Influence of gibberellic acid (GA_3) on productivity, nutrient uptake and post-harvest soil available nutrient status in lowland 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 Influence of gibberellic acid on productivity, nutrient uptake and post-harvest soil available nutrient status in lowland rice (*Oryza sativa* L.). 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 on yield of crop, nutrient uptake by the crop and nutrient availability status at end of the experimentation was critically studied under rice. The grain yield was strikingly impressive by Gibberellic @ 25 g ha^{-1} in both seasons. Among the treatments, Gibberellic @ 25 g ha^{-1} registered the higher nutrient uptake at harvest stage over other treatments and the control. The post harvest soil status of NPK was higher in control (T_1). The least values was recorded in Gibberellic @ 25 g ha^{-1} (T_5). Based on the above experimental results, it could be concluded that cultivation of rice with application of Gibberellic @ 25 g ha^{-1} was found to be an agronomically sound and ecologically safe practice for augmenting higher productivity of rice. Hence this can be recommended to the rice growing farmers of Tamil Nadu.

INTRODUCTION

Rice (Oryza sativa L.) crop occupies the enviable prime place among the food crops cultivated around the world and remains as the most important staple food crop of the world. Rice crop grows between 55°N and 36°S latitudes under diverse climate and weather conditions in different ecosystems. It is the king crop of Asia because 90% of the rice is being produced and consumed in Asia alone. Worldwide rice is grown on an area of 151 million hectare with a production of 597.8 million tonnes and with an average productivity of 4 tonnes/ha. In India, it is grown on nearly 42.41 million hectare with the production of 104.40 million tonnes triggering productivity of 2462 kg 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). While the food demand of the country is increasing day by day due to rapid population growth, the total cultivable area on the contrary is decreasing. To bridge the gap between these two and to meet up the need for food, one of the avenues is to use plant growth regulators to produce major changes in growth *vis-à-vis* productivity. Foliar application of plant growth regulators, both natural and synthetic, has proven worthwhile for improving crop growth against a variety of abiotic stresses. The introduction of chemical growth regulators has added a new dimension to the possibility for improving the growth and yield of rice corp. In principle, the availability of exogenous bio-regulators to modify plant growth offers great opportunity. Plant growth regulators play key role in contributing internal mechanisms of plant growth by interacting with key metabolic processes such as, nucleic acid metabolism and protein synthesis. Plant growth regulators so far have emerged as “magic chemicals” that could increase agricultural production at an unprecedented rate and help in removing and circumventing many of the barriers imposed by genetics and environment. Hormones regulate physiological process and synthetic growth regulators may enhance growth and development of field crops thereby increased total dry mass of a field crop (Dakua, 2002). Gibberellic acid (GA3) is the most widely used plant growth regulator which increases stem elongation along with plant height, growth, dry matter accumulation as well as yield in various crops (Akter et al. 2007). However, very few works have been done on the application of GA3 on rice (Elankavi *et al.*, 2009). Therefore, the present investigation were undertaken at the Annamalai University Experimental farm, Department of Agronomy, Annamalai Nagar to study the effect of GA3 on grain yield, nutrient uptake and post harvest available soil nutrient status in rice under Cauvery delta region of tamil nadu.

MATERIALS AND METHODS

Field experiments were conducted at the Experimental Farm, Annamalai University, Annamalai Nagar during *early samba* 2013 and *thaladi* 2014 to evaluate the Influence of gibberellic acid on productivity, nutrient uptake and post-harvest available nutrient status in lowland rice (*Oryza sativa* L.). The first crop received a rainfall of 1014.9 mm, distributed over 41 rainy days. The second crop received a rainfall of 225.6 mm, distributed over 9 rainy days. 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 were *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 were 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 cm ×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 sufficiently and the yield was recorded net plot wise and computed to kg ha^{-1}.

Statistical analysis

Plants were also analyzed for N, P and K uptake after harvest. The data on various studies recorded during the investigation were subjected to statistical scrutiny as suggested by Gomez and Gomez (1984).

Plant analysis

The plant samples after estimation of dry matter were chopped and powdered by using a Willey mill and were analysed for N, P and K contents.

