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Effect of plant growth enhancing substances on plant architecture of *Euphorbia milii* var. 'Pink Bold Beauty'

Kapadiya DB, Alka Singh, Bhandari AJ and Ahlawat TR

Abstract
The investigation aimed to study the effect of plant growth enhancing substances on plant canopy, vegetative growth and flowering as well as on overall appearance of *Euphorbia milii* plants grown in pot during 2015 – 2017. Application of silicon, spermine and salicylic acid at different concentrations significantly influenced the growth, flowering, pigments as well as overall appearance of *Euphorbia milii* plants during both the seasons as compared to untreated plants (control). Plants treated with 300 mg/l silicon and 3.0 mg/l salicylic acid showed maximum plant height, plant spread, number of branches with thicker stems and maximum number of leaves with increased leaf area during experiment. Early flower bud initiation (19.35 & 20.46 days) and flower opening (7.60 & 7.85 days) of *Euphorbia* flowers was observed with application of spermine at 30 mg/l. Maximum number of inflorescence per plant with increased inflorescence diameter, flowers per inflorescence with improved flower size were obtained from plants treated with 3.0 mg/l salicylic acid as recorded at 30, 60 and 90 DAS. Improved flowering period (161.89 and 150.90 days), delayed senescence and maximum *in situ* flower longevity (20.08 and 17.69 days) was observed in *Euphorbia* plants sprayed with spermine at 30 mg/l as compared to untreated plants. Maximum chlorophyll content (26.21 mg/l) in leaves was observed with application of silicon at 300 mg/l concentration. However, Maximum anthocyanin content (2.20 mg/l) in petal tissue was recorded with application of salicylic acid at 3.0 mg/l which was followed by silicon at 400 mg/l concentration. The highest overall appearance as pot plant (5) on visual basis was noted in *Euphorbia* plants sprayed with salicylic acid at 3.0 mg/l which was followed by salicylic acid at 2.0 mg/l and silicon at 400 and 300 mg/l as compared to untreated plants.

Keywords: Spermine, Silicon, Salicylic acid, *Euphorbia milii*, Plant architecture, Plant growth enhancing substances

Introduction
Euphorbia milii (Crown of thorns, Christ plant and Christ-thorn) is a succulent species of flowering plant in the spurge family Euphorbiaceae and endemic to Madagascar. The species is mainly appreciated for the beauty of the inflorescence, continuous flowering and the hardiness of the plants [Jankalski (2000)] [12]. The plants of *Euphorbia* can be grown year-round in dry, high temperature and high solar radiation areas as potted, bedding, or garden plants [Jankalski (2000)] [12]. *Euphorbia milii* is a much esteemed plant for pot culture owing to its brilliant inflorescences. However, it's a slow-growing and limited-branching habit limits its popularization for landscape purpose.
Plant growth enhancing substances *viz.* spermine [El-Saady *et al.* (2015)] [8], salicylic acid [Saadawy and Abdel-Moniem (2015)] [30] and silicon [Kamenidou *et al.* (2010), Sivanesan *et al.* (2010)] [14, 32] have been known to play important role in influencing branching as well as physiological management of plant architecture in different ornamental plants. The aim of this study was to examine the effect of plant growth enhancing substances on *Euphorbia milii* plants and to develop plant architecture model with good plant canopy with quality flowers in *Euphorbia milii*.

Materials & Methods
The present study was conducted during 2015-2017, under naturally ventilated polyhouse located at ATC of Soilless System, Dept. of Floriculture and Landscape Architecture, ACHF, NAU, Navsari, Gujarat. Experiment was laid out in completely randomized design and replicated thrice. Uniform plants of *Euphorbia milli* var. 'Pink Bold Beauty' plants were exposed to foliar spray of different concentrations of spermine (10, 20 and 30 mg/l), salicylic acid (1.0, 2.0 and 3.0 mg/l) and silicon (200, 300 and 400 mg/l) after 30 days of planting and repeated twice at 15 days interval. Each plant was sprayed with approximately 10 ml of freshly prepared solution at above mentioned concentrations. Plants considered as control were not exposed to foliar spray.

The data on various vegetative, flowering and flower quality parameters were recorded at 30, 60 and 90 days after spraying (DAS). The total chlorophyll content was determined by DMSO (Dimethylsulphoxide) method of Wellburn (1994) [36] and expressed in mg/g of fresh weight. Anthocyanin content in the petal tissue was analysed by the methods of Swain and Hillis (1959) [34]. Ornamental appearance as pot plant was measured on visual basis with consideration of plant canopy and inflorescence quality of *Euphorbia milii* plants. The statistical analysis was done by adopting the appropriate standard error (S.Em ±) method in each case as suggested by Panse and Sukhatme (1985) [28].

