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Effect of plant growth regulators on physiological behavior of rice (*Oryza sativa* L.) under *kharif* Konkan condition

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Abstract
A field experiment was conducted to study the effect of plant growth regulators on physiological behavior of rice (*Oryza sativa* L.) under *kharif* Konkan condition. Plant growth regulators at different concentration were applied through foliar spray at 30, 60, 90 and 120 DAS. The experiment consisted of 11 treatment comprising Triacontanol (10, 15and 15 ppm), CPPU (1, 2 and 3 ppm), salicyclic acid (15, 20 and 25 ppm) and paclobutrazol (50 ppm) treatment were imposed at 30, 60, 90 and 120 DAS. Among the treatments foliar application of salicylic acid @ 15 ppm and foliar application of triacontanol @ 15 ppm recorded significant difference on physiological parameters as compared to other treatments. The increased rate of photosynthesis and stomata conductance and reduced rate of transpiration have been achieved by the foliar application of salicylic acid @ 15 ppm. Chlorophyll content was found to be increased by the foliar application of triacontanol @ 15 ppm.

Keywords: Salicyclic acid, Triacontanol, CPPU, Paclobutrazol, Photosynthesis, Stomata conductance and Transpiration

Introduction
Rice (*Oryza sativa* L.) is the most important staple food crop. India is the world's second largest rice producer and consumer next to China. About 90 per cent of all rice grown in the world is produced and consumed in Asian region. In Maharashtra, the total area occupied by this crop is about 14.87 lakh hectares with annual production of 26.01 lakh tones and productivity is about 1.74 tones/ha [1]. Maximum productivity is observed in Konkan region and it contributes 42.91% of total rice production in the state. In green revolution era, previous efforts were taken for development of improved photo insensitive high yielding varieties and hybrids. Still there is space for the improvement of yielding potential of both hybrid as well as high yielding varieties of rice by bringing desirable manipulations in physiological attributes. The growth behavior of crop plant could be modified and controlled by applying small amounts of these chemical to leaves, seed, stem, fruits, or root [2]. studied the effect of various growth regulator and reported that foliar spray of 100 ppm salicylic acid exhibited significantly higher yield.

Material and Method
A field experiment was conducted at agricultural research botany farm, College of Agriculture, *Kharif* 2013-14 seasons. Plant growth regulators at different concentration were applied through foliar spray at 30, 60, 90 and 120 DAS. The experiment consisted of 11 treatment laid out in randomized block design with three replications. The experiment consisted of 11 treatment comprising Triacontanol (10, 15and 15 ppm), CPPU (1, 2 and 3 ppm), salicyclic acid (15, 20 and 25 ppm) and paclobutrazol (50 ppm) treatment were compared to Control Planting season *Kharif* (2013). Design Randomized Block Design, Total field area 660 m^2,Net plot size 4.5 x 2.4m^2, Spacing : 20 x 15 cm^2,treatments Eleven and Number of replications Three, varieties (Hybrid Sahyadri-3).

Result and Discussion
Application of chemicals to plants are of great use not only in agriculture as modifiers of nutrition or as regulators of growth, but also in the experimental sense of offering wide range of possibilities for exploring physiological phenomenon inside the plant [3].

Although the plant performance is attributed to the genetic factors, differences in the basic physiological and biochemical process are of great importance, as the plant metabolism depends on various biochemical constituents [4]. It is known that thousands of reactions are undergoing in the plants simultaneously which ultimately decide the growth and development and the final yield. Plant growth regulators have been shown to influence these processes in one way or the other.

Rate of Photosynthesis

In present investigation, photosynthesis rate was measured with the help of the infrared gas analyzer (LICOR 6400) at two active growth stages *i.e.* 60 to 90 DAS. It was observed that photosynthesis rate increased with advancing age of the crop from 60 to 90 DAS.

In the present study, significant difference were observed in all treatments of the plant growth regulators with respect to the total photosynthesis rate at 60 and 90DAS *i.e.* 60 DAS (3.6054 to 13.8457 µ/ mol/co^2 $m^{-2}sec^{-1}$) and 90 DAS (16.7173 to 22.1369 µ/ mol/co^2 $m^{-2}sec^{-1}$)in all treatment. The treatment T_7 (Foliar application of salicylic acid @ 15 ppm) recorded maximum total photosynthesis rate (22.1369 µ/ mol/co^2 $m^{-2}sec^{-1}$) 90 DAS. Salicylic acid application improved the performance of rice under both normal stress condition drought tolerance in rice was well associated with the accumulation of compatible solute, maintains of tissue water potential and enhanced potency of antioxidant system in which improved the integrity of cellular membrane and facilitated the rice plant to sustain photosynthesis and general metabolism. Similarly result also reported by [5].

