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Effect of Plant Growth Regulator and Nutrients on the Vegetative Growth of Potted Bromeliad (*Aechmea gamosepala albo marginata*)

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A B S T R A C T

The present study was conducted at Department of Floriculture department, College of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli (MS.) during year 2019-2020. The growth parameters were recorded periodically at 30 days intervals and root parameter was recorded at the end of experiment. From the present investigation it was recorded that the highest shoot length (47.94 cm) was found in Ethrel @ 500 ppm and 19:19:19 @ 1%. The highest length of leaves (43.91 cm), width of leaves (10.36 cm), number of leaves (20.93) was observed in ethrel @ 500 ppm and urea @ 2%. The highest leaf area (705.23 cm^2) and leaf area index (0.38) was obtained in @ 500 ppm and urea @ 2%.

Introduction

Bromeliads are tropical plants belonging to the family Bromeliaceae. Ornamental species of bromeliad were introduced 50 years after when Columbus introduced pineapple (*Ananas comusus*) from Spain on his voyage in 1493. They are perennial plants having rosette leaves which are spirally arranged. Bromeliads are terrestrial or epiphytic in nature. The genus *Aechmea* are epiphytic bromeliads and absorb and retain moisture through trichomes present on the leaf surface. The roots are modified due to provide anchorage to the plant. Bromeliads take water through the central tank which forms at the centre of the rosette leaves. As originating from tropical areas, almost all bromeliads are highly adaptive to tropical climatic conditions provided they are not exposed to direct sunlight. Bromeliads have great ornamental potential (Acebey *et al.*, 2010). It has also been suggested that bromeliads planted indoors reduce the temperature in the room. Bromeliads planted on roofs of buildings absorb some solar radiation, use it for photosynthesis and reflect back into the atmosphere. The long fibres extracted from the leaves of some bromeliad species are used to make hammocks (Brucher, 1989). In konkan, the cultivation of ornamental bromeliads is practiced in limited scale. The climatic conditions of konkan are endowed with high rainfall and high humidity all

round year which is favourable for the production of bromeliads. Due to its wide adaptability, low maintenance, beautiful shapes and colours of leaves have helped them to spread to wider markets and increased popularity in garden and landscaping.

As the growth of bromeliad is comparatively slow, it needs acceleration. Hence, considering the utility and demand of bromeliads, this present investigation was planned so as to study the effect of plant growth regulator and nutrients on vegetative growth of Bromeliad.

Materials and Methods

The field experiment was conducted at the department of Floriculture, College of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli (M.S.) during 2019-2020. Suckers of *Aechmea gamosepala albo marginata* were collected and potted in coconut husks. The potted plants were replicated thrice in split plot design with plant growth regulator i.e., Ethrel as main plot factor and Nutrients as subplot factors. The observations regarding various vegetative parameters were recorded at monthly interval. The data recorded for vegetative parameter were analysed statistically to express the results.

The vegetative parameters such as shoot length, length of leaves, width of leaves and number of leaves were taken at monthly interval for up to 120 days whereas, the length of roots, leaf area and leaf area index were studied at the end of experiment.

Shoot length (cm)

Shoot length was recorded by measuring from the substrate to the tip of the leaves with measuring scale.

Length of leaves (cm)

Length of leaves was calculated by measuring from the base to the tip of leaves. The average length of four leaves on each plant was taken.

Table.1

Treatment details	
Factor - 1: Growth Regulator – Ethrel	
E_1 – Ethrel 250 ppm	E_2 – Ethrel 500 ppm
Factor - 2: Nutrients	
N_1 – Urea @ 1%	N_5 – NPK-0:52:34 @0.5%
N_2 – Urea @ 2%	N_6 – NPK-0:52:34 @1%
N_3 – NPK-13:0:45 @0.5%	N_7 – NPK-19:19:19 @ 0.5%
N_4 – NPK-13:0:45 @ 1%	N_8 – NPK-19:19:19 @ 1%

Width of leaves (cm)

Width of leaves was calculated by taking the average of four leaves on each plant. The broader part each leaf was measured for the width.

Number of leaves

Number of leaves from selected plants were counted from each subplot.

Leaf area (cm^2)

Leaf area per plant was recorded at final stage with the help of leaf area meter.

