield (q/ha)	Test weight (g)
T1	AGMA BIOSTIMULANT GRANULE+100% NPK	At the time of transplanting	50.43	115.20	24.19
T2	AGMA BIOSTIMULANT GRANULE+100% NPK	15 days after transplanting	53.91	119.71	24.82
T3	AGMA BIOSTIMULANT GRANULE+100% NPK	30 days after transplanting	52.88	117.77	24.27
T4	AGMA BIOSTIMULANT GRANULE+100% NPK	40 days after transplanting	48.86	111.26	23.88
T5	AGMA BIOSTIMULANT GRANULE+80% NPK	15 days after transplanting	53.85	119.40	24.81
T6	AGMA BIOSTIMULANT GRANULE+80% NPK	30 days after transplanting	53.07	118.31	24.25
T7	CONTROL+100% NPK		45.29	103.62	23.02
T8	CONTROL+80% NPK		43.78	100.04	23.01
	SE(m)		3.21	4.74	1.38
	C.D. (5%)		8.37	11.23	**NS**

Table 5 Effect of AGMA Bio stimulant granule (K Max Super, AgroPower Gold, Gallant Gold, Krishi Value) on Soil pH, EC, Organic Carbon %, Available Nitrogen, Phosphorus and Potassium in soil.

Sl no.	Treatments	Application Window	Soil pH	Soil EC (dS/m)	Organic carbon (%)	Available N (Kg/ha)	Available P(Kg/ha)	Available K (kg/ha)
T1	AGMA BIOSTIMULANT GRANULE+100% NPK	At the time of transplanting	7.74	0.11	0.91	481.75	21.51	191.74
T2	AGMA BIOSTIMULANT GRANULE+100% NPK	15DAP	7.83	0.11	0.98	492.31	25.61	197.36
T3	AGMA BIOSTIMULANT GRANULE+100% NPK	30DAP	7.76	0.12	0.91	482.63	24.32	193.18
T4	AGMA BIOSTIMULANT GRANULE+100% NPK	40DAP	7.84	0.13	0.88	478.65	20.16	184.61
T5	AGMA BIOSTIMULANT GRANULE+80% NPK	15DAP	7.93	0.11	0.97	491.69	25.55	196.29
T6	AGMA BIOSTIMULANT GRANULE+80% NPK	30DAP	7.75	0.11	0.91	481.55	24.05	192.37
T7	CONTROL+100% NPK		7.84	0.14	0.81	447.92	18.17	182.64
T8	CONTROL+80% NPK		7.86	0.14	0.80	431.42	17.13	180.15
	SE(m)		0.23	0.00	0.04	22.20	1.24	8.77
	C.D. (5%)		NS	NS	0.13	63.37 63.37	3.63 3. 63	24.31 24.31

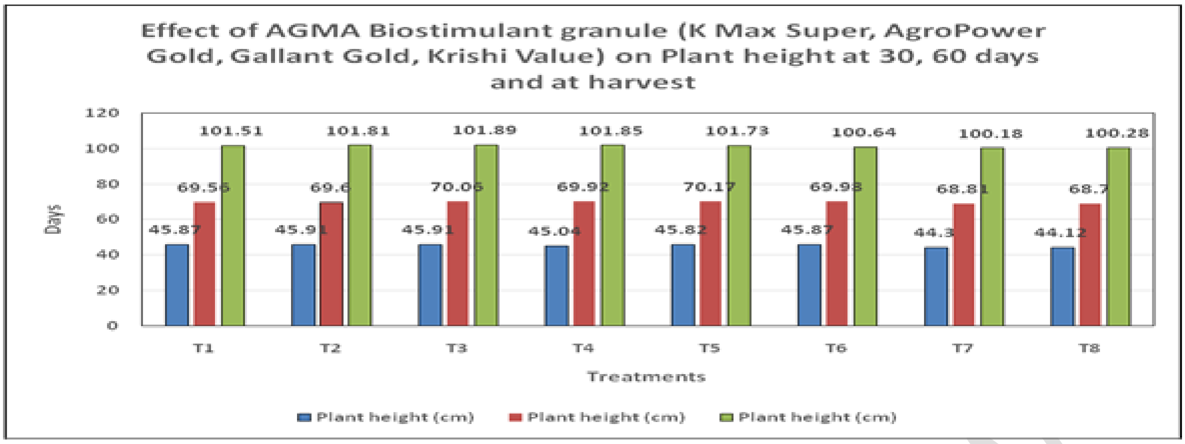

Fig 3. Effect of AGMA Bio stimulant granule on Plant height at 30, 60 days and at harvest.

