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Response of anthurium (*Anthurium andreanum* L.) to gibberellic acid and bio-fertilizer on growth and yield performance under soilless culture

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Abstract
A field experiment was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during the period of 2017-18 to evaluate the growth and flowering attributes of Anthurium under influence of GA3 and bio-fertilizer (*Azospirillum*). The experiment was laid out in a randomized block design (RBD) with three replications. The treatments were T_1 (19 all, It is a recommended fertilizer and it contains balanced nutrients NPK in a ratio of 19:19:19), T_2 (19 all + *Azospirillum*), T_3 (19 all + *Azospirillum* + 100 ppm GA_3), T_4 (19 all + *Azospirillum* + 150 ppm GA_3), T_5 (19 all + *Azospirillum* + 200 ppm GA_3), T_6 (19 all + *Azospirillum* + 250 ppm GA_3),T_7 (19 all + 100 ppm GA_3),T_8 (19 all + 150 ppm GA_3),T_9 (19 all + 200 ppm GA_3),T_{10} (19 all + 250 ppm GA_3). Data analysis over the period of experiment revealed that the highest plant height (42.78 cm), highest number of leaves (9), highest leaf length (32.26 cm), highest leaf breadth (20.23 cm), highest leaf area (309.37 cm^2), highest plant spread (29.23 cm) were found in treatment T_3 which is followed by T_7. Among flower parameters highest number of flower per plant (14.33) was recorded in the treatment T_3. This trend was reflected in spathe length (18.98cm), spathe breadth (13.43cm) and flower stalk length (42.27cm) for T_3. The highest self-life of spathe (52.20 days) and highest vase life of spathe (32.20 days) were recorded in treatment T_3. The study led to the conclusion that maximum growth parameters and flowering attributes of Anthurium could be achieved by application of treatment T_3.

Keywords: Gibberellic acid, bio-fertilizer (*Azospirillum*), growth, yield

Introduction

Anthurium (*Anthurium andreanum*) is an important tropical ornamental plant grown for its exotic beauty producing for its various colorful spathe and attractive foliage. They are very popular as cut flowers for their beauty, bold effect & long lasting qualities which are essential prerequisites for floral arrangements. The major producers in the world are Netherland, Mauritius and Hawaii. Asia is most rapidly growing market for Anthurium. It is basically a semiterrestrial tropical plant requiring warm, shaded and humid conditions, similar conditions that prevail in West Coast and Western ghat hilly regions of South India and some parts of North East India (Nataraj *et al*. 2018) [13].

In the 1950's, gibberellin was characterized as phytohormones. Phytohormones are organic compounds, non-nutrients, produced by plants and in low concentrations. They promote, inhibit or modify physiological and morphological processes of vegetables, fruit crops and other plants (Davies, 2004) [8]. The most important gibberellin is GA_3. GA_3 has been widely used in commercial horticultural cultivation as a growth regulator to improve plant growth. Exogenous application of GA_3 led to bigger shoots, leaves, stem and root by stimulating cell growth and division in many plants (Bose *et al*., 2013) [4]. Ecofriendly, cost-effective and organic-based inputs such as botanical pesticides, biofertilizers, disease and pest-resistant varieties in cultivation of horticultural crops will be safeguarding soil or growing media health and quality production. The use of various bioinoculants like *Azotobacter*, *Azospirillum* and VAM along with PGPRs not only will supplement various nutrients in the soil but also improve the quality and quantity of crops. Anthurium is susceptible to many soil borne diseases which reduce the growth and quality of plant and flowers. Therefore nowadays commercial cultivation of anthurium is mainly done in soilless culture where soil borne diseases cannot attack the plant. Keeping all these aspects in view, the present study was taken up to study the response of Anthurium to GA_3 and biofertilizers on growth and yield under soilless culture.

