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Effect of foliar spray of biostimulants on growth of transplanted rice (*Oryza sativa*)

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Abstract

A field experiment was conducted during *kharif* 2022 at the Experimental Farm of CSKHPKV, Palampur (H.P.) to study the effects of foliar spray of biostimulants on the growth of transplanted rice. The experiment which was conducted in Randomized Complete Block Design with thirteen treatments, replicated three times, revealed significant growth improvements with biostimulants *viz.*, Terra-Sorb complex, *jeevamrit*, and *panchagavya*. Specifically, a double spray of Terra-Sorb complex 1250 ml ha^{-1} (T_8) increased plant height by 20.7% at 90 days after transplanting (DAT) and 20.2% at harvest compared to the control. Statistically similar results were observed with treatments of 1000 ml ha^{-1}(T_7), 1500 ml ha^{-1}(T_9), and 2000 ml ha^{-1}(T_{10}) doses. Additionally, T_8 enhanced crop growth rates (CGR) by 10.8% (CGR_1) and CGR_2 by 24.5% over the control. A double spray of Terra-Sorb complex 1000 ml ha^{-1}(T_7) is recommended as an optimal dose for improving rice growth.

Keywords: Terra-Sorb complex, *jeevamrit, panchagavya*, biostimulants, transplanted rice, growth parameters

Rice (*Oryza sativa* L.) maintains a prominent position among the world's major food crops because of its greater tolerance to edaphic, climatic, and cultural conditions. More than 100 countries produce rice worldwide, with Asia producing and consuming more than 90 % of the world's rice (Fukagawa and Ziska 2019). In India, rice is cultivated over an area of about 45.77 million ha, yielding a total of 124.37 million tonnes and an average productivity of 2717 kg ha^{-1} (Anonymous 2022a). It is a staple food for majority of the population of Himachal Pradesh (Manuja *et al*. 2015) where it covers 10 % of the total area devoted to cereal production and holds third position in terms of acreage (Anonymous 2022b).

The farmers realize much of their food security from this crop but the low production level needs urgent attention (Sharma *et al*. 2015). Further, India's population is growing rapidly; however, in order to meet the demands of this growing population, we must increase global rice production to 160 million tonnes by 2030 (Mishra *et al*. 2013). Unfortunately, this has increased the reliance of the agricultural sector on chemical fertilisers, degrading the natural resources, particularly the soil and groundwater (Sharma and Sharma 2016; Sharma *et al*. 2003). One of the strategies that can be used to boost crop production and productivity without endangering the environment, is the use of biostimulants (Bulgari *et al*. 2015).

Any microbe or substance given to plants with the intention of enhancing nutritional efficiency, providing tolerance for different types of abiotic stresses, and/or enhancing crop quality attributes is referred to as a plant biostimulant (Jardin 2015). In this quest, "Terra-Sorb complex" is a foliar based new biostimulant spray which is made of L-amino acids and can play a crucial role in plant signaling, C: N metabolism, enhancing ion transport, promoting photosynthesis and encouraging stress tolerance. This product contains a significant amount of free amino acids and a fully balanced proportion of micronutrients (Kocira 2019).

Additionally, cow- based formulations, *viz*., *jeevamrit* and *panchagavya* have been advocated to be used in various crops especially under organic/ natural farming conditions. These act as biostimulants that enhance the nutrient status of the soil and improve crop

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yields (Maity *et al.* 2020).

Materials and Methods

The experiment was conducted at the Research Farm of Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. It is located in the North-Western Himalayas at 32°09' N latitude, 76°54' E longitude and 1290 m above mean sea level. The experiment comprised of thirteen treatments, viz., single spray of Terra-Sorb complex @ 500 ml ha^{-1}[T_1], 750 ml ha^{-1} [T_2], 1000 ml ha^{-1}[T_3] and 1250 ml ha^{-1}[T_4] each at tillering stage, double spray of Terra-Sorb complex @ 500 ml ha^{-1} [T_5], 750 ml ha^{-1} [T_6], 1000 ml ha^{-1} [T_7], 1250 ml ha^{-1} [T_8], 1500 ml ha^{-1}[T_9] and 2000 ml ha^{-1} [T_{10}]) at tillering and boot leaf stages, double spray of *jeevamrit* @ 10 % [T_{11}] at tillering and boot leaf stages, double spray of *panchagavya* @ 5 % [T_{12}] at tillering and boot leaf stages and control [water spray (T_{13})].

During the experimental period, the mean weekly maximum temperature ranged between 34.2°C in the 23rd standard week (4-10 June) and 24.2°C in the 41st standard week (8-14 October). Furthermore, the total rainfall received during the cropping season was 1852.6 mm. The physico-chemical properties of the experimental site have been presented in Table 1.

Data on various parameters were statistically analysed using the method proposed by Gomez and Gomez (1984). The critical difference (CD) was calculated for parameters whose effects were significant at the 5% confidence level.