Analytical methods employed for plant were as under

Particulars	Author(s)	Method
N content	Humphries, 1956	Micro Kjeldahl method
P content	Jackson (1973)	Spectro photometer using triacid digestion method
K content	Jackson (1973)	Flame photometer using triacid extract

Soil analysis

The post harvest composite soil samples were collected after the harvest of rice and analysed for post harvest available nutrients.Analytical methods employed for soil were as under

Particulars	Author(s)	Method
Available N	Subbiah and Asija (1956)	Alkaline permanganate method
Available P	Olsen *et al.* (1954)	Colorimeter method
Available K	Stanford and English (1949)	Flame photometric method

Result and discussion

Grain yield

The data on grain yield was significantly influenced by foliar application of gibberellic acid. Among the treatments, foliar application of 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. 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 @ 10 g ha^{-1} (T_2) were on par with each other and ranked next. This might be attributed to higher biomass production at early stages of crop growth through increased utilization of nutrients, leading to higher LAI and photosynthetic rate (Kumer *et al*., 1996) resulting in better performance as evident by growth and yield attributes which leads to maximum grain yield of rice. The present findings are in agreement with the findings Emongnor (2007) and Pepi Nursusilawathi (2014). The treatment T_7 (control) registered the lowest grain yield of 4050 and 3950 kg ha^{-1} during first and second season, respectively.

Nutrient uptake by rice crop

Increased uptake of N, P and K at maturity stage was observed various treatments with foliar application of growth promoters than control. Among the treatments, foliar application of Gibberellic acid @ 25 g ha^{-1} (T_5) significantly recorded the highest nutrient uptake of 190.29 and 185.43 kg ha^{-1} of N, 28.54 and 27.81 kg ha^{-1} of P_2O_5 and 126.86 and 123.81 kg ha^{-1} of K_2O during first and second season respectively. This higher uptake of nutrients *viz*., NPK might be due to taller plants and higher biomass recorded in this treatment which has directly influence on uptake of nutrients (Golam Adam *et al*., 2012). The next best treatment was (T_4) application of Gibberellic acid @ 20 g ha^{-1}. The treatment control (T_7) recorded the lowest uptake of 133.05 and 131.82 kg ha^{-1} of N, 19.95 and 19.77 kg ha^{-1} of P_2O_5 and 85.11 and 87.88 kg ha^{-1} of K_2O during first and second season respectively. This might be due to low biomass registered in this treatment which inturn poor uptake of nutrients.

Post harvest soil available nutrient

Among the treatments control (T_7) significantly recorded the higher post harvest soil available nitrogen of 226.32 and 231.68 kg $ha^{-1,}$ phosphorus of 16.81 and 18.02 kg ha^{-1}, potassium of 321.52 and 315.47 kg ha^{-1} during first and second season, respectively. This might be due to lesser value of DMP and minimum uptake of NPK registered under this treatment, which in turn higher values of post harvest soil available nitrogen, phosphorus and potassium in both the season. The present findings are in agreement with the findings of Awan and

Alizia, (1989). The least values of post harvest soil available nitrogen of 201.12 and 202.73 kg ha^{-1}, phosphorus of 8.90 and 10.92 kg ha^{-1} and potassium of 296.36 and 296.22 kg ha^{-1} during first and second season, respectively were recorded in Gibberellic @ 25 g ha^{-1} (T_5). This could be attributed to higher DMP and maximum uptake of NPK recorded under this treatment, which leads registered lower values of post harvest soil available nutrient status. Similar findings was reported by Shyamprakash *et al*. (2014).

CONCLUSION

From the results of the experiments, GA_3 had significant effect on grain yield of rice. Best result was obtained with Gibberellic @ 25 g ha^{-1} was found to be optimum concentration for getting the higher grain yield of rice.

