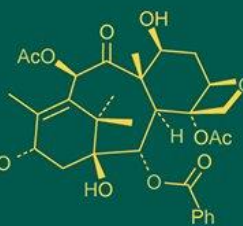
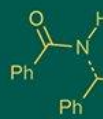


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Effect of plant growth regulators on growth, yield and fruit quality of ratoon banana (*Musa spp.*) cv. udhayam (ABB group)

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Abstract

The investigation was conducted to know the effect of plant growth regulators on growth, yield and fruit quality of Ratoon Banana (*Musa spp.*) cv. Udhayam (ABB group) during 2025-2026. at the Horticulture Research Farm, Horticulture Research Farm, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur (U.P.). The banana tissue culture cv. Udhayam ABB group was brought from National Research Council for Banana (NRCB), Trichy, Tamil Nadu. Tissue culture plants were left in shade nets condition for 2 weeks due to transportation and environmental stress. The experiment was laid out in Randomized Block Design with three replications and eleven treatments. The foliar application of plant growth regulators viz., T₀ Control, T₁ Brassinosteroids @ 1.0ppm, T₂ Brassinosteroids @ 2.0ppm, T₃ Brassinosteroids @ 3.0ppm, T₄ Brassinosteroids @ 4.0ppm, T₅ Brassinosteroids @ 5.0ppm, T₆ CCC@ 800ppm, T₇ CCC@ 900ppm, T₈CCC@ 1000ppm, T₉GA₃ @ 200 and T₁₀ GA₃ @ 300. The results revealed that growth, yield and fruit quality such as plant height (428.36), plant girth (72.78cm), number of leaves per plant (17.73), bunch weight (34.88kg), number of hands per bunch (14.15), no. of fingers hand⁻¹ (25.57), total no. of finger bunch⁻¹ (361.68), average fruit length(14.47cm), average fruit width(10.51cm), average weight (79.14g), total soluble solids (15.76 TSS °brix), titrable acidity (0.18%), reducing sugar (10.48%), non-reducing (6.63%) and total sugar (%) (17.11%). The maximum benefit cost ratio (1: 2.23) was found in treatment T₂ Brassinosteroids @ 2.0ppm and T₃ Brassinosteroids @ 3.0ppm.

Keywords: PGR, growth, yield, fruit quality and banana

Introduction

Banana (*Musa paradisiaca* L.) is one of the major fruit crop in the tropics and subtropics and make a vital contribution to the economies of a number of countries. It is very important in the nutrition of local population as well as tradable commodities with a large market throughout the developed world. Banana is a large herbaceous perennial monocotyledonous and monocarpic crop. It belongs to the family Musaceae in the order Scitamineae. It is known as “Apple of Paradise”. Its origin is the tropical region of South-East Asia. Banana crop has nutritional, medicinal and industrial value and is known for its antiquity and it is interwoven with Indian heritage and culture. Owing to its greater socio-economic significance and multifaceted uses, it is referred as „Kalpatharu“ (plant of virtues). It is a good source of income to the farmers in their respective growing regions (Bridge, 2000; Akinyemi *et al.*, 2010) ^[1, 3]. Banana fruit as an important horticultural crop in tropical and sub-tropical areas in the world is rich in carbohydrate compounds (ascorbic acid, β -carotene and soluble sugars), phenols, and minerals like potassium and calcium. Particularly, banana fruit can prevent chronic diseases like cardiovascular dysfunction and muscular degeneration because of its antimicrobial and therapeutic properties (Kanazawa and Sakakibara, 2000) ^[4]. Banana fruit ripens rapidly in accompany with significant changes of physicochemical and biochemical attributes such as transformation of starch to sucrose, mineral reduction and flavor formation once harvested, which causes green banana fruit into notably perishable (Alkarkhi *et al.*, 2011; Mohapatra *et al.*, 2010) ^[6, 10]. Now-a-days, the practice of application of plant growth regulators, chemicals and bunch management treatments are taken for improving the growth, maturity, yield and quality of banana fruits are gaining popularity. Plant growth regulators are perhaps the most powerful tool to achieve the goal. These are

defined as organic compounds other than nutrients which in small amount promotes/inhibit or modify any physiological response in plants and they are artificially synthesized. PGRs have been successfully used as foliar spray to increase flowering, synchronize bloom or change the time of flowering to avoid the adverse climatic condition or to shift harvest to a time when the market price is more remunerative. PGRs are applied to increase the fruit size directly by stimulating cell division or to increase fruit size and yield Rajan *et al.*, (2017) ^[7].