Table 1. Physico-chemical properties of the soil (0-15 cm) of experimental site

Soil property	Average values
Texture	Silty clay loam
Organic Carbon (g kg^{-1})	7.21
pH	5.6
EC (dsm^{-1})	0.062
Available nitrogen (kg ha^{-1})	287.2
Available phosphorus (kg ha^{-1})	23.2
Available potassium (kg ha^{-1})	246.1

Results and Discussion

Plant height (cm)

A close analysis of the data presented in Table 2 reveals that administration of biostimulants did not significantly affect the plant height at 30 DAT but thereafter, the increase was significant at 60 DAT, 90 DAT and at harvest. At 60 DAT, double spray of Terra-Sorb complex @ 1250 ml ha^{-1} at tillering and boot-leaf stages (T_8) produced significantly taller plants (85.3 cm), though the treatment was at par with double spray of Terra-Sorb complex @ 1000 ml ha^{-1} (T_7), 1500 ml ha^{-1} (T_9) and 2000 ml ha^{-1} (T_{10}) at both the stages and single spray of Terra-Sorb complex @ 1250 ml ha^{-1} at tillering stage only (T_4). Significantly lower plant height was observed in control plots (T_{13}) which was statistically at par with the single spray of Terra-Sorb complex @ 500 ml ha^{-1} (T_1). At 90 DAT and at harvest significantly higher plant height (101.0 cm and 104.8 cm, respectively) was observed with the double spray of Terra-Sorb complex @ 1250 ml ha^{-1} (T_8), though this

Table 2. Effect of biostimulants on plant height (cm) of rice at periodic intervals

Treatments	30 DAT	60 DAT	90 DAT	At harvest
T_1: Terra-Sorb complex (500 ml ha^{-1})*	55.3	75.4	88.2	92.2
T_2: Terra-Sorb complex (750 ml ha^{-1})*	56.3	78.4	92.7	95.1
T_3: Terra-Sorb complex (1000 ml ha^{-1})*	56.3	81.2	93.3	96.3
T_4: Terra-Sorb complex (1250 ml ha^{-1})*	56.7	83.5	94.1	97.6
T_5: Terra-Sorb complex (500 ml ha^{-1})**	55.2	79.8	93.6	96.5
T_6: Terra-Sorb complex (750 ml ha^{-1})**	56.2	80.5	95.2	99.7
T_7: Terra-Sorb complex (1000 ml ha^{-1})**	57.3	83.5	97.8	101.4
T_8: Terra-Sorb complex (1250 ml ha^{-1})**	56.9	85.3	101.0	104.8
T_9: Terra-Sorb complex (1500 ml ha^{-1})**	56.0	83.7	98.7	102.3
T_{10}: Terra-Sorb complex (2000 ml ha^{-1})**	57.3	84.6	99.5	103.7
T_{11}: Jeevamrit (10 %)**	54.5	81.3	94.6	97.7
T_{12}: Panchagavya (5 %)**	55.8	81.4	95.2	98.1
T_{13}: Control (Water spray)	54.1	74.5	83.7	87.2
SEm±	1.1	1.3	1.5	1.6
CD (P=0.05)	NS	3.8	4.4	4.7

*Application at tillering stage ** Application at tillering and boot-leaf stages
DAT- Days after transplanting

treatment was at par with the double spray of Terra-Sorb complex @ 1000 ml ha^{-1} (T_7), 1500 ml ha^{-1} (T_9) and 2000 ml ha^{-1} (T_{10}). Control treatment showed significantly lowest plant height (83.7 cm and 87.2 cm), at 90 DAT and at harvest, respectively. No significant increase in plant height observed at 30 DAT could be attributed to the first spray of biostimulants being done at 28 DAT, which might have not reflected on plant height.

The increase in plant height at 60 and 90 DAT and at harvest could be a result of amino acids present in Terra-Sorb complex. Amino acids being building blocks of proteins, act as precursors of plant hormones like gibberellin and auxins which might have stimulated internode and cell elongation. Similarly, higher plant height in wheat was recorded when supplied with amino acids due to their possible roles in cell enlargement and division (Navarro *et al*. 2021; Ghodake *et al*. 2022).

Crop Growth Rate (g m^{-2} day^{-1})

Data pertaining to crop growth rate (CGR) have been presented in Table 3. A close perusal of data revealed that CGR values were higher between 60 and 90 DAT than between 30 and 60 DAT, indicating that greater dry matter build-up occurred between 60 and 90 DAT. Significantly higher CGR_1(11.59 g m^{-2} day^{-1}) was recorded in T_8 with spray of Terra-Sorb complex @ 1250 ml ha^{-1} each at tillering and boot-leaf stages which was, however, at par with all other treatments except T_1 (single spray of Terra-Sorb complex@ 500 ml ha^{-1} at tillering stage) and control.

Significantly lower CGR_1 was observed under control though it was at par with T_1, T_2, T_5, T_6, T_{11} and T_{12}. Similarly, significantly higher CGR_2 (18.81 g m^{-2} day^{-1}) was recorded in T_8 (spray of Terra-Sorb complex @ 1250 ml ha^{-1} each at tillering and boot-leaf stages) which was statistically at par with spray of Terra-Sorb complex @ 1000 ml ha^{-1} (T_7), 1500 ml ha^{-1} (T_9) and 2000 ml ha^{-1} (T_{10}) at both the stages. Terra-Sorb complex contains free amino acids, which not only provided the plants with organic nitrogen but also promoted nitrogen absorption and assimilation. This enhanced leaf nitrogen content may have increased photosynthesis and photosynthate translocation, resulting in higher plant biomass (Colla *et al*. 2014) and growth, therefore, resulting in higher crop growth rate. Similar results were obtained with the application of seaweed based biostimulants by Nayak *et al*. (2020).