Leaf area index

Leaf area index was conducted at final stage by using the formula suggested by Watson (1947)

$$LAI = \frac{Total\ Leaf\ Area\ of\ the\ plant}{Spacing\ of\ the\ plant}$$

Length of roots (cm)

Roots of selected plants were washed and cleaned using tap water and then measured with scale at the end of the experiment.

Results and Discussion

Shoot length (cm)

From Table No. 1 in case of ethrel, significantly the highest shoot length was observed in E_2 (Ethrel @ 500 ppm) at 30, 60, 90 and 120 days after application (37.95 cm, 38.24 cm, 40.31 cm and 42.57 cm respectively) which was superior to E_1 (Ethrel @ 250 ppm), while the lowest shoot length was observed in E_1 (Ethrel @ 250 ppm) at 30, 60, 90 and 120 days after application (36.74 cm, 37.63 cm, 38.92 cm and 41.08 cm respectively). Among the different nutrients applied, it revealed that after 30 days of application, significantly the highest shoot length (41.59 cm) was observed in suckers treated with N_8 (19:19:19 at 1%) which was at par (41.30 cm) with N_7 i.e. (19:19:19 at 0.5%). Similarly, the lowest shoot length (31.56 cm) was registered in N_5 (0:52:34 at 0.5%).

At 60 days after application, significantly the highest shoot length (42.50 cm) was noticed in suckers treated with N_8 (19:19:19 at 1%) whereas, the lowest shoot length (32.33 cm) was revealed in N_5 (0:52:34 at 0.5%). At 90 days after application, significantly the highest shoot length (44.07 cm) was noticed in N_8 (0:52:34 at 0.5%) whereas, the lowest shoot length (33.49 cm) was observed in N_5 (0:52:34 at 0.5%).

At 120 days after application, significantly the highest shoot length (46.54 cm) was registered in N_8 (19:19:19 at 1%). Similarly, the lowest shoot length (35.60 cm) was noticed in N_5 (0:52:34 at 0.5%). On the contrary in an experiment, Giampaoli *et al.*, (2017) found that plant height increased with increase in levels of urea which is not the case in this research. Similar trend was found in Ferreira *et al.*, (2017) observed that shoot length increased by 10% in *Neoregelia cruerta* treated with 2% urea compared to control treatment.

Significant results were obtained 30 days after application, the highest shoot length (42.55 cm) was observed in treatment combination E_2N_8 (500 ppm of ethrel with 1% 19:19:19), while, the lowest shoot length (30.91 cm) was noted in E_1N_5 (250 ppm Ethrel with 0.5% 0:52:34). At 60 days after application, significantly the highest length of shoot (43.47 cm) was registered in E_2N_8 (500 ppm of ethrel with 1% 19:19:19) whereas, the lowest shoot length (30.91 cm) was noticed in E_1N_5 (250 ppm Ethrel with 0.5% of 0:52:34).At 90 days after application, it was revealed that significantly the highest shoot length (45.35) was observed in E_2N_8 (500 ppm of ethrel with 1% of 19:19:19) and the lowest shoot length (33.16 cm) was noted in E_1N_5 (250 ppm Ethrel with 0.5% 0:52:34. The highest shoot length (47.94 cm) was significant at 120 days after application in E_2N_8 (500 ppm of ethrel with 1% 19:19:19), whereas, the lowest shoot length (35.24 cm) was noticed in E_1N_5 (250 ppm Ethrel with 0.5% 0:52:34).

Length of leaves (cm)

As seen in Table No. 2, among the two levels of ethrel it can be seen that the highest length of leaves was obtained in E_2 (500 ppm of Ethrel) at 30, 60, 90 and 120 days after application (32.18 cm, 33.08cm, 34.34 cm and 36.14 cm respectively) which was superior over other treatments and the lowest length of leaves was registered in E_1 (250 ppm of Ethrel) at 30, 60, 90 and 120 days after application (29.95 cm, 30.80 cm, 32.09 cm and 33.84 cm respectively).At 30 days after application, the highest length of leaves (37.73 cm) was observed in N_2 (Urea @ 2 %) which was significantly superior over other treatments, whereas, the lowest length of leaves (25.96 cm) was noticed in N_5 (0.5% of 0:52:34). At 60 days after application, the highest length of leaves (38.76 cm) was registered in N_2 (Urea @ 2 %) which was significantly superior over other treatments, while, the lowest length of leaves (26.69 cm) was noted in N_5 (0.5% of 0:52:34). At 90 days

