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Response of Foliar Applied Growth Regulators on Yield and Quality Traits of Basmati Rice (*Oryza sativa* L.)

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Author's contributions

This 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 this manuscript. Author SPK guided for the research and analysis. Author RB managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Growth regulators is a chemical compound, which is either synthesized by the plants or exogenously applied. It affects the growth and metabolic rate thus affecting the yield and quality ofcrop. In this investigation, the Basmati rice plants were foliar sprayed with growth regulators (IAA, Kinetin, CCC, SADH and Ascorbic Acid) at tillering and before anthesis stage. Results showed a conspicuous increase in yield and quality traits in treated plants. The yield attributing traits like grain weight per plant,straw weight/plant, 1000 grain weight/test weight and Harvest Index (HI) was improved by the treatment of IAA. The quality trait *viz*. Grain Starch and Uncoocked and cooked grain size were significantly improved by IAA, while Grain Protein content was by Kinetin.

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1. INTRODUCTION

Rice (*Oryza sativa*) is physiologically a C_3type photosynthetic plant of *Kharif* season and one of the three most important food crops in the world. While, basmati rice is known as king of rice, also the oldest, common progenitor for most types [1]. Basmati rice has both aroma and post elongation cooking quality and no other rice in the world has these characteristics in combination. The taste is also different. Once the taste buds get used to basmati rice, no other rice will be likened. It is one of the major agricultural commodities, the country exports every year to earn foreign exchange. But since, the yield of basmati rice, per acre of land, is less than half of that of non-basmati rice and because of higher inputs-basmati rice has become unaffordable for most people.

So, it is very important to ensure the constant availability of basmati rice. Therefore, yield and quality boosting agronomic technique such as application of certain Growth Regulators needs due attention [2].

Therefore, an attempt was done to find out, how the certain growth regulating substances with their various concentrations influence yield and quality traits of basmati Rice. So, different levels of exogenous plant growth regulators (IAA, Kinetin, CCC, 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, 2015 at Student Instructional Farm, Chandra Shekhar Azad University of agriculture and technology, Kanpur. The Randomized Block Design used for the experimentation. The different concentrations of growth regulators were; IAA (25, 50 ppm), Kinetin (5, 10 ppm), CCC (2000, 4000 ppm), SADH(1000, 3000 ppm), Ascorbic Acid (50, 100 ppm). Each concentration was replicated three times. The quality characters which are estimated for basmati rice are:

2.1 Grain Starch Content

Starch content in the grains was estimated by using the method of McCready et al. [3].

2.2 Grain Protein Content (%)

Nitrogen content in the rice seed was estimated by using instrument, Semi-automatic Nitrogen Analyzer of model KEL PLUS. This instrument work on the principle of micro kjheldhal method of nitrogen analysis [4].

2.3 Grain Size (Uncooked) (mm)

One hundred grains of each basmati rice sample were taken randomly and measured the length, width and thickness by using micrometer (Vernier caliper).

2.4 Grain size (Cooked) (mm)

One hundred grains of boiled/cooked basmati rice sample were again taken randomly and measured the length, width and thickness by using micrometer (Vernier caliper).

3. RESULTS AND DISCUSSION

IAA 50 ppm improved the basmati rice grain yield per plant (Table 1). This is a major yield supporting hormone. The lower doses of this hormone also gave a positive support against control followed by IAA 25 ppm. Rest treatments also had significant influence on grain weight. Enhancement in grain weight per plant by IAA was due to expansion of leaves, which results in more photosynthesis, assimilation and ultimately more total dry matter. The finding is in agreement with Pandey et al. [5] and Seyyedeh et al. [6].

Maximum straw yield per plant was generated by the treatment of IAA 50 ppm and Ascorbic Acid 100 ppm. CCC and SADH had similar response. This conclusion was favored by Amin et al. [7].

An over view on test weight, which is weight of 1000-grains, revealed that IAA 50 ppm has an uplifting effect on test weight of basmati rice crop variety PB-1. Its decreasing concentrations also have an accomplishing effect on 1000 grain weight. Kinetin 5 ppm also had significant effect after IAA. The other growth regulators also have an assisting effect on increment of test weight of basmati rice grains. The control plant has lower test weight value. The major cause of higher test weight is due to cell division in growing grains (formation of sink size) and higher assimilates

production and transport in basmati rice crop. This investigation is also confirmed by the research work done by Pandey et al. [5] and Singh et al. [8].

The value of harvest index, which is the ratio of economic yield and biological yield, improved by IAA 50 ppm followed by other treatments. Other treatments *viz.,* Kinetin and SADH, CCC and Ascorbic Acid also have constructive power in comparison to control plant. The central cause to amplified Harvest Index was owed to construction of more assimilates which participate in the establishment of economic yield in comparison to biological yield. Clarification pre-arranged by Pandey et al. [5] and Samantasiuhar and Sahu [9] supported this research.

