

Physiological as Well as Growth Parameters of Basmati Rice (*Oryza sativa* L.) as Affected by Growth Regulators

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Authors' contributions

This research work was carried out in collaboration among all authors. Author LP designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Plant Growth regulators (PGRs) are known to improve physiological efficiency including the photosynthetic ability of plants and offer a significant role in realizing higher crop yields. It affects the physiological characters such as plant height, number of effective tillers per plant, number of leaves per plant, RWC, Chlorophyll Intensity and growth parameters such as CGR, RGR, and NAR of Basmati rice. The plants were foliar sprayed with PGRs (IAA, Kinetin, CCC, SADH and Ascorbic Acid) at tillering and before anthesis stage. Results showed a conspicuous increase in growth traits in treated plants. All the traits described above were significantly improved by the treatment of IAA.

Keywords: Foliar application; growth regulators; basmati rice; physiological characters.

1. INTRODUCTION

Basmati rice is known as king of rice, also the oldest, common progenitor for most types and priced for its characteristic long-grain, subtle aroma and delicious taste. It is one of the major agricultural commodities. It is the world's most sought-after rice, fetching up to 10 times more than common rice in international markets. India occupies total area for the cultivation of Basmati rice is of about 2 million ha and is the leading producer and exporter to the global market of the world but low yield is a major cause to prohibit the public demand. So, it is very important to ensure constant availability. To enhance the yield, numerous growth regulators have been used in agriculture, however, their impact has been relatively little and their application is limited to some specific objectives such as quality and quantity improvement. Although, PGRs are synthesized indigenously by plants; though, several studies show that plant can respond to exogenously applied growth regulators. Exogenous application of PGRs affects the endogenous hormonal pattern of the plant, either by supplementation of sub-optimal levels or by interaction with their synthesis, translocation or inactivation of existing hormone levels. It plays vital roles in the coordination of many growths and behavioural processes in plant, which regulates the amount, type and direction of plant growth. These regulators are also known to enhance the source-sink relationship and stimulate the translocation of photo-assimilates, thereby, increasing productivity. Therefore, an attempt was made to find out how, the certain growth-regulating substances with their various concentrations influence the physiology of Basmati Rice. So, different levels of exogenous plant growth regulators (Indole-3-acetic acid (IAA), Kinetin, Chlormequat Chloride (CCC), Succinic acid 2,2-dimethyl hydrazide (SADH) and Ascorbic Acid were used at two growth stages of basmati rice (*Oryza sativa* L.) in this investigation.

2. MATERIALS AND METHODS

The experiment was conducted during *Kharif* season, 2014. The treatments were, Indole-3-acetic acid (25,50 ppm), Kinetin (5,10 ppm), Chlormequat Chloride (2000,4000 ppm), Succinic acid 2,2-dimethyl hydrazide (1000,3000 ppm), Ascorbic Acid (50,100 ppm). Randomized Block Design (RBD) was used to assess the significance level with three replicates of each treatment.

The Standard error and value of Critical Difference were calculated as:

$$\text{StandardError(Diff.)} = \sqrt{\frac{2V_e}{r}}$$

Where, V_e = Error variance, r = Number of Replication

$$\text{C.D. At 5\% (P)} = \text{S.E. (diff)} \times \text{t-value (at 5\% Error degree of freedom)}$$

Where, P = Probability

2.1 Relative Water Content (RWC) (%)

RWC is probably the most appropriate measure of plant water status in terms of the physiological consequence of cellular water deficit. It was calculated by the formula given below;

$$\text{RWC (\%)} = \frac{(W-DW) \times 100}{(TW-DW)}$$

Where, W = Sample Fresh Weight (mg), DW = Sample Dry Weight (mg), TW = Sample Turgid Weight (mg)

2.2 Chlorophyll Intensity of Leaves (%)

It was recorded by the device: Chlorophyll Meter Model: SPAD- 502 PLUS and expressed in per cent.

3. RESULTS AND DISCUSSION

Foliar spray of growth regulators brought about significant changes in plant height. A multivariate statistical test has been used to carried out the data interpretation. It has been concluded that IAA 25 and 50 ppm and Kinetin 5 and 10 ppm promoted the plant height. Ascorbic Acid 100 ppm also gave a significant result. This increment in plant height is mainly due to stimulation of cell division and increase in the plasticity of cells [1-3].

Number of tillers per plant increased with the advancement of the crop stages in case of all growth regulators against control. More number of tillers per plant was mainly extended by the foliar spray of IAA 50 ppm followed by CCC 2000 ppm. IAA 25 ppm and Ascorbic Acid 50 and 100 ppm has also an uplifting effect on tiller number. Other hormones also supporting this character. Untreated plant possessed less number of tillers per plant in comparison to treated plants [1,4,2,5].

