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EFFECT OF GIBBERELLIC ACID (GA_3) ON GROWTH AND YIELD OF RICE (*Oryza sativa* L.)

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Abstract

Field investigations were carried out at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University during early samba (2013) and thaladi (2014) to study the effect of Gibberellic acid (GA_3) on growth and yield of rice. The experiments comprised of seven treatments *viz.*, T_1 - Gibberellic acid @ 5 g ha^{-1}, T_2 - Gibberellic acid @ 10 g ha^{-1}, T_3 - Gibberellic acid @ 15 g ha^{-1}, T_4 - Gibberellic acid @ 20 g ha^{-1}, T_5 - Gibberellic acid @ 25 g ha^{-1}, T_6 - Triacontanol 0.05% EC @ 250 ml ha^{-1} and T_7 - Control. The treatments were conducted in randomized block design (RBD) and replicated thrice. Rice variety BPT 5204 was used as test variety in both the seasons of study. The effect of Gibberellic acid on growth attributes, yield attributes and yield of crop was critically studied under rice. The growth and yield parameters of rice *viz*., plant height, number of tillers hil^{-1}, leaf area index, dry matter production, number of panicles m^{-2} and number of filled grains $panicle^{-1}$ were strikingly impressive by Gibberellic acid @ 25 g ha^{-1} in both seasons. In respect of grain and straw yields were also significantly higher in crop raised with application of Gibberellic acid over control. Among the different treatments, Gibberellic acid @ 25 g ha^{-1} recorded the highest grain and straw yields. This was followed by Gibberellic acid @ 20 g ha^{-1}, Triacontanol 0.05% EC @ 250 ml ha^{-1} and Gibberellic acid @ 10 g ha^{-1} were next in order and were on par in their values.. The harvest index was also higher with Gibberellic acid @ 25 g ha^{-1}. The lowest growth attributes, yield attributes, grain and straw yields were recorded in control (no foliar spray). Also the same treatment recorded lower harvest index. Based on the above experimental results, it could be concluded that cultivation of rice with application of Gibberellic acid @ 25 g ha^{-1} was found to be an agronomically sound and ecologically safe practice for augmenting higher productivity. Hence this can be recommended to the rice growing farmers of Tamil Nadu.

***Key words*:** Rice, Foliar application, Gibberellic acid, Triacontanol, Grain and Straw yield and Harvest index

Introduction

Rice (*Oryza sativa* L.) is one of the most important cereal crop of the world, grown in wide range of climatic zones more than 90 per cent of the World's rice is grown and consumed in Asia. Rice is grown in 114 countries across the world with an area of 164 million hectares and production of 741.4 million tonnes with the productivity of 4.4 t ha^{-1} (FAO, 2013). In India, rice is grown in an area of 44.10 million hectares with the production of 107 million tonnes and the productivity is 3.58 t ha^{-1}. In Tamil Nadu, rice is grown predominantly with an area of 2.2 million hectares resulting in production of 8.65 million tonnes with the productivity of 3.93 t ha^{-1} (TNAU, 2013). However, the yield is lower, as compared to the average productivity of rice producing countries such as Japan (6.50 t ha^{-1}), China (6.70 t ha^{-1}), Egypt (7.50 t ha^{-1}) and Israel (5.50 t ha^{-1}). At the current growth of population rice requirement increases dramatically and many nations are facing second generation challenging of producing more rice less cost in a deteriorating environment; hence it is challenging task to ensuring food and national security. Thus, improved technologies are required to bridge the gap to feed the increasing population. The introduction of chemical growth regulators has added a new dimension to the possibility for improving the growth and yield of rice corp. Foliar application of plant growth regulators, both natural and synthetic, has proven worthwhile for improving crop growth against a variety of abiotic stresses. Remarkable accomplishments of plant growth regulators (PGR) such as manipulating plant developments, enhancing yield and quality have been actualized in recent years using new emerging and efficient plant growth regulators. It has long been ascertained that plant hormones including auxins, gibberellins, cytokinin and ethylene etc., GA_3 being well known plant growth promoting hormones has shown to be involved in variety of plant growth and development processes (Frankenberger and Arshad, 1995). GA_3 is proved to improve effective portioning and translocation of accumulates from source to sink in the field crops (Senthil *et al.*, 2003). GA_3 application was very effective in increasing seed set rate and grain yield through elongation of plant height, promoting panicle and spikelet exsertion, enhancing stigma exsertion and longevity and receptivity in rice and also key to win higher grain yield in rice production. (Gavino *et al.,* 2008). But research on application of Gibberellic acid on rice crop for improvement of growth and yield is very meager. Considering the above facts, field experiments were conducted to study the influence of gibberelic acid on growth and yield of rice.