Materials and Method

The Anthurium (*Anthurium andreanum*) variety Tropical was evaluated under agro shade net house during 2017-18 at Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat (26^0 47′ N and 94^0 12′E). The experiment was laid out in randomized block design with three replications. The treatments consisted of *viz.*, T_1 (19 all, It is a recommended fertilizer and it contains balanced nutrients NPK in a ratio of 19:19:19), T_2 (19 all + *Azospirillum*), T_3 (19 all + *Azospirillum* + 100 ppm GA_3), T_4 (19 all + *Azospirillum* + 150 ppm GA_3), T_5 (19 all + *Azospirillum* + 200 ppm GA_3), T_6 (19 all + *Azospirillum* + 250 ppm GA_3), T_7 (19 all + 100 ppm GA_3),T_8 (19 all + 150 ppm GA_3),T_9 (19 all + 200 ppm GA_3),T_{10} (19 all + 250 ppm GA_3). The Anthurium's suckers were planted on the 30 cm raised beds framed with cemented bricks walls which hold the growing media. The beds were constructed by giving a gentle slope of 3 inch. The bed size was 1.2 m breadth and 12 m length. In between two beds 80 cm gap was given. At bottom black polythene is placed to prevent the contact of media with soil. The beds were filled up with 10.2 cm (4 inches) layer of brick pieces at the bottom, followed by 7.6 cm (3 inches) layer of charcoal on its top followed by 5.1 cm (2 inches) layer of coco husk (3 cm X 3 cm pieces).. For planting of each sucker a small pit was prepared and filled up with coco peat and sand in 3:1 ratio. The 20 cm long uniform suckers were root dip in bio-fertilizer (*Azospirillum*) slurry for 20 mints and after that they were planted in the small pits prepared in the bed and the pits were filled up with coco peat and sand in 3:1 ratio. Planting was done on 17^{th} of January, 2017 with 15 plants per treatment. A spacing of 30cm was maintained between both plant and rows. Different concentrations of GA_3 (100 ppm, 150 ppm, 200 ppm and 250 ppm) were applied as foliar spray to the plants at 50 and 100 days after planting for better growth and establishment. Care was taken so that there was no drifting of spray solution from one treatment to other. Fertilizer was applied in the form of complete fertilizer i.e. 19 all @ 2g/l for twice a week which is the also the recommended dose of fertilizer. Standard cultural practices like weeding, leaf pruning were followed to improve the vigor of the plants. Availability of water is one of the most important factors for successful Anthurium cultivation. During the dry period watering was done twice a day and otherwise it was done once manually.

Results and Discussion

Growth performance

Plant height

The highest plant height of 42.78 cm was recorded for the treatment T_3 (RDF + *Azospirillum* + 100 ppm GA_3) and second highest height of 40.66 cm was recorded for the treatment T_7 (19 all + 100 ppm GA_3). (Table 1 and Figure 1). This might be due the fact that gibberellin stimulates the expression of enzymes involved in cell wall loosening and genes controlling cell division and also stimulates microtubule rearrangements associated with cell expansion (Abbasaniayzare, 2012) [1]. Moreover, the root dip treatment with *Azospirillum* provided a more balance nutrition for plants as well as optimum absorption of more nutrition by roots accelerated the physiological process and improved the general growth phenomenon. The increase in plant height was due to the presence of a readily available form of nitrogen (Sankari *et al*. 2015) [18].

Leaf length and breadth (cm)

Significant increase in leaf length and breadth (32.26 cm and 20.23 cm respectively) was found for the treatment T_3 (RDF + *Azospirillum* + 100 ppm GA_3) showed in Table 1. Foliar application of GA3 might have influenced cell division and cell elongation resulting in enhanced vegetative growth of plant which also influences the better leaf growth. The other notable cause may be due to increased absorption of nutrients which resulted in increase in the synthesis of carbohydrates, chlorophyll content and increase the activity of hormones produced by *Azospirillum*. It also helped better proliferation of root growth and uptake of other nutrients to a great extent (Patel *et al*. 2016) [16].