after application, the highest length of leaves (40.22 cm) was observed in N_2 (Urea @ 2 %) which was significantly superior over other treatments and the lowest length of leaves (27.72 cm) was registered in N_5 (0.5% of 0:52:34). At 120 days, the highest length of leaves (42.23 cm) was noticed in N_2 (Urea @ 2 %) which was superior than other treatments and the lowest length of leaves (29.24 cm) was revealed in N_5 (0.5% of 0:52:34). Similar trend was found in an experiment done by Giampaoli *et al.*, (2017) on *Aechmea fasciata* with respect to leaf length which increased with increase in level of Urea reaching greatest value at concentrations of 1.54 g/L and 1.46 g/L. Little variation effects were observed in the trend due to interaction of nutrients and ethrel on length of leaves throughout the growing period.

At 30 days after application, the highest length of leaves (39.33 cm) was observed in treatment combination E_2N_2 (500 ppm of ethrel with 2% of Urea), while, lowest length of leaves (25.01 cm) was noted in E_1N_5 (250 ppm Ethrel with 0.5% 0:52:34).

At 60 days after application, the highest length of leaves (40.35 cm) was registered in E_2N_2 (500 ppm of ethrel with 2% of Urea) whereas, the lowest length of leaves (25.75 cm) was noticed in E_1N_5 (250 ppm Ethrel with 0.5% of 0:52:34.

At 90 days after application, it was revealed that the highest length of leaves (41.84 cm) was observed in E_2N_2 (500 ppm of ethrel with 2% of Urea) and the lowest length of leaves (26.73 cm) was noted in E_1N_5 (250 ppm Ethrel with 0.5% 0:52:34).

The highest length of leaves (43.91 cm) was revealed at 120 days of planting in E_2N_2 (500 ppm of ethrel with 2% of Urea), whereas, lowest length of leaves (28.24cm) was noticed in E_1N_5 (250 ppm Ethrel with 0.5% 0:52:34).

These results are in contradiction with Issakraisila *et al.*, (2017), stated that there was no significant effect of Urea and Ethrel on length of leaves in *Guzmania lingulata*, whereas significant effect due to Urea on *Aechmea gamosepala albo marginata* was observed in current study.

Width of leaves (cm)

As seen in Table No.3 with respect to the influence of ethrel, at 30,60, 90 and120 days the highest width of leaves was (6.22 cm, 6.82 cm, 7.65 cm and 8.77 cm respectively) observed in E_2 (Ethrel at 500 ppm) which was significantly superior over E_1 (Ethrel at 250 ppm). The lowest width obtained in E_1 (Ethrel at 250 ppm) at 30, 60, 90 and 120 days was (5.99 cm, 6.55 cm, 7.32 cm and 8.35 cm respectively).

30 days after application, N_8 recorded significant growth and noted the highest width of leaves (6.96 cm). Whereas, the lowest width of leaves (5.14 cm) was observed in N_5 (0:52:34 at 0.5 %).

At 60 days after application, the highest width of leaves (7.72 cm) was registered in N_8 (19:19:19 at 1%) which was significantly superior to other treatments, while, lowest width of leaves (5.63 cm) was noticed in N_5 (0:52:34 at 0.5 %).

At 90 days after application, significantly the highest width of leaves (8.73 cm) was observed in N_8 (19:19:19 at 1%), whereas, lowest width of leaves (6.33 cm) was noted in N_5 (0:52:34 at 0.5 %).

At 120 days after application, significantly the highest width of leaves (9.97 cm) was registered in N_8 (19:19:19 at 1%) and lowest width of leaves (7.34 cm) was recorded in N_5 (0:52:34 at 0.5 %). In interaction between nutrients and ethrel it was observed that at 30 days after application, the highest width of leaves (7.08 cm) was found in E_2N_8 (Ethrel 500 ppm and 19:19:19 at 1%). While the lowest width of leaves (5.00 cm) was observed in E_1N_5 (Ethrel 250 ppm and 0:52:34 at 0.5%)

At 60 days, the highest width of leaves (7.90 cm) was registered in E_2N_8 (Ethrel 500 ppm and 19:19:19 at 1%), whereas, lowest width of leaves (5.53 cm) was found in E_1N_5 (Ethrel 250 ppm and 0:52:34 at 0.5%). At 90 days after application, the

highest width of leaves (9.12 cm) was noticed in E_2N_8 (Ethrel 500 ppm and 19:19:19 at 1%), while, lowest width of leaves (6.25 cm) was observed in E_1N_5 (Ethrel 250 ppm and 0:52:34 at 0.5%).