Materials and Methods

Field experiments were conducted at the Experimental Farm, Department of Agronomy, Annamalai University, Annamalai Nagar during early samba (First season) 2013 and thaladi (Second season) 2014 to evaluate the effect of Gibberellic acid on growth and yield of rice. The weather at Annamalai nagar is moderately warm with hot summer months. The first crop received a rainfall of 1014.9 mm, distributed over 41 rainy days. The Relative humidity ranges from 77 to 92 per cent with a mean of 84.70 per cent. The second crop received a rainfall of 225.6 mm, distributed over 9 rainy days. The relative humidity ranges from 72 to 90 per cent with a mean of 84.95 per cent. A long duration rice variety BPT 5204 is selected for the study. The experiments were laid out in randomized block design with three replications. The treatment details are *viz.,* Gibberellic acid @ 5 g ha^{-1} - (T_1), Gibberellic acid @ 10 g ha^{-1}- (T_2), Gibberellic acid @ 15 g ha^{-1} - (T_3), Gibberellic acid @ 20 g ha^{-1} - (T_4), Gibberellic acid @ 25 g ha^{-1} - (T_5), Triacontanol 0.05% EC @ 250 ml ha^{-1} - (T_6) and Control (T_7). Gibberellic acid is recommended for foliar application as a diluted spray solution at different concentration according to treatments and the solution was taken for spraying for an area of one hectare. Triacontanol is also another recommended for foliar application as a dissolved and diluted spray solution @ 25ml in 1 litre of water and the solution was taken for spraying for an area of one hectare. Both Gibberellic acid and Triacontanol was uniformly sprayed using hand sprayer (Knapsack) in the evening hours on 20 days after planting. Gibberellic acid was supplied through Progibb 40% WSG. A fertilizer schedule of 150 kg N, 50 kg P_2O_5 and 50 kg K_2O ha^{-1} was followed. The entire dose of P_2O_5, half dose of N and K_2O was applied as basal. Remaining with half the dose of N and K_2O was top dressed in the equal splits at maximum tillering and panicle primodium initiation stages. Thirty days old paddy seedlings were planted @ 2 seedling $hill^{-1}$ with a spacing of 20 ×15 cm to accommodate a plant population of 33 seedlings m^{-2}. The experimental plots were harvested leaving the border rows to avoid border effect. Five sample plants in each plot were selected at random and peg marked permanently for recording biometric observations. The matured crop was harvested from the net plot area and the grain was hand threshed, winnowed and sun dried to bring the moisture content to 14 per cent and the yield was recorded net plot wise and computed to kg ha^{-1}.

Harvest index

The harvest index was calculated by using the following formula suggested by Varma (1973).

$$\text{Harvest index} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Statistical Analysis

The experiments data were statistically analysed as suggested by Panse and Sukhatme (1978). For significant results, the critical difference was worked out at 5 per cent probability level to draw statistical conclusions. The treatment differences that were non-significant at five per cent were denoted as NS.