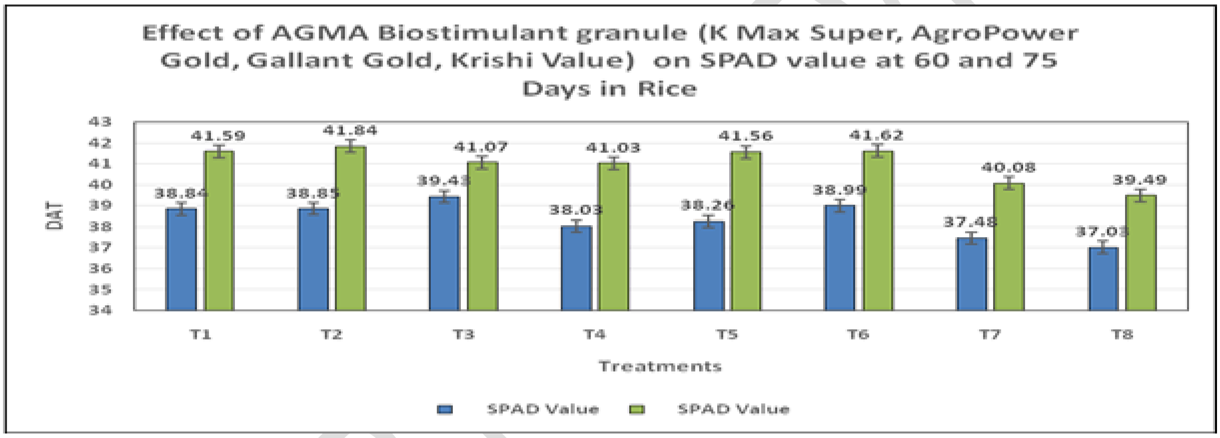

Fig 4. Effect of AGMA Bio stimulant granule on SPAD value at 60 and 75 Days in Rice.

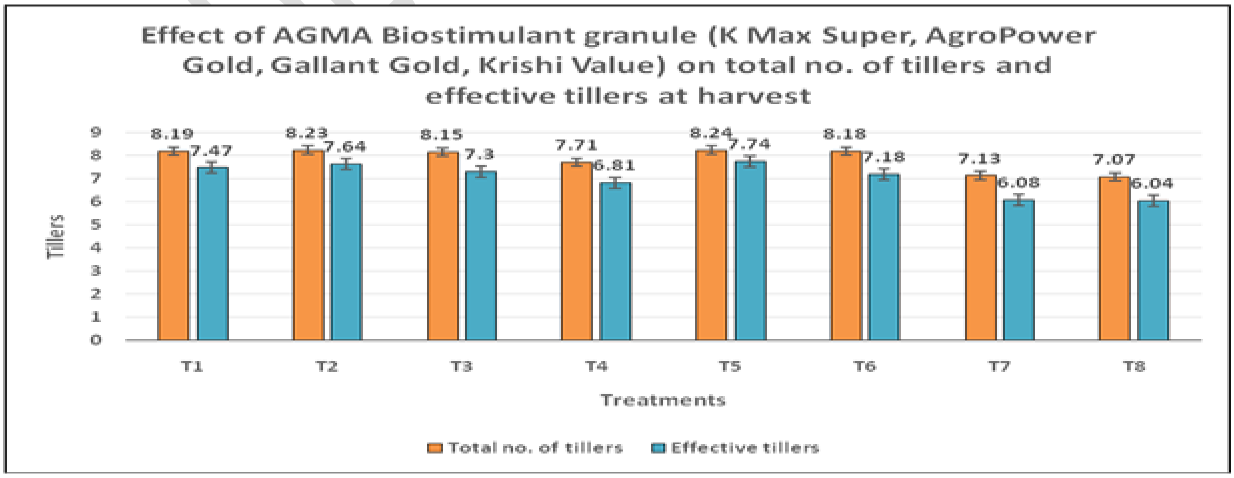

Fig 5. Effect of AGMA Biostimulant granules on total no. of tillers and effective tillers at harvest.

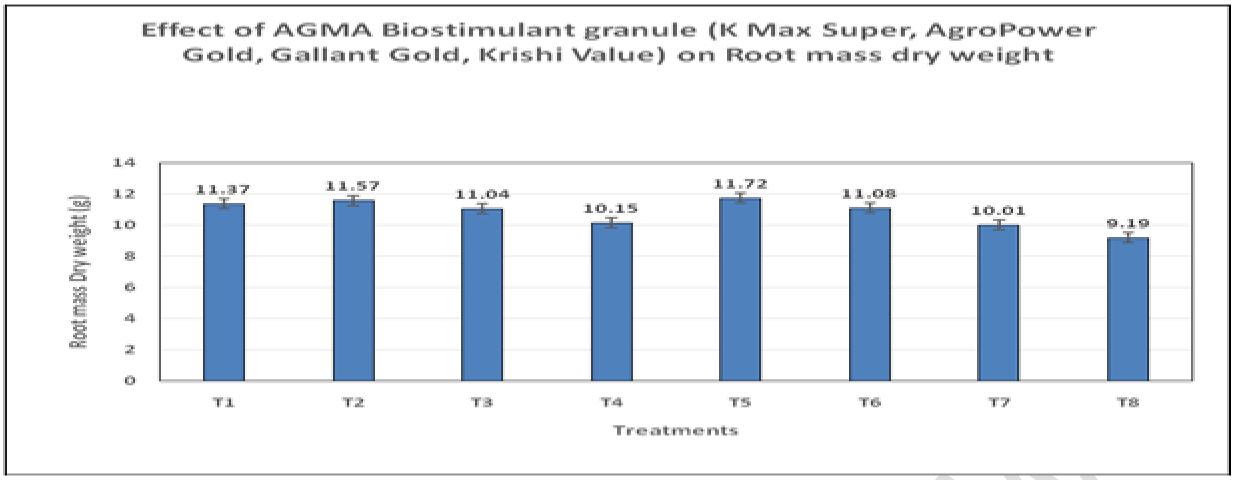

Fig 6. Effect of AGMA Biostimulant granule on Root mass dry weight.

