Current Journal of Applied Science and Technology

38(6): 1-7, 2019; Article no.CJAST.53377
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Effect of Foliar Spray of Primary Nutrients and their Frequency on Anthurium (*Anthurium andreanum* L.) var. Xavia under Protected Condition

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Authors' contributions

This work was carried out in collaboration among all authors. Author PK conducted trial, collected data, performed the statistical analysis and wrote the first draft of the manuscript. Author PS designed the study and managed the analyses of the study. Authors AB and RK managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2019/v38i630415
Editor(s):
(1) Dr. A. A. Hanafi-Bojd, Assistant Professor, Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, Iran.
Reviewers:
(1) R. K. Mathukia, Junagadh Agricultural University, India.
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(3) Aida A. Rizkalla, National Research Centre, Egypt.
Complete Peer review History: http://www.sdiarticle4.com/review-history/53377

Original Research Article

Received 10 October 2019
Accepted 17 December 2019
Published 21 December 2019

ABSTRACT

The experiment was conducted under protected conditions at the Polyhouse Complex, Department of Horticulture (Veg. and Flori.), Bihar Agricultural University, Sabour, Bhagalpur, Bihar during the year 2016-2017. The experiment was laid out in Factorial Completely Randomized Design with three replication and 10 treatment combinations, comprising five levels of water soluble fertilizer (1 g/l, 2 g/l, 3 g/l, 4 g/l and 5 g/l) and two frequencies of spray (once a week and twice a week). Plants were maintained in net house conditions (75% shade). The result indicated that among all treatment combinations, D_5F_2 (NPK 19:19:19 @ 5 g/l twice a week) found to be best in terms of vegetative growth, flowering and productivity of anthurium var. Xavia as it recorded maximum values for all the characters. The treatment combination D_5F_2 (NPK 19:19:19 @ 5 g/l twice a week) recorded maximum length and breadth of leaf (26.02 cm and 15.48 cm, respectively), plant spread east to west and north to south (62.67 cm and 62.37 cm, respectively), petiole length (36.76 cm), flower

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stalk length (29.17 cm), spathe length and breadth (9.61 cm and 8.30 cm, respectively) and higher yield of flowers per plant (4.13). It required minimum days (90.93 days) for first flower opening. Hence considering the positive effects on growth, flowering, yield and quality, the treatment combination D_5F_2 (NPK 19:19:19 @ 5 g/l twice a week) can be considered for adopting at the field level to get better qualitative and quantitative yield.

Keywords: Anthurium; protected; water soluble; vegetative; flowering; primary nutrient.

1. INTRODUCTION

Anthurium (*Anthurium andreanum*) is one of the most important ornamental evergreen slow-growing herbaceous perennial flower crops which are grown in several locations across the world. Taxonomically anthurium belongs to family Araceae. This evergreen plant is native to Columbia, Peru, Central and South America [1]. It requires shady, humid conditions as found in tropical forests hence suited to Indian climate. It is popular for its colourful long lasting flowers. Lately, it has gained identity as major cut flowers of the novel world. The genus *Anthurium*, with over 700 species is the biggest in the family Araceae [2]. The name anthurium is derived from the Greek word. It is also known as painted tongue, flaming flower or Tail flower. Among the number of species available, the most popular and economically important species are *Anthurium andreanum* and *Anthurium scherzerianum*, which possess attractive long lasting inflorescence. It produces numerous inflorescences (spadices) subtended by brightly coloured spathes or bracts, which are carried on long, slender peduncles. The spathes are characteristically heart-shaped, flat, puckered and shiny. Day temperatures of 25ºC to 28ºC and night temperature of 18ºC to 20ºC is supposed to be best for anthurium cultivation. The desirable night temperature for vegetative growth is 18.3ºC and for flowering 21ºC to 23.9ºC is needed [3]. Consequently, temperatures lower than 15ºC and more than 35ºC affects negatively. The optimum relative humidity of 60-80% is maintained for economic production of flowers. Anthurium is a shade loving plant hence proper provision of light and shade is utmost important.