Table 3. Effect of biostimulants on CGR of rice at periodic intervals

Treatments	CGR_1(g m^{-2} day^{-1})	CGR_2(g m^{-2} day^{-1})
T_1: Terra-Sorb complex (500 ml ha^{-1})*	10.88	14.97
T_2: Terra-Sorb complex (750 ml ha^{-1})*	11.04	15.52
T_3: Terra-Sorb complex (1000 ml ha^{-1})*	11.29	15.59
T_4: Terra-Sorb complex (1250 ml ha^{-1})*	11.48	15.70
T_5: Terra-Sorb complex (500 ml ha^{-1})**	10.96	16.86
T_6: Terra-Sorb complex (750 ml ha^{-1})**	11.03	17.00
T_7: Terra-Sorb complex (1000 ml ha^{-1})**	11.38	18.68
T_8: Terra-Sorb complex (1250 ml ha^{-1})**	11.59	18.81
T_9: Terra-Sorb complex (1500 ml ha^{-1})**	11.54	18.42
T_{10}: Terra-Sorb complex (2000 ml ha^{-1})**	11.56	18.59
T_{11}: *Jeevamrit* (10 %)**	10.97	16.86
T_{12}: *Panchagavya* (5 %)**	11.07	17.04
T_{13}: Control (Water spray)	10.46	15.11
SEm±	0.22	0.39
CD (P=0.05)	0.63	1.13

*Application at tillering stage ** Application at tillering and boot-leaf stages

CGR_1: Crop growth rate from 30 to 60 DAT, CGR_2: Crop growth rate from 60 to 90 DAT

Relative Growth Rate (mg g^{-1} day^{-1})

A close perusal of data (Table 4) revealed that the applied biostimulants did not significantly affect the relative growth rate from 30 to 60 DAT (RGR_1) but thereafter, the effect was significant from 60 to 90 DAT. Significantly higher RGR_2 was obtained with double spray of Terra-Sorb complex @ 750 ml ha^{-1} (28.8 mg g^{-1} day^{-1}) which was at par with T_5, T_6, T_8, T_9, T_{10}, T_{11} and T_{12}. The reason for this increase could be the enhancement of photosynthetic efficiency, as biostimulants have been shown to improve chlorophyll content and photosynthetic rate (Calvo *et al.* 2014).

Conclusion

The field experiment demonstrated that the administration of biostimulants, particularly the double spray of Terra-Sorb complex at 1250 mlha^{-1}, significantly improved plant height and crop growth rate (CGR) of rice, especially from 60 DAT onwards. At 60, 90 DAT, and harvest, Terra-Sorb complex treatments resulted in significantly taller plants and higher CGR compared to control. The increase in plant height and CGR was attributed to the amino acids in Terra-Sorb complex, which promote hormone production and enhance nitrogen absorption and assimilation, thereby improving photosynthesis and biomass accumulation. Relative growth rate (RGR) also improved significantly from 60 to 90 DAT with the application of Terra-Sorb complex, highlighting its effectiveness. Consequently, a double spray of Terra-Sorb complex at 1000 mlha^{-1}is recommended for optimal rice growth.

Table 4. Effect of biostimulants on RGR of rice at periodic intervals

Treatments	RGR_1 (mg g^{-1} day^{-1})	RGR_2 (mg g^{-1} day^{-1})
T_1: Terra-Sorb complex (500 ml ha^{-1})*	60.38	25.56
T_2: Terra-Sorb complex (750 ml ha^{-1})*	60.81	25.94
T_3: Terra-Sorb complex (1000 ml ha^{-1})*	60.85	25.64
T_4: Terra-Sorb complex (1250 ml ha^{-1})*	61.14	25.49
T_5: Terra-Sorb complex (500 ml ha^{-1})**	59.98	27.54
T_6: Terra-Sorb complex (750 ml ha^{-1})**	59.65	27.52
T_7: Terra-Sorb complex (1000 ml ha^{-1})**	60.76	28.80
T_8: Terra-Sorb complex (1250 ml ha^{-1})**	61.43	28.69
T_9: Terra-Sorb complex (1500 ml ha^{-1})**	61.24	28.35
T_{10}: Terra-Sorb complex (2000 ml ha^{-1})**	62.25	28.61
T_{11}: *Jeevamrit* (10 %)**	60.15	27.55
T_{12}: *Panchagavya* (5 %)**	61.07	27.66
T_{13}: Control (Water spray)	59.93	26.38
SEm±	1.81	0.62
CD (P=0.05)	NS	1.81

*Application at tillering stage ** Application at tillering and boot-leaf stages

RGR_1: Relative growth rate from 30 to 60 DAT, RGR_2: Relative growth rate from 60 to 90 DAT

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