At 120 days after application, significantly the highest width of leaves (10.36 cm) was noted in E_2N_8 (Ethrel 500 ppm and 19:19:19 at 1%), whereas, lowest width of leaves (7.26 cm) was observed in E_1N_5(Ethrel 250 ppm and 0:52:34 at 0.5%).

However, Issakraisila *et al.*, (2017) stated that there was no significant effect of Urea and Ethrel on the width of leaves in *Guzmania lingulata* which is in contradiction to the results found in this experiment.

Number of leaves

As shown in Table No. 4, at 30, 60, 90 and 180 days, the highest number of leaves (14.65, 15.30, 16.18 and 17.43 respectively) was observed in E_2 (Ethrel at 500 ppm) which was superior to E_1 (Ethrel at 250 ppm). At 30, 60, 90 and 120 days, the lowest number of leaves (14.07, 14.59, 15.24 and 16.34 respectively) was registered in E_1 (Ethrel at 250 ppm).

Different nutrients and their concentrations exhibited significant variation in the number of leaves.

30 days after application, significantly the highest number of leaves (16.23) was observed in N_2 (Urea at 2%) while the lowest number of leaves (12.08) was registered in N_5 (0:52:34 at 0.5%).

At 60 days after application, the highest number of leaves (17.08) was obtained in N_2 (Urea at 2%) which was significantly superior than other treatments, whereas, the lowest number of leaves (12.08) was noticed in N_5 (0:52:34 at 0.5%).

At 90 and 120 days after application, significantly the highest number of leaves (18.47 and 20.10 respectively) was observed in N_2 (Urea at 2%) and the lowest number of leaves (12.68 and 12.93 respectively) was registered in N_5 (0:52:34 at 0.5%).

Similar trend was observed in experiments where urea affected the number of leaves significantly and are stated below.

Giampaoli *et al.*, (2017) obtained similar results in which he stated that urea at 2% gave the highest number of leaves in *Aechmea fasciata.*

Zobatto *et al.*, (2019) gave similar results and concluded that increase in nitrogen levels in *Aechmea fasciata* increased the number of leaves and nitrogen is the main source for the growth of leaves. Bicshel and Starmann (2008) observed in *Dendrobium nobile,* a potted orchid that increased in nitrogen level gave the highest number of leaves which is in compliance with the fact that epiphtyes need nitrogen as the main source for growth of leaves. Interaction between nutrients and ethrel had a significant effect on the number of leaves throughout the growing period.

At 30 days after application the highest number of leaves (16.37) was obtained in E_2N_2 (500 ppm of ethrel with 2% of Urea) which was superior over other treatments. The lowest number of leaves (11.67) was noticed in E_1N_5 (Ethrel at 250 ppm with 0:52:34 at 0.5%).

At 60 days after application, significantly the highest number of leaves (17.27) was observed in E_2N_2 (500 ppm of ethrel with 2% of Urea), while the lowest number of leaves (11.80) was noticed in E_1N_5 (Ethrel at 250 ppm with 0:52:34 at 0.5%).

90 days after application, significantly the highest number of leaves (18.97) was registered in E_2N_2 (500 ppm of ethrel with 2% of Urea) and the lowest number of leaves (12.30) was noted in E_1N_5 (Ethrel at 250 ppm with 0:52:34 at 0.5%). 120 days after application, significantly the highest number of leaves (20.93) was obtained in E_2N_2 (500 ppm of ethrel with 2% of Urea) whereas, the lowest number of leaves (12.93) was observed in E_1N_5 (Ethrel at 250 ppm with 0:52:34 at 0.5%).