Anthurium requires a best potting media, high organic compost, with good aeration drainage facility, low salt concentration and with good water retention capacity [4]. It must be provided good anchorage, required pH (5.0) and EC (0.6 m. mhos/cm^2). It should have good structure and texture. Now a days, in many parts coconut husk and coco peat have been proved to be most popular media for anthurium cultivation. The nutrients supplied by the macro and micro elements are necessary for the various biochemical processes and normal plant growth and development that occur within the plant [5]. Foliar application of nutrients is gaining more importance in fertilization of various field and floricultural crops, in many countries [6]. Foliar application of nutrients is easy and quick approach to provide its requirement. Nutrients needs of anthurium can be met through different sources, of which, major source chemical fertilizers. Keeping in view the limited studies and less available information regarding effect of foliar spray of primary nutrients, the present investigation "Effect of foliar spray of primary nutrients and their frequency of spray on anthurium (*Anthurium andreanum* L.) var. Xavia under protected conditions was carried out.

2. MATERIALS AND METHODS

The present investigation was conducted at the Polyhouse Complex, Department of Horticulture (Veg. and Flori.), Bihar Agricultural University, Sabour, Bhagalpur, Bihar, situated in the core of the vast Indo-Gangetic plains of north eastern India at an altitude of 45.57 m above mean sea level and lies at longitude of 87º2' 42" east and latitude of 25º15' 40'' north under subtropical to slightly semi-arid climatic condition. The maximum and minimum temperature during cropping period was recorded to be 33.2ºC and 25.1ºC, respectively. Nine months old uniformly developed suckers of anthurium var. 'Xavia' having good demand for cut flowers was used for the present experiment. Small size (30 cm) clay pots with aeration holes were used for planting of anthurium. Coconut husk, brick pieces and charcoal were used as potting mixture. Plants maintained in 75 per cent shade net and 60-65 per cent relative humidity. Ten treatment combination involving five different doses/levels of primary nutrients NPK (19:19:19) viz. D_1-1 g/l, D_2-2 g/l, D_3-3 g/l, D_4-4 g/l and D_5-5 g/l) and two frequency of application of primary nutrients viz. F_1-once a week and F_2- twice a week, thus the total 10 treatment combinations was represented as D_1F_1 (NPK 19:19:19 @ 1g/l once a week), D_1F_2 (NPK 19:19:19 @1g/l twice a week, D_2F_1 (NPK 19:19:19 @ 2 g/l once a week), D_2F_2 (NPK

19:19:19 @ 2 g/l twice a week),D_3F_1 (NPK 19:19:19 @ 3 g/l once a week), D_3F_2 (NPK 19:19:19 @ 3 g/l twice a week), D_4F_1 (NPK 19:19:19 @ 4 g/l once a week), D_4F_2 (NPK 19:19:19 @ 4 g/l twice a week), D_5F_1 (NPK 19:19:19 @ 5 g/l once a week) and D_5F_2 (NPK 19:19:19 @ 5 g/l twice a week). Experiment was laid out in Factorial Completely Randomized Design and all treatment combinations replicated three times. The water soluble fertilizers of calcium nitrate (0.5 g/l) plus magnesium sulphate (0.5 g/l) at 15 days interval were used during the course of investigation for all the treatment. The micronutrient mixture was also applied once in fortnight interval @ 0.5 g per liter. The important vegetative growth as length and breadth of leaf, plant spread, petiole length, number of leaves per plant and flowering characters viz., days taken to first flower opening, period of inflorescence emergence to spathe unfurling, length of flower stalk, length and breadth of spathe, spadix length and number of flower per plant were recorded. All the mean values of the recorded data were statistically analyze in FCRD design and tabulated.