Number of leaves per plant

The leaves serve as the active site for food synthesis in plant. The highest number of leaves per plant (Table 1 and Figure 2) was recorded in the treatment T_3 (19 all + *Azospirillum* + 100 ppm GA_3) i.e. 9.00 and T_7 (19 all + 100 ppm GA_3) i.e. 8.00. Gibberellic acid increases the alpha amylase activity, auxin stimulating effect and cell wall loosing, increased cell elongation along with the cell enlargement. All these caused effect on increased number of leaf, thereby causing increased photosynthetic area. Thus, this caused increase in carbohydrate food material (Chaudhari 2003) [7]. Bio-fertilizers increase the absorption of the macro and micro nutrients of plant. Production of more number of leaves might also be due to the increased availability of N in growing media, which is an important component of chlorophyll and protein thus causing more growth (Kumar and Singh, 2007) [12].

Yield performance

Number of flowers per plant

The number of flowers per plant is the major yield contributing factor in anthurium. The number of flowers per plant was significantly influenced by the different treatments. The treatment T_3 (RDF + *Azospirillum* + 100 ppm GA_3) resulted in highest number of flower i.e. 14.33 (Table 2 and Figure 3). The probable reason for increase in the number of flower could be due to the effect of gibberellic acid on transformation of metabolites from vegetative phase to reproductive phase by increasing number of flower buds. These results are in line with findings of Henny and Hamilton (1992) [10] and Anjali *et al.* (2014) [2] in Anthurium. The highest number of flower was found in the treatments which were treated with bio-fertilizer. This may be also due to *Azospirillum* which might have stimulated the rate of multiplication of lateral roots and root surface area so as to absorb more nutrients from media for flower production. Similar results were reported by Jawaharlal and Padmadevi (2004) [11] in Anthurium.

Spathe length (cm) and spathe breadth (cm)

Marked differences were noticed among the treatments on spathe length and spathe breadth. The highest spathe length and breadth were noticed for the treatment T_3 (RDF + *Azospirillum* + 100 ppm GA_3) and the second highest spathe length and breadth were noticed for T_7 (RDF + 100 ppm GA_3) which is showed in Table 2 and Figure 4. The role of GA_3 in improving the spathe size may be ascribed to the translocation of metabolites at the site of spathe development. Gibberellic acid has been reported to induce an entire developmental program by activation of regulatory genes in the later stages of corolla development as observed by Preethi (1990) [17] in rose. The increased spathe width might also be due to the role of biofertilizers in enhancing nutrient uptake and helped in production of auxin like substances which may be responsible for better translocation of photosynthates from site of synthesis to apical region and there by increased the spathe width. The present findings are in line with the reports of Pandey *et at*. (2017) [14] in Dahlia, Pansuriya *et al*. (2018) [15] in Gladioulus.

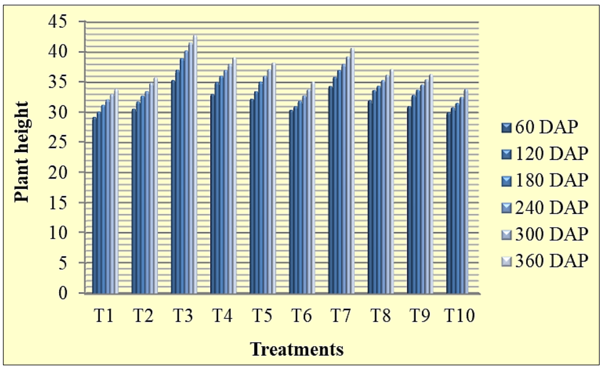
Number of sucker per plant

In the present study the number of suckers per plant was influenced significantly by plant growth regulators. T_3 (RDF + *Azospirillum* + 100 ppm GA_3) recorded the maximum number of suckers per plant followed by T_7 (RDF + 100 ppm GA_3) respectively which is showed in Table 2 and Figure 3. This is in agreement with the findings of Reddy *et al*. (1997) [22] in China aster. The higher number of suckers by using GA_3 might be due to increase in the number and size of leaves as a result of higher translocation of the photosynthates and eventually that would have been used for the production of propagules (suckers) (Sharifuzzaman *et al.* 2011) [19] in Anthurium. More number of suckers production may be due to the bioactive substances produced by *Azospirillum* and the better network of mycorrhizal hyphae around root zone This result are in agreement with Chandrappa (2002) [5] in Anthurium.