Results and Discussion

Growth Attributes

In both the experiments, there was perceptible difference observed in rice growth attributes due to effect of Gibberellic acid. Among the various treatment tested, application of Gibberellic acid @ 25 g ha^{-1} (T_5) had significantly registered the highest plant height of 125.72 and 124.84 cm, tillers number of 12.23 and 11.83 $hill^{-1}$, LAI of 7.66 and 7.45 and DMP of 12686 and 12000 kg ha^{-1} (Table 1) during first and second season, respectively. Results indicated that application of Gibberellic acid @ 25 g ha^{-1} (T_5) was the optimum dose for producing the higher plant height, more number of tillers $hill^{-1}$ and DMP. The result of the present study is similar to the findings of Prasad *et al*. (2013) who observed that application of GA_3 had significantly registered the higher growth attributes of plant. GA_3 application might have increased the translocation of assimilates to the vegetative organ which resulted in the maximum of plant height, number of tillers $hill^{-1}$. (Khadija *et al*., 2013; Pepi nur Susilavathi *et al*., 2014). The increased LAI could be attributed to the increased functional leaf area and delayed senescence as spray of growth promoter (Chen *et al*., 1982). The control (T_7) registered the least plant height of 93.69 and 93.02 cm, tillers number of 7.20 and 6.95 $hill^{-1}$, LAI of 5.35 and 5.31 and DMP of 7950 and 7560 kg ha^{-1} during first and second season, respectively.

Yield Attributes

Among the treatments, foliar application of Gibberellic acid @ 25 g ha^{-1} (T_5) significantly registered higher number of 394.29 and 377.48 panicles m^{-2} and number of 91.45 and 91.22 filled grains $panicle^{-1}$ during first and second season, respectively and it was significantly superior over other treatments. This treatment was followed by Gibberellic acid @ 20 g ha^{-1} (T_4) and Triacontanol 0.05% EC @ 250 ml ha^{-1} (T_6), Gibberellic acid @ 10 g ha^{-1} (T_2) were on par with each other and ranked next. Foliar application of GA_3 registered higher yield attributes *viz.,* number of higher panicles m^{-2} and number of filled grains $panicle^{-1}$. This

might be attributed to the increased supply of photosynthetic materials and its efficient mobilization in plants giving rise to increased stimulation of yield attributes ultimately resulting in increased number of panicles m^{-2}. Similar results were reported by Tiwari *et al*. (2011). The plant growth regulators like GA_3 might be involved in formation of grain filling and their optimum nourishments have resulted in less number of aborted grains and thus maximized the survival of filled grains $plant^{-1}$. These results are in conformity with the findings of Prabagaran and Ponnuswamy (1997). The control (T_7) registered the least number of 231.64 and 169.36 panicles m^{-2} and number of 69.49 and 71.51 filled grains $panicle^{-1}$ during first and second season, respectively.

Grain and Straw Yield

Foliar nutrient management practices significantly influenced the grain and straw yields of rice in both the seasons. Among the treatments, Gibberellic acid @ 25 g ha^{-1} (T_5) significantly registered the higher grain yield of 5530 and 5390 kg ha^{-1} during first and second season, respectively. The grain yield recorded in this treatment was 27 and 25 per cent higher than control (T_7) in first and second season, respectively. Also the same treatment recorded higher straw yield of 7314 and 7274 kg ha^{-1} during first and second season, respectively. This might be due heavier build up of sufficient food reserves diversified towards the developing higher number of panicles and filled grains $plant^{-1}$ due to spraying of growth regulators which in turn registered higher grain yield (Elankavi *et al.,* 2009). Besides, higher grain yield might be due to better translocation of photosynthates from source to sink. (Bhatt and Singh, 1997). This treatment was followed by Gibberellic acid @ 20 g ha^{-1} (T_4), Triacontanol 0.05% EC @ 250 ml ha^{-1} (T_6) and Gibberellic acid @ 10 g ha^{-1} (T_2) were on par with each other and ranked next. The treatment T_7 (control) registered the lowest grain yield of 4050 and 3950 kg ha^{-1} and straw yield of 6177 and 6175 kg ha^{-1} during first and second season, respectively.