3. RESULTS AND DISCUSSION

3.1 Vegetative Growth Parameters

3.1.1 Effect of different primary nutrients foliar spray

Application of different levels of primary nutrients exhibit significant effect on various vegetative growth parameters, viz., length and breadth of leaves, plant spread, petiole length. Whereas, number of leaves per plant was not affected by different levels of primary nutrient spay (Tables 1 and 2). Among different levels of primary nutrients, maximum leaf length (25.43 cm) and leaf breadth (15.32 cm) were recorded in treatment D_5, which was at par with D_3 and D_4 treatments. Maximum number of leaves (4.47) was also recorded in D_5 treatment. The plants spread in N-S (60.92 cm) direction was recorded maximum under treatment D_5 which was at par with $D_4$and D_3 treatments. Similarly, maximum plant spread in E-W (61.03 cm) was recorded with treatment D_5, which was at par with D_4 and D_3 treatments. The treatment D_5 ragistered significantly higher values for petiole length (35.51 cm) which was at par with treatment D_4. All vegetative growth parameters increased due to higher dose of nutrients, especially NPK spray during vegetative period in orchid noticed by Ali, et al. [7]. It might be due to optimum availability of the nutrients. Moreover, a suitable foliar primary nutrient combination such as nitrogen, phosphorus and potash, which is necessary for the synthesis of protein and cytokinin, consequently affects cell division. Similar results have also been reported by Srinivasa and Reddy [8], Baboo and Singh [9] and Barad et al. [10].

3.1.2 Effect of frequencies of the primary nutrient spray

In case of frequencies of the foliar spray, the higher growth of vegetative characters viz. leaf length and breadth, plant spread and petiole length were recorded in F_2 i.e. spray twice a week as compared to F_1 i.e. spray once a week for the same characters. Frequent application of nutrients and readily supply of nitrogen is responsible for more transport of metabolites for plant growth have been reported by Marschner [11]. These results are in parallel with those reported by Sunitha, et al. [12] and Gaur, et al. [13].

3.1.3 Interaction effect

Interaction effect of different levels of primary nutrients and their frequencies per week failed to exhibit any significant effect on various vegetative growth parameters.

3.2 Flowering, Yield and Quality Parameters

3.2.1 Effect of different primary nutrients foliar spray

Different levels of primary nutrients significantly influence days to first flower opening, length and breadth of spathe, flower stalk length, spadix length and number of flower per plants. The minimum days to first flower opening (91.47 days) was recorded in treatment D_5 which was at par with D_4 treatment. The early flowering was probably due to increased availability of nutrients during the vegetative (juvenile) phase, which increased photosynthesis and respiration with enhanced carbon-di-oxide fixation, there by induced early flowering. The present results are in accordance with the findings of Jawaharlal, et al. [14], Srinivasa and Reddy [8] and Gurjar, et al. [15] in anthurium. In case of spathe length (9.49 cm) was recorded maximum in D_4 which was at par with D_5 (9.48 cm) and D_3 (9.18 cm). Whereas, maximum spathe breadth (8.20 cm) was recorded in treatment D_5. The maximum flower stalk length (28.43 cm) was also recorded

in treatment D_5 which was at par with D_4 and D_3 treatments. Number of flowers per plant was noted significantly maximum (3.63) in the treatment D_5 which was at par with D_4 (3.53). Optimum levels of balanced NPK nutrition as it enhances better photosynthetic activity and production of carbohydrates, which helps in better partitioning of nutrients from source to sink, reported by Tatte, et al. [16] in anthurium. These findings are in accordance with the results of Gurjar, et al. [15] and Jadhav, et al. [17] in anthurium. Foliar spray of different concentration of water soluble fertilizers significantly influenced the all flowering parameters in orchid have also been reported by Panda, et al. [18].

3.2.2 Effect of frequencies of primary nutrient spray

Frequencies of primary nutrients spray significantly affected the number of days required for first flowering. Anthurium plants sprayed with nutrients twice in a week (F_2) took the minimum days to first flower opening (93.55 days). It might be due to optimum availability of the nutrients. These results are in line with Gurjar, et al. [15] in anthurium. The maximum spathe length (9.36 cm) and breadth (8.02 cm) were recorded in treatment F_2. Whereas, minimum spathe length (8.88 cm) and breadth (7.74 cm) were observed in treatment F_1. It is clear from the data that frequency of the nutrients spray significantly influenced the flower stalk length. The maximum flower stalk length (28.13 cm) was recorded in F_2 *i.e.* spray twice a week, while minimum stalk length (26.62 cm) in treatment F_1. The significantly maximum number of flowers per plant (3.42) was recorded in F_2 treatment. The higher growth of spathe and flower stalk length might be due to optimum availability of nutrients and good growth and development of plant. These results are in agreement with the results of Srinivasa and Reddy [8] and Gurjar, et al. [15] in anthurium.