Table 2. Effect of gibberellic acid on growth and grain yield of rice

Treatments	Grain yield (kg ha^{-1})		Nitrogen uptake (kg ha^{-1})		Phosphorus uptake (kg ha^{-1})		Potassium uptake (kg ha^{-1})	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season
T_1	4500	4330	142.66	141.01	21.39	21.15	95.11	94.01
T_2	4730	4620	152.79	150.28	22.91	22.54	101.86	100.19
T_3	5095	4990	172.11	168.30	25.81	25.24	114.74	112.20
T_4	5425	5295	181.57	177.45	27.23	26.81	121.05	118.30
T_5	5530	5390	190.29	185.43	28.54	27.81	126.86	123.81
T_6	4845	4710	161.94	159.04	24.29	23.85	107.96	106.03
T_7	4050	3950	133.05	131.82	19.95	19.77	88.11	87.88
SEd	56	48	3.90	3.76	0.58	0.62	2.93	2.89
CD (p=0.05)	120	110	9.21	8.89	1.39	1.34	6.21	5.92

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 4. Effect of gibberellic acid on post harvest soil available nutrient status in rice

Treatments	Available N		Available P_2O_5		Available K_2O	
	First season	Second season	First season	Second season	First season	Second season
T_1	220.35	225.68	14.80	16.46	317.09	311.70
T_2	215.64	219.17	12.81	14.94	312.84	307.44
T_3	208.43	211.28	10.70	12.81	304.56	302.45
T_4	203.32	205.17	9.12	11.31	300.31	298.34
T_5	201.12	202.42	8.90	10.92	296.36	296.22
T_6	213.64	217.59	12.20	14.32	308.83	306.67
T_7	226.32	231.68	16.81	18.02	321.52	315.47
SEd	1.46	1.39	0.34	0.32	1.95	1.78
CD (p=0.05)	3.04	2.86	0.76	0.74	4.11	3.68

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).

REFRENCES:

Akter, A., E. Ali, M. M. Z. Islam, R. Karim and A. H. M. Razzaque. 2007. Effect of GA3 on growth and yield of mustard. *Int. J. Sustain. Crop Prod.* **2**(2): 16-20.

Awan I, Alizai HK. 1989. Effect of plant growth regulators on ripening, grain contributing characters of lentil. M. S. Thesis, Dept. Crop Bot., Bangladesh Agric. Univ.

Dakua MF. 2002. Effect of CI-IAA, TNZ-303 and GABA on growth, yield and yield development and rice quality. Int. Rice Res. Newslett. 149:30-31.

Emongor, V. 2007. Gibberellic Acid (GA3) influence on vegetative growth, nodulation and yield of cowpea (*Vigna unguiculata* (L.) Walp. *J. Agron.* **6**: 509-517.

Golam adam, A.M.M, Nargis jahan and Sirajul Hoque. 2012. Effects of naphthalene acetic acid on nutrient uptake by two varieties of rice (Oryza sativa L.). Journal of Crop and Weed, 5(2): 128-130.

Gomez, K. A. and A. A. Gomez. 1984. *Statistical procedures for agricultural research*. 2nd edition. John Wiley, New York.

Humphries, E.C. 1956. Mineral components and ash analysis: Modern methods of plant analysis. Springer -Verlag (Berlin), **1**: 468-502.

Jackson, M.L. 1973. Soil chemical analysis. Prentice Hall of India Ltd., New Delhi.

Kumer, S. Singh, P. Katiyar, R.P. Vaish C.P., Khan. A.A. *Seed Research* 24 (1996) 11- 14.

Olsen.S.R., C.V.Cole, F.S.Watnabe and L.A.Dean.1954. Estimation of available phosphorus by extraction with sodium carbonate. U.S.Dept.Agric., 939:1-19.

Pepi nur Susilavathi, Memen Surahman, Bambang, S. Purwoko, Tatiek and K.Suharsi. 2014. Effect of GA_3 concentration on hybrid rice seed production in Indonesia. Intl J.of applied sci and Tech., 4: 23.

Shyam Prakash, G. Mahajan, N.Sharma and Sardana. 2014. Enhancing grain yield and nitrogen use efficiency in rice through foliarly applied gibberellic acid in dry direct seeded rice. J.of crop improvement, 29:(1) 65-81.

Stanford, S. and L.English. 1949. Use of flame photometer for rapid soil test for K and Ca. Agron. J., 41: 446-447.

Subbiah, B.V. and G.Asija.1956. A rapid procedure for estimation of available nitrogen in soils. Curr. Sci., 25:259-260.

TNAU. 2013. Rice area, yield and production Tamil Nadu Agricultural University