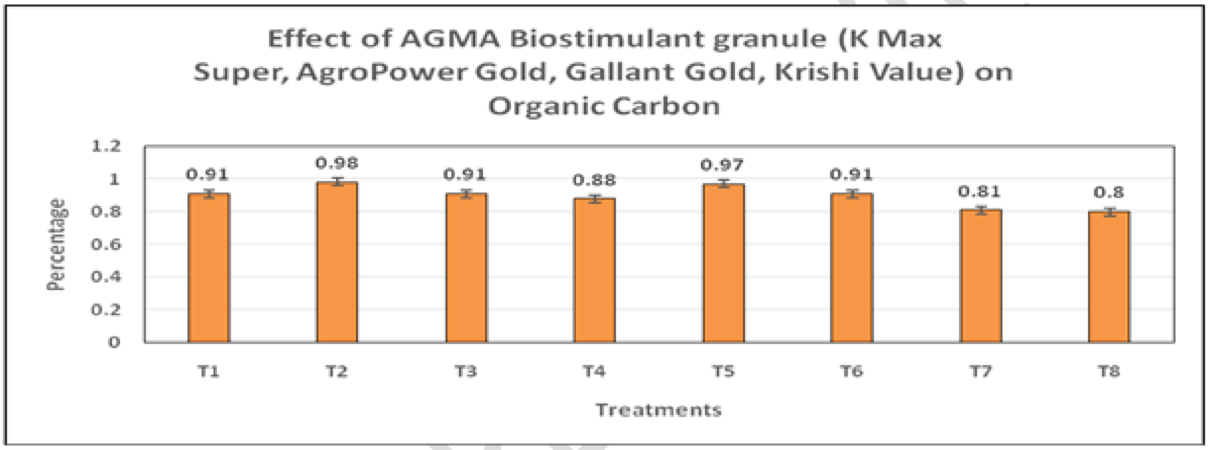

Fig. 7 Effect of AGMA Biostimulant granule on Organic Carbon.

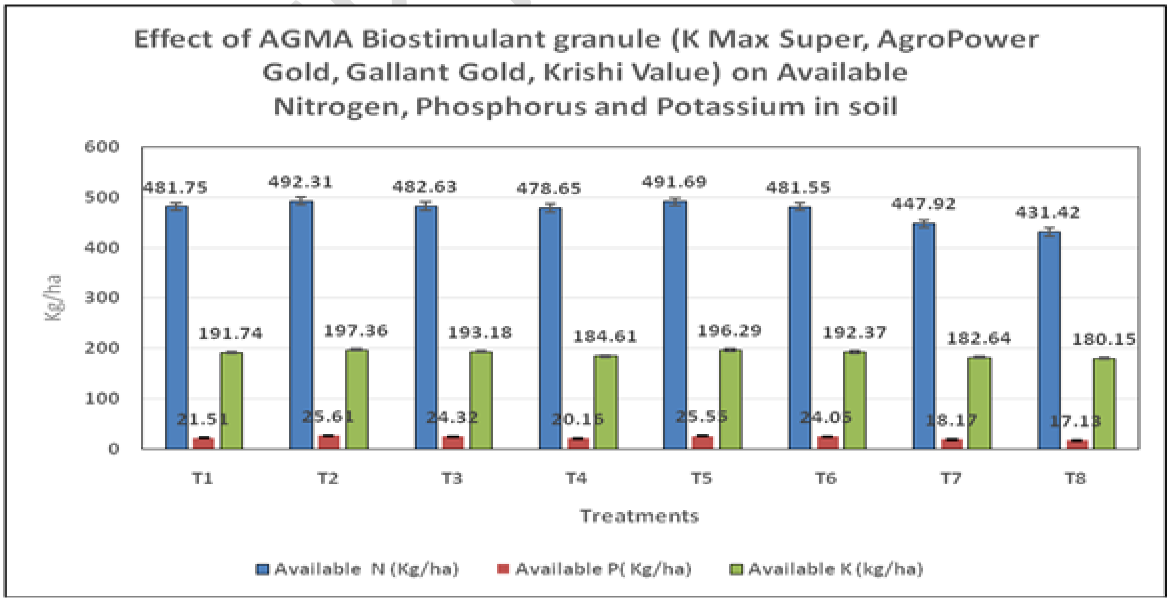

Fig. 8 Effect of AGMA Biostimulant granule on Available Nitrogen, Phosphorus and Potassium in soil.