Materials and methods

The present studies on the “Effect of plant growth regulators on growth, yield and fruit quality of Ratoon Banana (*Musa spp.*) cv. Udhayam (ABB group)” was carried out during the *Kharif* season of the year 2025-2026 at the Horticulture Research Farm, Horticulture Research Farm, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur (U.P.). The banana tissue culture cv. Udhayam ABB group was brought from National Research Council for Banana (NRCB), Trichy, Tamil Nadu. Tissue culture plants were left in shade nets condition for 2 weeks due to transportation and environmental stress. The climate is typically semi-arid, characterized by hot, dry summers and moderately to severely cold winters. The average annual rainfall varies from 800 to 900 mm, with a mean annual precipitation of approximately 818 mm. Rainfall predominantly occurs during the monsoon season from June to the last week of September, with occasional frost and showers during the winter months due to the North-East monsoon in December and January. Geographically, this region is classified under a sub-tropical climate and is located at 26°47' N latitude and 82°12' E longitude, within the Indo-Gangetic alluvial region of eastern Uttar Pradesh, India. The annual rainfall in this area is about 1100 mm, with 85 percent occurring during the monsoon (mid-June to the end of September). The experiment was laid out in randomized block design with 11 treatments, viz. T₀Control, T₁Brassinosteroids @ 1.0ppm, T₂Brassinosteroids @ 2.0ppm, T₃Brassinosteroids @ 3.0ppm, T₄Brassinosteroids @ 4.0ppm, T₅Brassinosteroids @ 5.0ppm, T₆ CCC@ 800ppm, T₇ CCC@ 900ppm, T₈ CCC@ 1000ppm, T₉ GA₃ @ 200 and T₁₀ GA₃ @ 300. A total of 33 uniform plants, each 1 years old and spaced 1.8×1.8 metres apart, were selected for the study. The biometrical observations were recorded on three selected plants of each treatment to assess the effect of treatments on growth, yield and fruit quality of banana in the following characters. All the recorded observations were subjected to statistical analysis. The data on growth, yield and quality components were subjected to Fisher's method of analysis of variance (ANOVA) as outlined by Panse and Sukhatme (1985) where the 'F' test was significant for comparison of the treatment means, CD values were worked out at 5% probability level.

Results and discussion

The results of foliar application of PGRs viz., Brassinosteroids, CCC and GA₃ are summarized in the Table 1. It is evident from the data illustrated in table 1 that there was significant differences among the treatments for vegetative growth parameters at harvest of Banana (*Musa spp.*) cv. Udhayam (ABB) group. The data shown that foliar application of plant growth regulators viz., Brassinosteroids @ 1.0, 2.0, 3.0, 4.0 and 5.0ppm, CCC@ 800, 900, 1000 and

1200ppm and GA₃ @ 200, GA₃ @ 300 have significant effect on plant height (cm) at harvest, plant girth (cm) at harvest and increased number of leaves per plant (at harvest) as compared to control (T₀). The maximum increased plant height (cm) at harvest, plant girth (cm) at harvest and increased number of leaves per plant (at harvest) (428.36, 72.78 and 17.73) was found in treatment T₅ Brassinosteroids @ 5.0ppm. Whereas the minimum plant height (cm) at harvest, plant girth (cm) at harvest and increased number of leaves per plant (at harvest) (305.43, 56.15 and 8.61) was recorded in T₀ Control. Similar findings were reported by Vardhini and Rao (2002) ^[9], who observed enhanced vegetative growth in plants treated with brassinosteroids due to increased metabolic and physiological activities. Likewise, Anuradha and Rao (2007) ^[2] reported that application of brassinosteroids significantly increased plant height and leaf production by promoting cell expansion and photosynthetic activity. Comparable results were also obtained by Sairam (1994) ^[8], who noted improved stem girth and vegetative growth with brassinosteroid application in several horticultural crops. Furthermore, Khripach *et al.* (2000) ^[5] stated that brassinosteroids play a vital role in enhancing overall plant growth and development through regulation of physiological and biochemical processes.