Results & Discussion

Vegetative Growth Parameters

Euphorbia milii plants sprayed with different growth enhancing chemicals significantly influenced vegetative growth parameters as compared to untreated (control) plants (Table 1 & 2). Foliar application of silicon positively influenced plant growth and development of *Euphorbia milii* var. 'Pink Bold Beauty'. Significantly maximum plant height at 30 DAS (11.61, 13.53 cm), 60 DAS (21.49, 24.64 cm) and 90 DAS (29.06, 32.91 cm) as well as plant spread at 30 DAS (14.83, 16.05 cm), 60 DAS (20.48, 23.38 cm) and 90 DAS (26.86, 30.38 cm) was recorded with 400 mg/l silicon (T_9) during first and second year respectively. Si supplementation has been indicated to stimulate photosynthetic rate, reduction in transpiration rate [Ma and Takahashi (2002)] [23] and increase in water use efficiency [Hossain *et al.* (2002)] [11]. Thicker stems were observed with 400 mg/l silicon (T_9) application during first year (2.72, 3.74 and 4.12 cm) and second year (2.79, 3.82 and 4.76 cm) at 30, 60 and 90 DAS, respectively. Beneficial effect of silicon is due to formation of a protective outer layer composed of biogenic silica in shoots which increases the structural components of the plant [Bélanger *et al.* (2003)] [2] and modification of plant cell wall properties [Horst *et al.* (1999)] [10]. Thus, foliar application of Silicon resulted in better vegetative growth as also observed in rose [Ehret *et al.* (2005)] [7], in gerbera [Savvas *et al.* (2002)] [31], and in chrysanthemum [Carvalho-Zanão *et al.* (2012)] [5].

Plants treated with salicylic acid at 3.0 mg/l (T_6) exhibited more number of branches per plant at 30 DAS (5.47, 4.33), at 60 DAS (6.19, 6.49) and at 90 DAS (6.67, 7.29) with higher number of leaves at 30 DAS (12.39, 14.35), at 60 DAS (20.88, 23.25) and at 90 DAS (30.99, 35.02) which was at par with treatment T_5 and T_9 during the experiment. Salicylic acid being a phenolic compound of hormonal nature produced by plants, plays an important role by regulating physiological processes [Karlidag *et al.* (2009)] [15] *viz.* germination, plant growth [Kong *et al.* (2014)] [20], transpiration rate, stomatal regulation and photosynthesis, ion uptake and transport [Khan *et al.* (2003)] [17] and there by influence plant growth. Further, there is evidence of a cross-talk between the SA and auxin signalling pathways during plant vegetative growth [Rivas-San and Plasencia (2011)] [29], which may have also contributed to vegetative growth. However, application of 400 mg/l silicon (T_9) showed maximum leaf area during first year (16.96, 22.84 and 24.83 cm^2) and second year (18.97, 25.77 and 28.13 cm^2) at 30, 60 and 90 DAS, respectively.

Table 1: Effect of plant growth enhancing substances on vegetative growth parameters of *Euphorbia milii* var. 'Pink Bold Beauty'

Treatments	Plant Height (cm)						Plant Spread (cm)						Stem Girth (cm)					
	2015-2016			2016-2017			2015-2016			2016-2017			2015-2016			2016-2017		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1 – Spermine – 10 mg/l	7.54	14.97	23.72	8.98	16.92	26.40	8.18	14.09	21.24	10.66	15.36	22.98	2.20	2.12	2.93	1.97	2.01	3.02
T_2 – Spermine – 20 mg/l	8.05	15.79	24.37	9.55	17.88	27.19	9.02	14.88	21.94	11.34	16.36	23.92	2.27	2.19	3.33	2.08	2.11	3.10
T_3 – Spermine – 30 mg/l	8.56	16.60	25.02	10.11	18.84	27.99	9.85	15.68	22.64	12.01	17.36	24.86	2.33	3.27	3.73	2.39	2.92	3.19
T_4 – Salicylic acid – 1.0 mg/l	9.07	17.42	25.68	10.68	19.81	28.79	10.68	16.49	23.35	12.68	18.37	25.79	2.24	2.34	2.93	2.06	2.31	3.29
T_5 – Salicylic acid – 2.0 mg/l	9.58	18.23	26.34	11.25	20.78	29.60	11.51	17.29	23.05	13.36	19.07	25.73	2.46	3.42	3.53	2.38	3.39	4.45
T_6 – Salicylic acid – 3.0 mg/l	10.59	19.86	27.69	12.39	22.71	31.24	14.17	18.89	25.46	14.70	21.38	28.60	2.59	3.57	4.33	2.64	3.62	4.97
T_7 – Silicon – 200 mg/l	10.08	19.05	27.01	11.82	21.74	30.41	12.34	17.08	23.75	13.03	18.37	26.07	2.52	3.50	3.93	2.48	3.52	4.43
T_8 – Silicon – 300 mg/l	11.10	20.68	28.37	12.96	23.67	32.07	14.00	19.68	26.16	15.37	22.38	29.54	2.66	3.66	4.73	2.69	3.72	4.66
T_9 – Silicon – 400 mg/l	11.61	21.49	29.06	13.53	24.64	32.91	14.83	20.48	26.86	16.05	23.38	30.48	2.72	3.74	4.12	2.79	3.82	4.76
T_{10} - Control	7.03	14.16	23.08	8.41	15.95	25.62	7.35	13.29	20.54	9.99	14.35	22.05	2.05	2.14	2.53	1.87	1.91	2.92
S.Em. ±	0.77	1.42	1.28	0.90	1.62	1.44	0.54	1.16	1.27	0.81	1.38	1.41	0.12	0.14	0.34	0.18	0.15	0.17
C.D.	2.26	4.20	3.79	2.66	4.78	4.24	1.60	2.43	3.07	2.39	4.06	4.16	0.37	0.41	1.00	0.54	0.45	0.51

