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Short communication

Enhancing growth and productivity of rice (*Oryza sativa* L.) using biostimulant 'Armurox'

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Abstract

A field experiment was undertaken during *kharif* 2023 to study the efficacy of biostimulant - Armurox in rice, comprising of eleven treatments *i.e.* single spray at tillering or two sprays at tillering and boot leaf stages at 500, 750, 1000 and 1250 ml ha^{-1} along with two sprays of 1500 and 2000 ml ha^{-1} and control treatment (water spray) following randomized complete block design, replicated thrice. Double spray of Armurox @ 1000, 1250, 1500 and 2000 ml ha^{-1}at tillering and boot leaf stage recorded more plant height and dry matter accumulation at 60 days after transplanting (DAT), 90 DAT and harvest stage, but significantly better than control. Similar trends were recorded for CGR (30-60 and 60-90 DAT) and grain yield. Thus, double spray of Armurox at1000 ml ha^{-1}may help to improve rice growth and yield.

Keywords: Armurox, biostimulant, growth parameters, rice

Rice is the staple food for a significant portion of India's population, and in 2021–22, it was grown on an area of 46.38 million hectares, yielding a total production of 130.29 million tonnes with an average productivity of 2809 kg/ha (Anonymous 2023a). While in Himachal Pradesh, during the year 2021-22, rice was cultivated over an area of 66.16 thousand hectares, with a total production of 167.52 thousand metric tonnes (Anonymous 2023b).

Farmers rely heavily on this crop for their food security, but the low production levels require immediate attention (Sharma *et al*. 2015). The demand for rice in India is growing every year and it is estimated that by 2025, the requirement would be 140 million tonnes (Duttarganvi *et al*. 2016). For years farmers have relied on chemical fertilizers for increasing production of crops because their use has boosted agricultural productivity, helping ensure global food security, particularly in developing countries. However, the overuse of chemical fertilizers also leads to serious environmental degradation, greenhouse gas emission and soil quality deterioration (Sharma *et al*. 2018). A key strategy to enhance crop production and productivity while protecting the environment is the application of biostimulants (Bulgari *et al*. 2015).

A plant biostimulant is a substance or microorganism used to improve plant nutrition, help plants to cope with stress, and enhance crop quality, without depending on its nutrient content (Du Jardin 2015). Armurox is a new biostimulant formulated by Godrej Agrovet Ltd. which contains soluble silicon and free amino acids that boosts silicium absorption and its concentration in leaves. Silicon (Si) enhances canopy photosynthesis by keeping leaf blades erect, improving light interception (Tamai and Ma 2008).

The experiment was conducted on the Research Farm of the Department of Agronomy, College of Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (H.P.) during the *kharif* season of 2023.The Research Farm is in the North-Western Himalayas at 32°09' N latitude, 76°54' E longitude and at 1290 m above mean sea level. This region represents the sub humid mid-hills zone of

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Himachal Pradesh and is characterized by a wet and temperate climate. The soil of the experimental site was silty clay loam in texture, acidic in reaction and was rated as medium in available nitrogen, phosphorus and potassium.

The experiment was laid out in Randomized Complete Block Design comprising of eleven treatments *viz*., T_1 – 500 ml/ha (one spray at tillering stage), T_2 – 750 ml/ha (one spray at tillering stage), T_3 – 1000 ml/ha (one spray at tillering stage), T_4 – 1250 ml/ha (one spray at tillering stage), T_5 – 500 ml/ha (two sprays at tillering and boot leaf stages), T_6 – 750 ml/ha (two sprays at tillering and boot leaf stages), T_7 – 1000 ml/ha (two sprays at tillering and boot leaf stages), T_8 – 1250 ml/ha (two sprays at tillering and boot leaf stages), T_9 – 1500 ml/ha (two sprays at tillering and boot leaf stages), T_{10} – 2000 ml/ha (two sprays at tillering and boot leaf stages) and T_{11} – control (water spray). The crop was raised with recommended package of practices while using hybrid PAC 807$^+$ in the investigation. The data was recorded on plant height and dry matter accumulation at periodic intervals and at harvest and were used to calculate crop growth rate (CGR) and relative growth rate (RGR) using standard formulas. Data was analysed using analysis of variance technique as enshrined by Gomez and Gomez (1984).