Table 1. Effect of foliar spray of primary nutrients and their frequencies on vegetative growth of anthurium (*Anthurium andreanum* L.) var. Xavia

Fertilizer doses	Number of leaves/plant			Leaf length (cm)			Leaf breadth (cm)		
	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean
D_1(NPK 19:19:19 @ 1 g/l)	4.00	4.13	4.07	23.80	24.02	23.91	13.93	14.21	14.07
D_2 (NPK 19:19:19 @ 2 g/l)	4.20	4.33	4.27	23.93	24.25	24.09	14.10	14.65	14.38
D_3 (NPK 19:19:19 @ 3 g/l)	4.27	4.40	4.33	24.21	25.49	24.85	14.48	15.17	14.82
D_4(NPK 19:19:19 @ 4 g/l)	4.33	4.47	4.40	24.55	25.88	25.22	14.74	15.45	15.10
D_5(NPK 19:19:19 @ 5 g/l)	4.40	4.53	4.47	24.85	26.02	25.43	15.15	15.48	15.32
Mean	4.24	4.37		24.27	25.13		14.48	14.99	
	D	F	D*F	D	F	D*F	D	F	D*F
S. Em. ±	0.10	0.07	0.15	0.36	0.22	0.50	0.26	.016	0.36
C.D. at 5%	NS	NS	NS	1.05	0.66	NS	0.75	0.48	NS
C. V. %	5.78			3.52			4.25		

Table 2. Effect of foliar spray of primary nutrients and their frequencies on vegetative growth of anthurium (*Anthurium andreanum* L.) var. Xavia

Fertilizer doses	Plant spread North-South (cm)			Plant spread East-West (cm)			Petiole length (cm)		
	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean
D_1 (NPK 19:19:19 @ 1 g/l)	55.57	56.17	55.87	55.17	56.25	55.71	30.35	32.84	31.59
D_2 (NPK 19:19:19 @ 2 g/l)	55.75	59.00	57.38	56.33	58.28	57.31	31.28	33.64	32.46
D_3 (NPK 19:19:19 @ 3 g/l)	58.75	60.42	59.58	58.00	60.23	59.12	33.33	34.31	33.82
D_4 (NPK 19:19:19 @ 4 g/l)	59.08	61.50	60.29	58.47	62.32	60.39	33.78	36.79	35.28
D_5 (NPK 19:19:19 @ 5 g/l)	59.17	62.67	60.92	59.68	62.37	61.03	34.27	36.76	35.51
Mean	57.66	59.95		57.53	59.89		32.60	34.87	
	D	F	D*F	D	F	D*F	D	F	D*F
S. Em. ±	1.01	0.64	1.42	0.86	0.54	1.22	0.43	0.72	0.61
C.D. at 5%	2.96	1.88	NS	2.54	1.61	NS	1.26	0.80	NS
C. V. %	4.19			3.59			3.11		

Table 3. Effect of foliar spray of primary nutrients and their frequencies on flowering and quality of anthurium (*Anthurium andreanum* L.) var. Xavia

Fertilizer doses	Days to first flower opening			Spathe length(cm)			Spathe breadth (cm)		
	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean
D_1 (NPK 19:19:19 @ 1 g/l)	99.47	98.93	99.20	8.64	8.68	8.66	7.35	7.43	7.39
D_2 (NPK 19:19:19 @ 2 g/l)	99.20	95.47	97.33	8.63	8.96	8.80	7.37	8.02	7.69
D_3 (NPK 19:19:19 @ 3 g/l)	98.47	91.27	94.87	8.81	9.55	9.18	7.84	8.14	7.99
D_4 (NPK 19:19:19 @ 4 g/l)	94.53	91.13	92.83	8.99	9.98	9.49	8.05	8.22	8.14
D_5 (NPK 19:19:19 @ 5 g/l)	92.00	90.93	91.47	9.35	9.61	9.48	8.10	8.30	8.20
Mean	96.73	93.55		8.88	9.36		7.74	8.02	
	D	F	D*F	D	F	D*F	D	F	D*F
S. Em. ±	0.76	0.48	1.01	0.11	0.07	0.16	0.06	0.04	0.09
C.D. at 5%	2.24	1.41	3.16	0.33	0.21	0.47	0.19	0.12	0.27
C. V. %	1.95			3.03			2.02		