An overview on Grain Starch Content (%) defined that the rate of starch content is progressively increased by the treatment of IAA 50 ppm followed by Kinetin 10 ppm. CCC and Ascorbic Acid also have incrementing effect on this attribute. SADH also accelerate the starch content value non-significantly. The major cause of establishing high starch content is production of higher assimilates. This research work was approved by the research work of Amin et al. [7,10].

Table 1. Grain weight/plant (g), straw weight/plant, test weight (g) and harvest index (%) of basmati rice was affected by the foliar applied growth regulators treatment

S.No.	Treatments	Grain weight/plant (g)	Straw weight/plant (g)	Test weight (g)	Harvest index (%)
1	Control	15.79	22.55	18.65	38.28
2	IAA 25 ppm	24.33	25.75	22.82	39.56
3	IAA 50 ppm	26.92	26.54	23.38	40.36
4	KN 5 ppm	20.18	24.10	22.56	39.66
5	KN 10 ppm	21.68	24.98	21.48	39.88
6	CCC 2000 ppm	19.19	23.25	21.50	39.64
7	CCC 4000 ppm	18.20	23.87	20.50	39.38
8	SADH 1000 ppm	22.80	22.86	21.00	39.33
9	SADH 3000 ppm	21.99	23.79	20.77	39.42
10	AsA 50 ppm	21.20	24.85	21.32	38.99
11	AsA 100 ppm	22.08	25.70	20.17	39.36
	S.E (diff.)	0.70	0.35	0.84	0.31
	C.D at 5% P	1.45	0.73	1.76	0.64

Table 2. Quality characters *i.e.* grain starch content, grain protein content (%) and grain size (uncooked and cooked) (mm) of basmati rice was affected by the foliar applied growth regulators treatment

S.No.	Treatments	Grain starch content (%)	Grain protein content (%)	Uncooked grain size (mm)	Cooked grain size (mm)
1	Control	62.06	6.44	6.30	12.31
2	IAA 25 ppm	67.25	6.70	6.81	12.84
3	IAA 50 ppm	67.98	6.88	7.23	13.30
4	KN 5 ppm	66.23	6.86	6.90	12.96
5	KN 10 ppm	67.23	6.91	7.16	13.16
6	CCC 2000 ppm	65.16	6.59	6.65	12.73
7	CCC 4000 ppm	64.66	6.55	6.44	12.49
8	SADH 1000 ppm	63.00	6.84	6.68	12.70
9	SADH 3000 ppm	62.42	6.60	6.50	12.55
10	Ascorbic Acid 50 ppm	65.69	6.58	6.69	12.73
11	Ascorbic Acid 100 ppm	64.25	6.66	7.04	13.09
	S.E (diff.)	0.49	0.10	0.15	0.22
	C.D at 5% P	1.02	0.21	0.32	0.46

Protein content of grain, a major quality trait, is depended on nitrogen content, enhanced by the Kinetin 10 ppm, its lower dose also improved the per cent value of protein followed by Ascorbi Acid 100 ppm and SADH 1000 ppm. However, CCC had no any elevating effect on protein content (%). The chief basis of yielding higher protein is the formation and translocation of huge quantity of amino acids from producer to consumer site in the basmati rice plant. Our result is also similar with the research of Pandey et al. [5] and Piebiep et al. [11].

It is evident that grain size (Uncooked and Cooked) was maximized by the action of different growth regulators. The chief treatment was IAA 50 ppm in accelerating this value, followed by Kinetin 10 ppm. The other treatments are also helpful for improving this rate**.** However, CCC indicates non-significant increase in grain size of Basmati rice variety PB-1. Grain size of basmati rice is enlarged after cooking. It is an important trait of aromatic rice. It is maximized by the treatment of IAA 50 ppm and Kinetin 10 ppm. Rest treatments are also effective in this matter. Improvement in grain size is primarily due to cell division, cell enlargement and high quantity of food material transport. This finding is also related with the statement given by Ma and Smith [12].

4. CONCLUSION

According to above outcome of the experiment, it may be inferred that the foliar application of IAA 50 ppm appreciated the Grain Weight per plant (g), straw weight/plant (g), Test weight (g) and HI (%) of basmati rice. IAA and Kinetin improved theGrain Starch Content (%) while, Kinetin 10 ppm improved the grain protein content. IAA 50 ppm accelerated the Grain Size (uncooked and cooked). The enhancement of grain yield of basmati rice plant was due to increase in number of panicles, number of grains/panicle, grain weight/plant, grain yield and harvest index. Starch content was accelerated due to high dry matter production sand its transport towards sink. Grain size is results due to regulation of cell division in growing grains (formation of sink size). The protein content was enhanced by Kinetin mainly due to its capacity to produce maximum nitrogen and direct the flow of amino acids through the plant towards the sink.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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