Table.2 Effect of ethrel and nutrients on shoot length (cm) of bromeliad (*Aechmea gamosepala albo marginata*)

Treatment	Shoot length (cm)											
	30 DAA			60 DAA			90 DAA			120 DAA		
	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean
N_1	39.05	39.34	**39.20**	39.97	40.49	**40.23**	41.26	42.35	**41.81**	43.53	44.49	**44.01**
N_2	39.10	39.56	**39.33**	40.29	40.84	**40.56**	41.74	42.49	**42.12**	44.11	44.71	**44.41**
N_3	35.49	35.74	**35.62**	36.44	36.52	**36.48**	37.47	37.85	**37.66**	39.63	40.07	**39.85**
N_4	36.40	36.54	**36.47**	37.24	37.35	**37.29**	38.53	38.92	**38.72**	40.69	41.12	**40.91**
N_5	30.91	32.21	**31.56**	31.88	32.79	**32.33**	33.16	33.82	**33.49**	35.24	35.95	**35.60**
N_6	32.04	35.28	**33.66**	32.70	35.94	**34.32**	33.73	36.96	**35.35**	35.50	39.06	**37.28**
N_7	40.27	42.34	**41.30**	40.98	43.39	**42.18**	42.71	4.72	**43.72**	44.78	47.20	**45.99**
N_8	40.64	42.55	**41.59**	41.54	43.47	**42.50**	42.79	45.35	**44.07**	45.13	47.94	**46.54**
Mean	**36.74**	**37.95**	**37.34**	**37.63**	**38.85**	**38.24**	**38.92**	**40.31**	**39.62**	**41.08**	**42.57**	**41.82**
	E	**N**	**E x N**	**E**	**N**	**E x N**	**E**	**N**	**E x N**	**E**	**N**	**E x N**
Result	**SIG**	**SIG**	**SIG**	**SIG**	**SIG**	**NS**	**SIG**	**SIG**	**NS**	**SIG**	**SIG**	**NS**
SEm±	**0.09**	**0.35**	**0.49**	**0.10**	**0.38**	**0.54**	**0.13**	**0.38**	**0.54**	**0.07**	**0.42**	**0.59**
CD @ 5%	**0.57**	**1.00**	**1.14**	**0.59**	**1.11**	**-**	**0.81**	**1.11**	**-**	**0.41**	**1.21**	**-**

Treatment details

Nutrient	N_1 - Urea @ 1%	N_2 - Urea @ 2%	N_3 - 13:0:45 @ 0.5%	N_4 -13:0:45 @ 1%
	N_5 - 0:52:34 @ 0.5%	N_6 - 0:52:34 @ 1%	N_7 -19:19:19 @ 0.5%	N_8 - 19:19:19 @1%
Ethrel	E_1 - Ethrel @ 250 ppm		E_2 - Ethrel @ 500 ppm	

Table.3 Effect of ethrel and nutrients on length of leaves (cm) of bromeliad (*Aechmea gamosepala albo marginata*)

Treatment	Length of leaves (cm)											
	30 DAA			60 DAA			90 DAA			120 DAA		
	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean
N_1	33.79	37.81	**35.80**	34.73	38.82	**36.77**	36.12	40.32	**38.22**	38.08	42.30	**40.19**
N_2	36.13	39.33	**29.73**	37.16	40.35	**38.76**	38.60	41.84	**40.22**	40.55	43.91	**42.23**
N_3	28.32	29.73	**29.02**	29.16	30.59	**29.88**	30.35	31.90	**31.12**	32.06	33.64	**32.85**
N_4	28.72	30.02	**29.37**	29.56	30.96	**30.26**	30.83	32.13	**31.48**	32.48	33.97	**33.22**
N_5	25.01	26.91	**25.96**	25.75	27.63	**26.69**	26.73	28.70	**27.72**	28.24	30.23	**29.24**
N_6	25.76	27.84	**26.80**	26.52	28.57	**27.54**	27.51	29.38	**28.45**	28.97	30.79	**29.88**
N_7	30.53	31.86	**31.20**	31.34	32.88	**32.11**	32.71	34.22	**33.46**	34.57	36.12	**35.35**
N_8	31.37	33.91	**32.64**	32.18	34.81	**33.50**	33.87	36.20	**35.03**	35.77	38.16	**36.97**
Mean	**29.95**	**32.18**	**31.07**	**30.80**	**33.08**	**31.94**	**32.09**	**34.34**	**33.21**	**33.84**	**36.14**	**34.99**
	E	**N**	**E x N**	**E**	**N**	**E x N**	**E**	**N**	**E x N**	**E**	**N**	**E x N**
Result	**SIG**	**SIG**	**NS**	**SIG**	**SIG**	**NS**	**SIG**	**SIG**	**NS**	**SIG**	**SIG**	**NS**
SEm±	**0.34**	**0.41**	**0.58**	**0.36**	**0.43**	**0.60**	**0.30**	**0.42**	**0.60**	**0.33**	**0.41**	**0.58**
CD @ 5%	**2.09**	**1.18**	**-**	**2.20**	**1.24**	**-**	**1.85**	**1.22**	**-**	**2.01**	**1.19**	**-**