Self-life and vase life of flower (days)

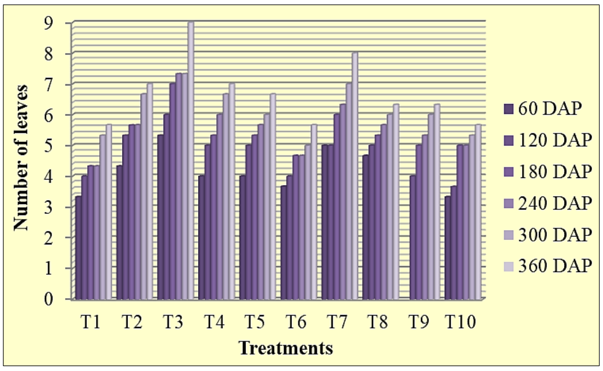
Like all other morphological characters in terms of superiority caused by T3 (RDF + *Azospirillum* + 100 ppm GA_3), the highest self-life of spathe (52.20 days) and vase life of spike (32.60 days) was recorded for the treatment T3 (RDF + *Azospirillum* + 100 ppm GA_3) which is showed in Table 2. The increase in self-life and vase life of flowering may be due to the application of GA3 as foliar spray that might have influenced the continuity in the water conductance by the tissues without any blockage and GA3 might have also increased the osmatically driven water uptake by the flower stalks. The self-life of the flowers depends on genetic makeup and water quality, the major factor contributing to deterioration is vascular blockage (Chopde, 2007) [6]. Similar findings of increase in the self-life and vase life of flowers with GA_3 application was reported by Delvadia *et al*. (2009) [9] in gaillardia. Inoculation with biofertilizers influenced flower longevity due to the increased nutrient uptake by plant and greater development of water conducting tissues. The delay in senescence may be due to presence of ethylene inhibitors in plant which delay senescence of florets. These results are in corroboration with the findings of Barreto *et al.* (2002) [3] in gerbera. It might also be due to overall food and nutrient status of flowers under the treatments. Srivastava *et al.* (2007) [20] reported the effect of *Azospirillum* and organic manures on the post-harvest quality of tuberose cv. Double and showed significant increase in vase life over the untreated control. This might be due to the availability of N to the plant which improves the quality of flower due to better phosphorelation in plants.

In conclusion, of all the treatments, it was found that application of NPK 19:19:19 together with 100 ppm GA_3 at 100 ppm and *Azospirillum* (root deep treatment) i.e. Treatment T_3 proved to be the best in *Anthurium andreanum* Cv, Tropical Red for overall growth and yield performance. Thus to mitigate the demand of Anthurium cut flower in both the national and international market this treatment may be a solution for the flower growers.