An increase in plant height was observed due to increase in the concentration of Armurox up to 1250 ml ha^{-1} applied twice at tillering and boot leaf stages at all the dates of observation (Table 1). However, further increase in concentration to 1500 and 2000 ml ha^{-1} did not significantly increase the plant height. The lowest plant height was observed in the control treatment of water spray.

The significant increase in plant height with this biostimulant is likely due to its silicon and amino acid content. Amino acids promote cell division and elongation, influencing plant height and acting as precursors to phyto - hormones like auxins, which regulate stem growth. Silicon enhances water and nutrient uptake, boosts chlorophyll production, and improves photosynthesis efficiency, further contributing to increased plant height. Sood *et al*. (2024) have also reported similar results in rice using amino acid based biostimulant. Similarly, Hassan *et al*. (2019) observed significantly taller maize plants with the use of Armurox.

Highest dry accumulation occurred with the double application of Armurox at 1250 ml ha^{-1}, but statistically it was similar to double applications at 750, 1000, 1500, and 2000 ml ha^{-1}, as well as single applications at 1000 and 1250 ml ha^{-1} at all the dates of observation. Both single and double application rates produced similar results, while the control (water only) showed significantly lower dry matter. The increase in dry

Table1. Effect of application of Armuroxon the plant height and dry matter accumulation at periodic intervals and at harvest in rice

Treatments	Dose (ml ha^{-1})	Plant height (cm)				Dry matter accumulation (g m^{-2})			
		30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest
T1: Armurox*	500	57.8	78.4	87.6	92.6	82.9	399.1	805.9	899.5
T2: Armurox *	750	58.2	80.4	90.9	94.5	84.7	414.8	830.7	934.8
T3: Armurox *	1000	58.9	82.2	91.5	95.2	85.9	421.7	847.3	961.4
T4: Armurox *	1250	59.4	84.6	92.3	95.7	86.7	425.2	862.0	976.1
T5: Armurox #	500	59.6	81.9	93.1	96.3	84.3	414.7	864.6	979.5
T6: Armurox #	750	60.2	82.9	95.2	98.4	85.2	428.7	901.5	1024.6
T7: Armurox #	1000	60.5	84.4	97.4	101.5	86.9	439.8	936.9	1069.7
T8: Armurox #	1250	60.6	86.9	100.8	104.9	87.3	443.5	950.1	1085.0
T9: Armurox #	1500	60.8	85.7	99.0	103.2	88.8	440.0	944.8	1070.7
T10: Armurox #	2000	60.4	84.5	98.7	102.8	86.5	440.9	947.5	1078.0
T11: Control (Water Spray)	-	57.1	74.7	86.0	90.4	81.2	379.2	724.9	818.8
SEm±		0.91	1.32	1.5	1.6	2.6	7.5	16.8	21.1
CD (P=0.05)		NS	3.9	4.4	4.7	NS	22.0	49.4	62.3

* Single spray at tillering stage # Double spray at tillering and boot leaf stages

matter accumulation may result from silicon's positive effect on enzymatic activity and its role in adjusting leaf inclination to enhance sunlight absorption (Hassan *et al*. 2019). This likely led to larger leaf area, higher chlorophyll production, and improved photosynthesis. Additionally, the amino acids in the biostimulant Armurox may have boosted enzymatic activity, promoted protein synthesis and resulted in greater biomass production.