Treatment details

Nutrient	N_1 - Urea @ 1%	N_2 - Urea @ 2%	N_3 - 13:0:45 @ 0.5%	N_4 -13:0:45 @ 1%
	N_5 - 0:52:34 @ 0.5%	N_6 - 0:52:34 @ 1%	N_7 -19:19:19 @ 0.5%	N_8 - 19:19:19 @1%
Ethrel	E_1 - Ethrel @ 250 ppm		E_2 - Ethrel @ 500 ppm	

Table.4 Effect of ethrel and nutrients on width of leaves (cm) of bromeliad (*Aechmea gamosepala albo marginata*)

Treatment	Width of leaves (cm)											
	30 DAA			60 DAA			90 DAA			120 DAA		
	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean
N_1	6.27	6.44	**6.36**	6.81	7.11	**6.96**	7.61	7.90	**7.76**	8.78	9.02	**8.90**
N_2	6.38	6.54	**6.46**	6.94	7.17	**7.06**	7.77	7.98	**7.87**	8.93	9.16	**9.05**
N_3	5.53	6.01	**5.77**	6.02	6.53	**6.28**	6.71	7.34	**7.02**	7.11	8.41	**7.76**
N_4	6.10	6.16	**6.13**	6.60	6.73	**6.66**	7.39	7.52	**7.46**	8.42	8.61	**8.52**
N_5	5.00	5.27	**5.14**	5.53	5.73	**5.63**	6.25	6.40	**6.33**	7.26	7.42	**7.34**
N_6	5.18	5.36	**5.27**	5.68	5.78	**5.73**	6.37	6.55	**6.46**	7.39	7.54	**7.47**
N_7	6.63	6.92	**6.78**	7.27	7.59	**7.43**	8.10	8.40	**8.25**	9.29	9.66	**9.47**
N_8	6.85	7.08	**6.96**	7.54	7.90	**7.72**	8.33	9.12	**8.73**	9.58	10.36	**9.97**
Mean	**5.99**	**6.22**	**6.11**	**6.55**	**6.82**	**6.68**	**7.32**	**7.65**	**7.48**	**8.35**	**8.77**	**8.56**
	E	**N**	**E x N**	**E**	**N**	**E x N**	**E**	**N**	**E x N**	**E**	**N**	**E x N**
Result	**SIG**	**SIG**	**NS**	**SIG**	**SIG**	**NS**	**SIG**	**SIG**	**NS**	**SIG**	**SIG**	**SIG**
SEm±	**0.02**	**0.07**	**0.10**	**0.02**	**0.08**	**0.11**	**0.01**	**0.10**	**0.14**	**0.03**	**0.09**	**0.13**
CD @ 5%	**0.12**	**0.20**	**-**	**0.13**	**0.22**	**-**	**0.05**	**0.29**	**-**	**0.18**	**0.26**	**0.37**

Treatment details

Nutrient	N_1 - Urea @ 1%	N_2 - Urea @ 2%	N_3 - 13:0:45 @ 0.5%	N_4 -13:0:45 @ 1%
	N_5 - 0:52:34 @ 0.5%	N_6 - 0:52:34 @ 1%	N_7 -19:19:19 @ 0.5%	N_8 - 19:19:19 @1%
Ethrel	E_1 - Ethrel @ 250 ppm		E_2 - Ethrel @ 500 ppm	

Table.5 Effect of ethrel and nutrients on number of leaves of bromeliad (*Aechmea gamosepala albo marginata*)