Rate of stomatal conductance

In present investigation, stomatal conductance was measured with the help of the infrared gas analyzer (LICOR 6400) at two active growth stages *i.e.* 60 to 90 DAS. It was observed that stomatal conductance increased with advancing age of the crop from 60 to 90 DAS.

In the present study, significant difference were observed in all treatments of the plant growth regulators with respect to the total stomatal conductance at 60 and 90DAS *i.e.* 60 DAS (0.3671 to 0.7749 µ/ mol/H_2O $m^{-2}sec^{-1}$) and 90 DAS (0.8395 to 2.1277 µ/ mol/ H_2O $m^{-2}sec^{-1}$)in all treatment. The treatment T_7 (Foliar application of salicylic acid @ 15 ppm) recorded maximum total stomatal conductance (2.1277 µ/ mol/ H_2O $m^{-2}sec^{-1}$), 90 DAS. The lowest stomata conductance found in treatments T_6 (0.8302 µ/ mol/ H_2O $m^{-2}sec^{-1}$). The stomata conductance, which is a component of photosynthesis, showed positive association with photosynthetic rate and total dry matter while it had no relationship with grain yield. Similarly related result were also reported by [6].

Rate of transpiration rate

In present investigation, total transpiration rate was recorded measured with the help of the infrared gas analyzer (LICOR 6400) at two active growth stages *i.e.* 60 to 90 DAS. It was observed that rate of transpiration rate increased with advancing age of the crop from 60 to 90 DAS.

The transpiration rate of plant is one of the important physiological process. It correlates with the water uptake, Water use efficiency and also to rate of photosynthesis. It may depends on the environmental condition during the growth stages of crop. There was variation found in the rate of transpiration among the treatments and its growth stages. In the present investigation, the rate of transpiration found maximum at 90 DAS than 60 DAS in treatments. Treatment T_9 (8.641µg m^{-2} sec^{-1}) showed higher rate of transpiration during all growth stages of crop. The lowest transpiration rate was found in treatment T_{11} (5.860 µg m^{-2} sec^{-1}). Similar related results were also reported in paclobutrazol treatments in their environmental factors study and [7] in rice.

Total chlorophyll content

Total chlorophyll content of a leaves was significantly influenced by plant growth regulators, over the control. Total chlorophyll content was increased from 30 to 60 DAS thereafter it declined upto harvest.

In the present study, significant differences were observed in all treatments of the plant growth regulators with respect to the total chlorophyll content at all stages *i.e.* 30 DAS (0.6624 to 1.1886 mg/g), 60 DAS (1.0662 to 1.9756 mg/g), 90DAS (0.5233 to 1.3964 mg/g) and 120 DAS (0.2543 to 0.7843 mg/g),in all treatment. The treatment T_2 (Foliar application of triacontanol @ 15 ppm) recorded maximum total chlorophyll content T_2 (0.7843 mg/g) 120 DAS. Similarly results loss in total chlorophyll towards maturity of the crop was observed earlier by [8].

Table 1: Mean Photosynthesis of hybrid rice Sahyadri-3 as influenced by different treatments**.**

Treatments	Photosynthesis rate (µ/mol CO^2 $m^{-2}sec^1$)	
	Days after sowing	
	60	90
T_1-Foliar application of Tricontanol @ 10ppm	7.2913	19.2686
T_2-Foliar application of Tricontanol @ 15ppm	13.0815	22.1092
T_3-Foliar application of Tricontanol @ 20ppm	3.9559	18.1075
T_4-Foliar application of CPPU @ 1ppm	3.6054	18.0978
T_5-Foliar application of CPPU @ 2ppm	5.5794	21.8542
T_6-Foliar application of CPPU @ 3ppm	10.1123	19.6293
T_7-Foliar application of Salicylic acid @ 15ppm	13.8457	22.1369
T_8-Foliar application of Salicylic acid @ 20ppm	5.8029	18.7835
T_9-Foliar application of Salicylic acid @ 25ppm	8.8488	21.7225
T_{10}-Foliar application of Paclobutrazol @ 50ppm	5.5553	18.9064
T_{11}Control	6.6821	16.7173
Mean	7.6691	19.7576
S.Em±	0.266	0.412
CD at 5%	0.784	1.216

Table 2: Mean Stomata conductance of hybrid rice Sahyadri-3 as influenced by different treatments.