The results of foliar application of PGRs viz., Brassinosteroids, CCC and GA₃ are summarized in the Table 1. It is evident from the data illustrated in table 1 that there was significant differences among the treatments for yield and yield attributes at harvest of Banana (*Musa spp.*) cv. Udhayam (ABB) group. The data shown that foliar application of plant growth regulators viz., Brassinosteroids @ 1.0, 2.0, 3.0, 4.0 and 5.0ppm, CCC@ 800, 900, 1000 and 1200ppm and GA₃ @ 200, GA₃ @ 300 have significant effect on bunch weight (kg), number of hands per bunch, no. of fingers hand⁻¹, total no. of finger bunch⁻¹, average fruit length(cm), average fruit width(cm) and average weight (g) as compared to control (T₀). The maximum bunch weight (kg), number of hands per bunch, no. of fingers hand⁻¹, total no. of finger bunch⁻¹, average fruit length(cm), average fruit width(cm) and average weight (g) (34.88, 5.94, 25.57, 361.68, 14.47, 10.51 and 79.14) was found in treatment T₅ Brassinosteroids @ 5.0ppm. Whereas the minimum bunch weight (kg), number of hands per bunch, no. of fingers hand⁻¹, total no. of finger bunch⁻¹, average fruit length(cm), average fruit width(cm) and average weight (g) (21.24, 14.15, 19.09, 89.61, 10.08, 7.25 and 42.33) was recorded in T₀ Control. These findings are in close conformity with the results of Khripach *et al.* (2000) ^[5], who reported that brassinosteroids significantly improved fruit growth and yield attributes by stimulating cell division and elongation. Similar observations were also made by Vardhini and Rao (2002) ^[9], who found enhanced yield and fruit characteristics in crops treated with brassinosteroids due to improved metabolic activity and assimilate partitioning. Anuradha and Rao (2007) ^[2] also reported increased fruit size, fruit weight, and overall yield with brassinosteroid application owing to enhanced photosynthetic efficiency and nutrient mobilization. Further, Sairam (1994) ^[8] observed that brassinosteroids positively influenced reproductive growth and yield parameters in horticultural crops under different growing conditions.

The results of foliar application of PGRs viz., Brassinosteroids, CCC and GA₃ are summarized in the Table 1. It is evident from the data illustrated in table 1 that

there was significant differences among the treatments for biochemical parameters at harvest of Banana (*Musa* spp.) cv. Udhayam (ABB) group. The data shown that foliar application of plant growth regulators viz., Brassinosteroids @ 1.0, 2.0, 3.0, 4.0 and 5.0ppm, CCC@ 800, 900, 1000 and 1200ppm and GA₃ @ 200, GA₃ @ 300 have significant effect on total soluble solids (TSS), acidity (%), reducing sugar (%), non-reducing (%) and total sugar (%) as compared to control (T₀). The maximum total soluble solids (TSS 15.76 °Brix), minimum acidity (0.18%), reducing sugar (10.48%), non-reducing (6.63%) and total sugar (17.11%) was found in treatment T₅ Brassinosteroids @ 5.0ppm. Whereas the minimum total soluble solids (TSS 11.47 °Brix), maximum acidity (0.49%), reducing sugar (7.37%), non-reducing (5.08%) and total sugar (12.45%)

was recorded in T₀ Control. The present findings are in agreement with the observations of Vardhini and Rao (2002)^[9], who reported that brassinosteroids enhanced fruit ripening and improved biochemical constituents in fruits through increased metabolic activity. Similar results were also reported by Anuradha and Rao (2007)^[2], who observed higher TSS and sugar content with brassinosteroid application due to increased photosynthetic efficiency and carbohydrate accumulation. Khripach *et al.* (2000)^[5] further stated that brassinosteroids improve fruit quality by regulating physiological and biochemical processes associated with sugar metabolism and organic acid conversion. In addition, Sairam (1994)^[8] reported enhancement in quality attributes and accumulation of soluble sugars in crops treated with brassinosteroids.