Treatment	Number of leaves											
	30 DAA			60 DAA			90 DAA			120 DAA		
	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean
N_1	15.63	16.20	**15.92**	16.37	16.93	**16.65**	17.07	18.30	**17.68**	18.70	20.37	**19.53**
N_2	16.10	16.37	**16.37**	16.90	17.27	**17.08**	17.97	18.97	**18.47**	19.27	20.93	**20.10**
N_3	13.67	14.20	**13.93**	14.03	14.93	**14.48**	14.53	15.63	**15.08**	15.33	16.23	**15.78**
N_4	14.10	14.30	**14.20**	14.50	15.13	**14.82**	15.10	15.87	**15.48**	15.83	16.57	**16.20**
N_5	11.67	12.50	**12.08**	11.80	12.80	**12.30**	12.30	13.07	**12.68**	12.93	13.63	**13.28**
N_6	12.43	13.50	**12.97**	12.70	13.87	**13.28**	13.10	14.50	**13.80**	13.67	15.37	**14.52**
N_7	14.40	14.70	**14.55**	15.17	15.33	**15.25**	15.73	16.23	**15.98**	17.30	18.00	**17.65**
N_8	14.53	15.40	**14.97**	15.27	16.13	**15.70**	16.10	16.90	**16.50**	17.70	18.33	**18.02**
Mean	**14.07**	**14.65**	**14.36**	**14.59**	**15.30**	**14.95**	**15.24**	**16.18**	**15.71**	**16.34**	**17.43**	**16.89**
	E	**N**	**E x N**	**E**	**N**	**E x N**	**E**	**N**	**E x N**	**E**	**N**	**E x N**
Result	**SIG**	**SIG**	**SIG**	**SIG**	**SIG**	**SIG**	**SIG**	**SIG**	**SIG**	**SIG**	**SIG**	**SIG**
SEm±	**0.03**	**0.07**	**0.10**	**0.04**	**0.09**	**0.12**	**0.03**	**0.09**	**0.13**	**0.04**	**0.12**	**0.16**
CD @ 5%	**0.16**	**0.20**	**0.28**	**0.26**	**0.25**	**0.35**	**0.15**	**0.27**	**0.38**	**0.25**	**0.34**	**0.47**

Treatment details

Nutrient	N_1 - Urea @ 1%	N_2 - Urea @ 2%	N_3 - 13:0:45 @ 0.5%	N_4 -13:0:45 @ 1%
	N_5 - 0:52:34 @ 0.5%	N_6 - 0:52:34 @ 1%	N_7 -19:19:19 @ 0.5%	N_8 - 19:19:19 @1%
Ethrel	E_1 - Ethrel @ 250 ppm		E_2 - Ethrel @ 500 ppm	

Table.6 Effect of ethrel and nutrients on Leaf area (cm^2) and leaf area index of bromeliad (*Aechmea gamosepala albo marginata*) at the end of experiment

Treatment	At the end of experiment					
	Leaf Area (cm^2)			Leaf area index		
	E_1	E_2	Mean	E_1	E_2	Mean
N_1	233.62	234.34	**233.98**	0.37	0.37	**0.37**
N_2	234.15	235.08	**234.61**	0.37	0.38	**0.38**
N_3	218.56	219.64	**219.10**	0.35	0.35	**035**
N_4	219.17	220.45	**219.81**	0.35	0.35	**0.35**
N_5	208.59	210.06	**209.32**	0.33	0.34	**0.33**
N_6	209.25	210.48	**209.87**	0.33	0.34	**0.34**
N_7	226.53	227.75	**227.14**	0.36	0.36	**0.36**
N_8	227.63	228.46	**228.04**	0.36	0.37	**0.36**
Mean	**222.19**	**223.28**	**222.73**	**0.36**	**0.36**	**0.36**
	E	**N**	**E x N**	**E**	**N**	**E x N**
Result	**SIG**	**SIG**	**SIG**	**SIG**	**SIG**	**SIG**
SEm±	**0.01**	**0.06**	**0.08**	**0.00002**	**0.0001**	**0.0001**
CD @ 5%	**0.08**	**0.17**	**0.23**	**0.00012**	**0.0003**	**0.0004**

Treatment details

Nutrient	N_1 - Urea @ 1%	N_2 - Urea @ 2%	N_3 - 13:0:45 @ 0.5%	N_4 -13:0:45 @ 1%
	N_5 - 0:52:34 @ 0.5%	N_6 - 0:52:34 @ 1%	N_7 -19:19:19 @ 0.5%	N_8 - 19:19:19 @1%
Ethrel	E_1 - Ethrel @ 250 ppm		E_2 - Ethrel @ 500 ppm	

Table.7 Effect of ethrel and nutrients on length of roots (cm) of bromeliad (*Aechmea gamosepala albo marginata*) at the end of experiment (120 days)