Harvest Index (%)

Among the treatments, the high harvest index of 43.29 in first season and 42.88 in second seasons was recorded with Gibberellic acid @ 25 g ha^{-1} (T_5). This treatment was followed by Gibberellic acid @ 20 g ha^{-1} (T_4). The treatments T_6 and T_2 were on par with each other and ranked next. This might be due to GA_3 application accelerated photosynthetic activity and translocation of photosynthates to sink, which leads to recorded higher harvest index. This result is in harmony with those obtained by Khan, (1998). The least harvest index of 40.58 and 40.03 in first and second season, respectively was recorded in control (T_7).

Conclusion

Foliar spraying with Gibberellic acid @ 25 g ha^{-1} on 20 DAT could be recommended for farmers of coastal areas of Tamilnadu for *early samba* and *thaladi* season to achieve higher production in rice.

Table 1 : Effect of Gibberellic acid on growth attributes of rice

Treatments	Plant height (cm)		Number of tillers $hill^{-1}$		LAI		DMP (kg ha^{-1})	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season
T_1	106.96	101.70	8.08	7.91	5.83	5.77	9200	8510
T_2	111.19	105.88	8.91	8.77	6.32	6.25	10186	9620
T_3	118.08	117.70	10.56	10.40	6.99	6.86	11474	10850
T_4	122.20	121.79	11.54	11.50	7.35	7.23	12105	11500
T_5	125.72	124.84	12.23	11.83	7.66	7.45	12686	12000
T_6	113.94	108.34	9.63	9.42	6.62	6.45	10796	10050
T_7	93.69	93.02	7.20	6.95	5.35	5.31	7950	7560
SEd	1.73	1.73	0.33	0.29	0.13	0.12	283	296
CD(p=0.05)	3.84	3.63	0.78	0.69	0.32	0.29	623	608

Treatment details - Gibberellic acid @ 5 g ha^{-1} - (T_1), Gibberellic acid @ 10 g ha^{-1}- (T_2), Gibberellic acid @ 15 g ha^{-1} - (T_3), Gibberellic acid @ 20 g ha^{-1} - (T_4), Gibberellic acid @ 25 g ha^{-1} - (T_5), Triacontanol 0.05% EC @ 250 ml ha^{-1} - (T_6) and Control - (T_7).

Table 2 : Effect of Gibberellic acid on yield attributes, grain and straw yields and harvest index in rice

Treatments	Number of panicles m^{-2}		Filled grains panicle^{-1}		Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Harvest index	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season
T_1	263.64	236.25	75.57	75.00	4500	4330	6177	6175	42.14	41.21
T_2	292.30	236.72	79.61	78.98	4730	4620	6414	6412	42.44	41.87
T_3	346.63	298.63	86.21	84.86	5095	4990	6857	6846	42.62	42.15
T_4	383.29	364.57	90.40	88.88	5425	5295	7104	7070	43.05	42.68
T_5	394.29	377.48	91.45	91.22	5530	5390	7314	7274	43.29	42.88
T_6	313.96	269.63	81.69	81.02	4845	4710	6626	6622	42.23	41.56
T_7	231.64	169.36	69.49	71.51	4050	3950	5930	5917	40.58	40.03
SEd	7.59	6.83	1.75	1.56	56	48	102	98	0.11	0.10
CD (p=0.05)	16.23	14.21	3.75	3.36	120	110	226	216	0.29	0.27

Treatment details - Gibberellic acid@5 g ha^{-1}-(T_1), Gibberellic acid @ 10 g ha^{-1}-(T_2), Gibberellic acid @15 g ha^{-1}-(T_3), Gibberellic acid @ 20 g ha^{-1}-(T_4), Gibberellic acid @ 25 g ha^{-1}-(T_5), Triacontanol 0.05% EC @ 250 ml ha^{-1}-(T_6) and Control-(T_7).

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