Table 4. Effect of foliar spray of primary nutrients and their frequencies on flower quality and yield of anthurium (*Anthurium andreanum* L.) var. Xavia

Fertilizer doses	Flower stalk length (cm)			Spadix length (cm)			No. of flower stalks/plant		
	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean
D_1 (NPK 19:19:19 @ 1g/l)	23.63	27.08	25.35	4.32	4.45	4.38	2.40	2.82	2.61
D_2 (NPK 19:19:19 @ 2 g/l)	26.64	27.27	26.95	4.38	4.54	4.46	2.60	3.03	2.82
D_3 (NPK 19:19:19 @ 3 g/l)	27.25	28.50	27.88	4.49	4.65	4.57	2.88	3.13	3.01
D_4(NPK 19:19:19 @ 4 g/l)	27.35	29.17	28.26	4.60	4.74	4.67	3.07	4.00	3.53
D_5(NPK 19:19:19 @ 5 g/l)	28.23	28.62	28.43	4.63	4.77	4.70	3.13	4.13	3.63
Mean	26.62	28.13		4.48	4.63		2.82	3.42	
	D	F	D*F	D	F	D*F	D	F	D*F
S. Em. ±	0.35	0.25	0.49	0.08	0.05	0.12	0.04	0.02	0.05
C.D. at 5%	1.02	0.64	1.44	NS	NS	NS	0.11	0.07	0.16
C. V. %	3.09			4.37			3.01		

3.2.3 Interaction effect

The data presented in the Tables 3 and 4 revealed that the interaction effect of primary nutrient foliar spray and frequencies were significant in case of flowering and yield characters, except spadix length. The minimum days required for first flower opening (90.93 days) was recorded in D_5F_2 treatment, which was at par with D_4F_2 (91.13 days), D_3F_2 (91.27 days) and D_5F_1 (92.00 days). The maximum spathe length (9.98 cm) and spathe breadth (8.30 cm) was found in D_5F_2, and D_4F_2, respectively. The maximum flower stalk length (29.17 cm) was recorded in treatment combination of D_4F_2 which was at par with D_5F_2 (28.62 cm), D_3F_2 (28.50 cm) and D_5F_1 (28.23 cm) treatments. It might be due to optimum availability of the nutrients rather than excess. Moreover, a suitable foliar nutrient combination such as nitrogen, phosphorus and potash, which is necessary for the synthesis of protein and cytokinin, consequently affects cell division. Similar results were obtained by Srinivasa and Reddy [8]. The treatment combination of D_5F_2 recorded maximum yield of flowers per plant (4.13) which was at par with D_4F_2. It might be due to balance dose of NPK which increase the vegetative growth, favourable for the synthesis of peptide bond, protein and carbohydrate metabolism that are essential for flower development as reported by Gurjar, et al. [15].

4. CONCLUSION

From the result obtained in this investigation, it can be concluded that anthurium variety Xavia responded well to different levels of primary

nutrients (NPK) and their frequencies under protected conditions for growth, flowering, quality and yield. In this study, among all treatments, D_5F_2 (NPK 19:19:19 @ 5 g/l twice a week) found to be best in terms of vegetative growth, flowering yield and quality of anthurium as it recorded maximum values for all the characters. Based on these findings, it is recommended that the application of water soluble fertilizer (19:19:19 NPK) at the rate of 5 g/l twice a week foliar spray under shade net house is suitable for the successful growth, yield and quality of anthurium var. Xavia for higher productivity.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/53377