Treatment	At the end of experiment (120 days)		
	Length of roots (cm)		
	E_1	E_2	Mean
N_1	11.65	12.33	**11.99**
N_2	11.66	11.51	**11.59**
N_3	10.42	9.99	**10.21**
N_4	11.09	10.72	**10.91**
N_5	8.21	8.26	**8.24**
N_6	9.59	9.71	**9.65**
N_7	13.14	13.17	**13.16**
N_8	12.19	13.48	**12.84**
Mean	**10.99**	**11.15**	**11.07**
	E	**N**	**E x N**
Result	**SIG**	**SIG**	**SIG**
SEm±	**0.02**	**0.05**	**0.07**
CD @ 5%	**0.14**	**0.15**	**0.21**

Treatment details

Nutrient	N_1 - Urea @ 1%	N_2 - Urea @ 2%	N_3 - 13:0:45 @ 0.5%	N_4 -13:0:45 @ 1%
	N_5 - 0:52:34 @ 0.5%	N_6 - 0:52:34 @ 1%	N_7 -19:19:19 @ 0.5%	N_8 - 19:19:19 @1%
Ethrel	E_1 - Ethrel @ 250 ppm		E_2 - Ethrel @ 500 ppm	

Leaf Area (cm^2)

As shown in Table No. 5, in case of effect of ethrel, significantly the highest leaf area (223.28 cm^2) was noticed in E_2 (Ethrel at 500 ppm) which was superior to E_1 (Ethrel at 250 ppm), whereas, lowest leaf area (222.19 cm^2) was recorded in E_1 (Ethrel at 250 ppm)

Significant effect was observed in N_2 (Urea at 2%) where the highest leaf area was (234.61 cm^2), whereas, the lowest leaf area (209.32 cm^2) was obtained in N_5 (0:52:34 at 0.5%).

Similar trend was observed by Monda *et al.*, (2014) in their study in *Dendrobium sp.* that N:P:K at 4:3:2 gave the highest leaf area and total leaf area.

From the data given in Table No. () it can be seen the highest leaf area (235.08 cm^2) was registered in E_2N_2 (500 ppm of ethrel with 2% of Urea) which was significantly superior over other treatments, while, the lowest leaf area (208.59 cm^2) was noted in E_1N_5 (Ethrel at 250 ppm with 0:52:34 at 0.5%).

Leaf Area Index

As shown in Table No. 5, significant effects were obtained due to ethrel on leaf area index where the highest value recorded was (0.357) which was superior to E_1 (Ethrel at 250 ppm), whereas, the lowest leaf area index (0.355) was recorded in E_2 (Ethrel at 500 ppm) and E_1 (Ethrel at 250 ppm) respectively. The highest leaf area index (0.375) was obtained in N_2 (Urea at 2%) which was significantly superior over other treatments except for N_1 (Urea at 1%) (0.374), while, the lowest leaf area index (0.335) was observed in N_5 (0:52:34 at 0.5%).The highest leaf area index (0.376) was noticed in E_2N_2 (500 ppm of ethrel with 2% of Urea) which was superior over other treatments except for E_1N_2 (250 ppm of ethrel with 2% of Urea) and E_2N_1 (500 ppm of ethrel with 1% of Urea). The lowest leaf area index (0.334) was found in E_1N_5 (Ethrel at 250 ppm with 0:52:34 at 0.5%).

Length of roots (cm)

As seen in Table No. 6, the highest length of roots (11.15 cm) was registered in E_2 (Ethrel at 500 ppm) which was superior over E_1 (Ethrel at 250 ppm) and the lowest length of roots (10.99 cm) was noticed in E_1 (Ethrel at 250 ppm). Significant effect was obtained in N_7 (19:19:19 @ 0.5%) where the highest length of roots observed was (13.16 cm) which was superior over other treatments, whereas, the lowest length of roots (8.24 cm) was observed in N_5 (0:52:34 at 0.5%).

The highest length of roots (13.17 cm) was observed in E_2N_7 (Ethrel at 500 ppm + 19:19:19 @ 0.5%) which was significantly superior over other treatments, whereas, the lowest length of roots (8.21 cm) was registered in E_1N_5 (Ethrel at 250 ppm + 0:52:34 at 0.5%).

In present investigation it was found that Urea @2% had the best result in terms of length of leaves, number of leaves, leaf area and leaf area index.

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