Table 1. Influence of various growth regulators on plant height (cm), number of tillers/plant, number of leaves/plant and relative water content (%) of basmati rice at maturity

S. No.	Treatments	Plant Height (cm)	Number of Tillers/plant	Number of Leaves/plant	Relative water content (%)
1	Control	60.08	6.98	42.61	58.12
2	IAA 25 ppm	73.84	9.89	58.72	63.61
3	IAA 50 ppm	76.90	10.95	60.47	64.89
4	KN 5 ppm	68.76	7.51	51.59	62.57
5	KN 10 ppm	71.56	8.89	53.39	62.35
6	CCC 2000 ppm	60.02	9.53	53.56	60.13
7	CCC 4000 ppm	62.68	8.84	50.39	61.43
8	SADH 1000 ppm	56.50	9.87	57.55	61.28
9	SADH 3000 ppm	58.37	8.53	54.62	61.41
10	Ascorbic Acid 50 ppm	66.13	7.96	52.70	64.62
11	Ascorbic Acid 100 ppm	67.37	9.46	55.04	62.82
	Average	65.66	8.95	53.69	62.11
	S.E (diff.)	0.76	0.46	0.66	0.57
	C.D at 5% P	1.59	0.95	1.37	1.20

Table 2. Growth regulators affected the chlorophyll intensity (%) CGR (Mg cm⁻² day⁻¹), RGR (mg g⁻¹ day⁻¹) and NAR (mg cm⁻² day⁻¹) of basmati rice

S. No.	Treatments	Chlorophyll intensity (%)	CGR	RGR	NAR
		At anthesis	In between dough to maturity	In between dough to maturity	In between anthesis to dough
1	Control	34.06	9.43	6.41	30.85
2	IAA 25 ppm	35.10	16.70	7.15	36.55
3	IAA 50 ppm	37.20	18.40	7.18	38.71
4	KN 5 ppm	37.90	16.72	7.44	40.29
5	KN 10 ppm	36.63	16.78	8.04	35.65
6	CCC 2000 ppm	35.20	15.07	7.34	33.70
7	CCC 4000 ppm	34.15	15.10	7.77	32.92
8	SADH 1000 ppm	33.42	14.97	7.82	33.29
9	SADH 3000 ppm	32.65	13.45	7.38	30.96
10	Ascorbic Acid 50 ppm	34.45	14.68	6.68	35.85
11	Ascorbic Acid 100 ppm	35.75	15.07	6.72	33.90
	Average	35.14	15.12	7.27	34.79
	S.E (diff.)	0.15	0.91	0.11	0.44
	C.D at 5% P	0.32	1.90	0.22	0.91

Table 3. Correlation matrix between physiological and growth parameters of Basmati rice as affected by growth regulators

	Plant Height	Tillers/plant	Leaves/plant	RWC (%)	Chl. int. (%)	CGR	RGR	NAR
Plant Height	-	0.3657	0.4409	0.7363**	0.7681**	0.7055*	-0.03118	0.7766**
Tillers/plant	-	-	0.8716**	0.4606	0.1462	0.6606*	0.3141	0.2198
Leaves/plant	-	-	-	0.7114*	0.1978	0.7905**	0.3339	0.4364
RWC (%)	-	-	-	-	0.4412	0.7805**	0.03801	0.7086*
Chl. int.(%)	-	-	-	-	-	0.6494*	0.0877	0.8581**
CGR	-	-	-	-	-	-	0.5034	0.7898**
RGR	-	-	-	-	-	-	-	0.1336
NAR	-	-	-	-	-	-	-	-

The significant enhancement in a number of leaves of Basmati rice crop was accelerated significantly against control after treatment of growth regulators. Extended green leaf area was found by the treatment of IAA 50 ppm followed SADH 1000 ppm, IAA 25 ppm, CCC 2000 and 4000 ppm and Ascorbic Acid 50 and 100 ppm. The most probable reason behind this character is cell division and its elongation [4,6,7].

Relative Water Content (%) of leaves was significantly enhanced by the growth regulators. The maximum RWC was found under the treatment of IAA followed by Ascorbic Acid, Kinetin, CCC and SADH [8,9].

Chlorophyll intensity, which is a biochemical character and play a key role in photosynthesis, is mainly induced by the use of Kinetin 5 ppm followed by IAA 50 ppm. SADH and CCC failed to enhance chlorophyll intensity. Increment in chlorophyll intensity was due to formation, maintenance and development of chloroplast by the treatment of these hormones [1,10,9].

Growth parameter trait i.e. CGR (mg/cm²/day) was increased between Dough to Maturity. The inclined value of CGR was found in case of IAA 50 ppm followed by its lower dose i.e. 25 ppm. SADH is also successful in accelerating CGR level during both the years. Other treatment also had a mounting effect on CGR. The uplifted value of CGR is due to the assimilation of higher biomass and economic yield [11].

Between Dough to Maturity, the value of RGR (mg g⁻¹day⁻¹) was mainly insisted by the Kinetin 5 and 10 ppm. The other treatments support this and control plant have lower rate of RGR value [12].

Between Anthesis to Dough, the greatest value of NAR (mg cm⁻² day⁻¹) was obtained by the Kinetin 5 ppm followed by IAA 50 ppm. The main cause of increased NAR value is maximum transport of assimilated towards the grain [12].

4. CONCLUSION

According to above outcome of the experiment, it may be inferred that the foliar application of IAA 50 ppm at tillering and pre-anthesis stage appreciated the plant height, number of tillers/plant, number of leaves/plant, RWC and CGR, however, Kinetin 5 ppm reported higher value of chlorophyll intensity, RGR and NAR of Basmati rice. Ascorbic Acid also gave positive

response. However, CCC and SADH reduced the plant height but significantly accelerate the number of tillers and leaves of basmati rice plant.

Pearson Correlation coefficient among the observed characters showed that the positive correlation (** and *) was found among the traits (Table 3). Plant height was significantly correlated with RWC, Chlorophyll intensity and NAR. Number of tillers was positively correlated with number of leaves. Number of leaves/plant was significantly correlated with CGR. RWC was highly significant with CGR. However, chlorophyll intensity and CGR showed significant correlation with NAR [13,14].

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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