Note: DAP = Days after planting

Fig 1: Plant heights in different growth stage



Note: DAP = Days after planting

Fig 2: Number of leaves at different growth stages

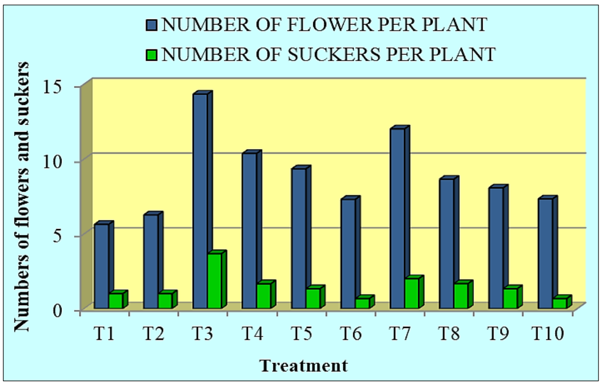


Fig 3: Number of flower and number of sucker per plant

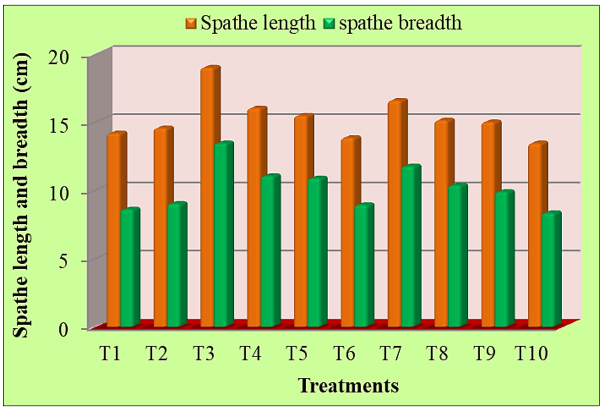


Fig 4: Spathe length and spathe breadth

Table 1: Response of Anthurium (*Anthurium andreanum* L.) to gibberellic acid and bio-fertilizer on growth performance after 360 days after planting (DAP)

Treatments	Plant height (cm)	Leave length (cm)	Leave breadth (cm)	No. of sucker per plant	No. of leaves
T1 - Recommended dose of NPK fertilizers @ 19:19:19 (RDF)	33.85	24.05	17.26	1.00	5.67
T2 - 19 all + Azospirillum	35.76	25.13	17.73	1.00	7.00
T3 - 19 all + Azospirillum + 100 ppm GA3	42.78	32.26	20.23	3.67	9.00
T4 - 19 all + Azospirillum + 150 ppm GA3	39.11	27.32	18.83	1.66	7.00
T5 - 19 all + Azospirillum + 200 ppm GA3	38.23	25.87	18.26	1.33	6.67
T6 - 19 all + Azospirillum + 250 ppm GA3	35.06	23.16	17.30	0.67	5.67
T7 - 19 all + 100 ppm GA3	40.66	29.89	19.57	2.00	8.00
T8 - 19 all + 150 ppm GA3	37.15	25.45	18.56	1.67	6.33
T9 - 19 all + 200 ppm GA3	36.31	25.05	17.86	1.33	6.33
T10 - 19 all + 250 ppm GA3	34.95	23.47	16.90	0.67	5.67
S.Ed. (±)	1.15	0.99	0.27	0.42	0.52
CD 0.05	2.54	2.10	0.57	0.85	1.10

Table 2: Response of Anthurium (*Anthurium andreanum* L.) to gibberellic acid and bio-fertilizer on yield performance after 360 days after planting (DAP)

Treatments	No. of flower per plant	Spathe length (cm)	Spathe breadth (cm)	No. of sucker per plant	Self-life (days)	Vase life (days)
T1 - Recommended dose of NPK fertilizers 19:19:19 (RDF)	5.63	14.17	8.58	1.00	38.13	18.40
T2 - 19all + Azospirillum	6.26	14.54	9.00	1.00	39.23	18.80
T3 - 19 all + Azospirillum + 100 ppm GA3	14.33	18.98	13.43	3.67	52.20	32.60
T4 - 19 all + Azospirillum + 150 ppm GA3	10.37	16.00	11.03	1.66	48.33	23.43
T5 - 19 all + Azospirillum + 200 ppm GA3	9.34	15.54	10.86	1.33	46.73	21.80
T6 - 19 all + Azospirillum + 250 ppm GA3	7.30	13.83	8.91	0.67	40.37	19.43
T7 - 19 all + 100 ppm GA3	12.01	16.56	11.75	2.00	49.16	25.26
T8 - 19 all + 150 ppm GA3	8.65	15.11	10.34	1.67	45.50	21.40
T9 - 19 all + 200 ppm GA3	8.07	14.98	9.87	1.33	43.27	20.63
T10 - RDF + 250 ppm GA3	7.33	13.43	8.32	0.67	40.30	19.33
S.Ed. (±)	0.98	1.12	0.93	0.42	1.15	0.15
CD 0.05	2.06	2.35	1.95	0.85	2.45	0.31

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