Table 1: Effect of plant growth regulators on growth, yield and fruit quality of Ratoon Banana (*Musa* spp.) cv. Udhayam (ABB group)

Treatment symbols	Growth, yield and fruit quality														
	Plant height (cm) at harvest	Plant girth (cm) at harvest	Increase d number of leaves per plant (at harvest)	Bunch weight (kg)	Number of hands per bunch	No. of fingers hand ⁻¹	Total no. of finger bunch ⁻¹	Average fruit length (cm)	Average fruit width (cm)	Average weight (g)	Total soluble solids (TSS)	Titrate Acidity (%)	Reducing sugar (%)	Non-reducing (%)	Total sugar (%)
T ₀	305.43	56.15	8.61	21.24	5.94	15.09	89.61	10.08	7.25	42.33	11.47	0.49	7.37	5.08	12.45
T ₁	398.47	68.28	15.19	32.39	12.76	22.41	285.96	13.19	10.04	70.28	14.70	0.33	9.54	6.11	15.65
T ₂	405.40	68.38	15.33	33.41	13.14	23.44	308.09	13.40	10.20	72.41	15.20	0.29	10.18	6.25	16.44
T ₃	410.37	69.53	16.32	34.27	13.74	23.99	329.59	13.95	10.31	73.66	15.34	0.25	10.24	6.35	16.59
T ₄	415.59	71.51	17.64	34.58	13.89	24.16	335.55	14.22	10.42	75.44	15.49	0.23	10.34	6.56	16.89
T ₅	428.36	72.78	17.73	34.88	14.15	25.57	361.68	14.47	10.51	79.14	15.76	0.18	10.48	6.63	17.11
T ₆	359.40	63.23	12.23	26.84	9.41	19.55	184.01	11.40	9.12	61.11	12.12	0.46	8.87	5.64	14.51
T ₇	356.43	63.82	13.45	27.38	10.08	20.20	203.68	12.10	9.47	63.19	12.54	0.43	9.07	5.75	14.82
T ₈	348.21	63.23	13.48	28.51	10.57	20.68	218.58	12.24	9.69	63.76	13.23	0.41	9.18	6.84	16.02
T ₉	378.36	66.41	14.29	30.34	11.45	21.07	241.18	12.48	9.80	66.34	13.54	0.38	9.33	5.88	15.21
T ₁₀	381.23	69.39	14.15	30.57	11.44	21.45	245.41	12.70	9.87	68.68	14.30	0.35	9.59	6.06	15.65
F-Test	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
C.D.	0.307	0.451	0.401	0.279	0.218	0.242	5.042	0.209	0.130	0.940	0.183	0.019	0.128	0.887	0.917
SE(m)	0.103	0.152	0.135	0.094	0.073	0.082	1.697	0.070	0.044	0.316	0.062	0.007	0.043	0.299	0.309
SE(d)	0.146	0.215	0.191	0.133	0.104	0.115	2.400	0.100	0.062	0.448	0.087	0.009	0.061	0.422	0.437
C.V.	0.047	0.395	1.622	0.535	1.106	0.654	1.153	0.956	0.783	0.819	0.763	3.287	0.789	8.475	3.433

Conclusion

Based on the findings of the experiment, it is concluded that T₅ Brassinosteroids @ 5.0ppm showed the highest plant height (428.36), plant girth (72.78cm), number of leaves per plant (17.73), bunch weight (34.88kg), number of hands per bunch (14.15), no. of fingers hand⁻¹ (25.57), total no. of finger bunch⁻¹ (361.68), average fruit length (14.47cm), average fruit width (10.51cm), average weight (79.14g), total soluble solids (15.76 TSS °brix), titrable acidity (0.18%), reducing sugar (10.48%), non-reducing (6.63%) and total sugar (%) (17.11%).

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