Treatments	Stomata conductance(µ/mol H_2O $m^{-2}sec^{-1}$)	
	Days after sowing	
	60	90
T_1-Foliar application of Tricontanol @ 10ppm	0.4892	1.2617
T_2-Foliar application of Tricontanol @ 15ppm	0.7198	1.5846
T_3-Foliar application of Tricontanol @ 20ppm	0.4591	1.4905
T_4-Foliar application of CPPU @ 1ppm	0.4052	0.9586
T_5-Foliar application of CPPU @ 2ppm	0.4499	1.0294

T_6-Foliar application of CPPU @ 3ppm	0.4998	0.8302
T_7-Foliar application of Salicylic acid @ 15ppm	0.7749	2.1277
T_8-Foliar application of Salicylic acid @ 20ppm	0.7203	0.9879
T_9-Foliar application of Salicylic acid @ 25ppm	0.5408	1.5535
T_{10}-Foliar application of Paclobutrazol @ 50ppm	0.4544	0.9522
T_{11}Control	0.3671	0.8805
Mean	0.5346	1.2415
S.Em±	0.023	0.192
CD at 5%	0.069	0.567

Table 3: Mean Transpiration rate of hybrid rice Sahyadri-3 as influenced by different treatments**.**

Treatment	**Transpiration rate (µg m^{-2} sec^{-1})**	
	Days after sowing	
	60	**90**
T_1-Foliar application of Tricontanol @ 10ppm	3.146	8.153
T_2-Foliar application of Tricontanol @ 15ppm	2.779	7.686
T_3-Foliar application of Tricontanol @ 20ppm	2.707	8.444
T_4-Foliar application of CPPU @ 1ppm	2.914	7.101
T_5-Foliar application of CPPU@2ppm	2.020	8.333
T_6-Foliar application of CPPU@3ppm	2.696	8.131
T_7-Foliar application of Salicylic acid@15ppm	3.331	7.743
T_8-Foliar application of Salicylic acid@20ppm	3.721	6.728
T_9-Foliar application of Salicylic acid@25ppm	2.720	8.641
T_{10}-Foliar application of Paclobutrazol@50ppm	3.296	7.997
T_{11}Control	3.310	5.860
Mean	2.967	7.711
S.Em±	0.163	0.317
CD at 5%	0.480	0.935

Table 4: Mean total chlorophyll content of hybrid rice Sahyadri-3 as influenced by different treatments.

Treatments	**Total Chlorophyll content(mg/g)**			
	Days after sowing			
	30	**60**	**90**	**120**
T_1-Foliar application of Tricontanol @ 10ppm	1.1450	1.8312	1.2234	0.4554
T_2-Foliar application of Tricontanol @ 15ppm	1.6551	1.8900	1.3964	0.7843
T_3-Foliar application of Tricontanol @ 20ppm	1.1886	1.3779	0.8552	0.2853
T_4-Foliar application of CPPU @ 1ppm	1.0740	1.8858	0.5233	0.3524
T_5-Foliar application of CPPU @ 2ppm	1.2448	1.5333	0.8887	0.4253
T_6-Foliar application of CPPU @ 3ppm	0.8878	1.0662	0.9871	0.5119
T_7-Foliar application of Salicylic acid @ 15ppm	0.8954	1.9756	1.1378	0.3559
T_8-Foliar application of Salicylic acid @ 20ppm	0.7234	1.3464	0.9884	0.4456
T_9-Foliar application of Salicylic acid @ 25ppm	0.7770	1.3224	1.1233	0.5447
T_{10}-Foliar application of Paclobutrazol @ 50ppm	0.6624	1.5444	1.2851	0.4491
T_{11}Control	0.9879	1.4403	0.8743	0.2543
Mean	0.9498	1.5731	0.9293	0.4166
S.Em±	0.0394	0.0521	0.0621	0.0357
CD at 5%	0.1150	0.1521	0.1821	0.1043

Conclusion

From present investigation, it could be stated that growth regulators like triacontanol, CPPU, salicylic acid and paclobutrazol significantly influenced the physiological behavior Among these plant growth regulators, the salicylic acid found better for, physiological behavior other treatments, including control. However more systematic work to presisdy standardize application the mode, time and doses of salicylic acid, warent's further study.

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