The crop growth rate (CGR) indicated that CGR values were higher between 60 and 90 days after transplanting (DAT) compared to the period between 30 and 60 DAT (Table 2). This implies that dry matter accumulated was more during the 60 to 90 DAT period. Significantly higher CGR at 30-60 DAT was recorded when double application of Armurox at 1250 ml ha^{-1} at tillering and boot leaf was done though this treatment was at par with double application rates of this biostimulant at rates of 750 ml ha^{-1}, 1000 ml ha^{-1}, 1500ml ha^{-1} and 2000 ml ha^{-1}. Similarly, significantly higher CGR during 60-90 DAT was recorded with double application of this biostimulant at 1250 ml ha^{-1} at tillering and boot leaf stages, remaining at par with double application doses of 1000 ml ha^{-1},1500ml ha^{-1} and 2000ml ha^{-1}.

Amino acids present in Armurox play a crucial role in enhancing crop growth by promoting nitrogen absorption and ultimately protein synthesis, which supports vital physiological processes in rice. Also, presence of silicon in this biostimulant improves structural integrity and optimizes leaf inclination, enhancing light absorption and photosynthesis. Together, they boost enzymatic activity and nutrient efficiency, resulting in higher crop growth rates. Sood *et al*. (2024) obtained similar results with the application of amino acid based biostimulant.

A detailed analysis of the data revealed that this biostimulant had no significant impact on the relative growth rate between 30 and 60 DAT. However, its effect became significant during the 60 to 90 DAT period. Significantly higher RGR between 60 and 90 DAT were recorded with double application of this biostimulant at 1500 ml ha^{-1} at tillering and boot leaf stages though this treatment was statistically at par with double application doses of 750 ml ha^{-1}, 1000 ml ha^{-1}, 1500 ml ha^{-1} and 2000 ml ha^{-1}. The increase could be attributed to enhanced photosynthetic efficiency, as biostimulants are known to improve chlorophyll content and boost the photosynthetic rate (Calvo *et al*. 2014). These results are in conformity with Sood et al. (2024).

The grain yield of rice as shown in Table 2 was significantly impacted by the application of biostimulant Armurox with double application of this biostimulant @ 1250 ml ha^{-1}at tillering and boot leaf stages, remaining at par with double application at doses of 1000 ml ha^{-1}, 1500 ml ha^{-1} and 2000 ml ha^{-1}, recorded significantly higher grain yield. The control

Table 2. Effect of application of Armurox on the Crop Growth Rate (CGR), Relative Growth Rate (RGR) and grain yield of rice at periodic intervals

Treatment	Dose (ml ha^{-1})	CGR(30-60 DAT) (g m^{-2} day^{-1})	CGR(60-90 DAT) (g m^{-2} day^{-1})	RGR(30-60 DAT) (mg g^{-1} day^{-1})	RGR(60-90 DAT) (mg g^{-1} day^{-1})	Grain Yield (q ha^{-1})
T_1	500*	10.34	13.73	51.56	23.85	42.27
T_2	750*	10.82	14.03	52.36	23.55	44.16
T_3	1000*	10.85	14.52	52.16	24.06	45.50
T_4	1250*	11.08	14.76	52.45	24.03	46.49
T_5	500#	11.01	15.00	53.03	24.49	46.36
T_6	750#	11.43	15.76	53.62	24.78	48.44
T_7	1000#	11.78	16.57	54.28	25.21	51.06
T_8	1250#	11.88	16.89	54.25	25.40	51.34
T_9	1500#	11.78	16.83	54.14	25.54	51.12
T_{10}	2000#	11.81	16.54	54.29	25.49	51.26
T_{11}: Control	(Water Spray)	9.88	11.52	50.69	21.60	38.16
SEm±		0.17	0.29	0.87	0.34	0.97
CD (P=0.05)		0.51	0.85	NS	0.99	2.81

* Single spray at tillering stage # Double spray at tillering and boot leaf stages

treatment in which water was sprayed recorded significantly lower grain yield. The double application also proved better than the single application of this biostimulant.

Conclusion

From the present study, it can be concluded that application of Armurox, a biostimulant that contained silicon and amino acids can be used to enhance the productivity of rice crop. Double application of this biostimulant 1000 ml ha^{-1} resulted in better growth of rice leading to higher productivity of rice.

Conflict of interest: Authors declare no competing interest.

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