Table 2: Effect of plant growth enhancing substances on vegetative growth parameters of *Euphorbia milii* var. 'Pink Bold Beauty'

Treatments	Number of Branches per Plant						Number of Leaves per Plant						Leaf Area (cm^2)					
	2015-2016			2016-2017			2015-2016			2016-2017			2015-2016			2016-2017		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1 – Spermine – 10 mg/l	2.75	3.49	3.59	1.60	3.28	4.02	7.70	11.87	19.93	7.99	12.47	22.04	8.61	15.21	19.09	12.08	17.12	20.69
T_2 – Spermine – 20 mg/l	3.10	3.82	3.98	1.94	3.68	4.43	8.29	13.00	21.31	8.79	13.82	23.66	9.65	16.17	19.81	12.94	18.20	21.62
T_3 – Spermine – 30 mg/l	3.44	4.16	4.36	2.28	4.08	4.84	8.87	14.12	22.69	9.58	15.17	25.28	10.70	17.12	20.52	13.81	19.28	22.55
T_4 – Salicylic acid – 1.0 mg/l	4.45	5.18	5.51	3.31	5.29	6.06	10.63	17.50	26.85	11.97	19.21	30.15	11.74	18.07	21.24	14.67	20.36	23.48
T_5 – Salicylic acid – 2.0 mg/l	5.13	5.85	6.28	3.99	6.09	6.88	11.80	19.75	29.61	13.56	21.91	33.40	12.79	19.02	21.96	15.53	21.44	24.41
T_6 – Salicylic acid – 3.0 mg/l	5.47	6.19	6.67	4.33	6.49	7.29	12.39	20.88	30.99	14.35	23.25	35.02	14.87	20.93	23.39	17.25	23.60	26.27
T_7 – Silicon – 200 mg/l	3.77	4.50	4.75	2.62	4.48	5.25	9.46	15.25	24.08	10.38	16.52	26.91	13.83	19.98	22.68	16.37	22.52	25.34
T_8 – Silicon – 300 mg/l	4.11	4.84	5.13	2.97	4.88	5.66	10.04	16.38	25.46	11.17	17.86	28.53	15.92	21.88	24.11	18.11	24.69	27.20
T_9 – Silicon – 400 mg/l	4.79	5.51	5.90	3.65	5.69	6.47	11.21	18.63	28.23	12.76	20.56	31.77	16.96	22.84	24.83	18.97	25.77	28.13
T_{10} – Control	2.42	3.15	3.21	1.26	2.88	3.62	7.11	10.75	18.55	7.20	11.12	20.42	7.57	14.26	18.37	11.22	16.04	19.76
S.Em. ±	0.18	0.35	0.27	0.21	0.22	0.29	0.54	1.01	1.33	0.60	1.10	1.49	0.71	1.42	1.16	0.88	1.60	1.29
C.D.	0.53	1.05	0.78	0.63	0.63	0.86	1.60	2.97	3.93	1.77	3.23	4.39	2.10	4.19	3.42	2.59	4.72	3.80

Table 3: Effect of plant growth enhancing substances on flowering parameters of *Euphorbia milii* var. 'Pink Bold Beauty'

Treatments	Days required for flower bud initiation		Days required for bud initiation to flower opening		Days required for flower opening to flower senescence	
	2015-2016	2016-2017	2015-2016	2016-2017	2015-2016	2016-2017
T_1 – Spermine – 10 mg/l	21.85	22.22	8.50	8.96	14.72	16.98
T_2 – Spermine – 20 mg/l	20.18	21.34	8.05	8.40	15.74	17.78
T_3 – Spermine – 30 mg/l	19.35	20.46	7.60	7.85	16.77	18.59
T_4 – Salicylic acid – 1.0 mg/l	25.47	24.89	9.84	10.64	11.65	14.57
T_5 – Salicylic acid – 2.0 mg/l	24.64	23.99	9.39	10.08	12.67	15.37
T_6 – Salicylic acid – 3.0 mg/l	22.82	23.10	8.94	9.52	13.70	16.18
T_7 – Silicon – 200 mg/l	24.95	27.62	11.19	12.31	8.57	12.16
T_8 – Silicon – 300 mg/l	24.12	26.71	10.74	11.75	9.60	12.96
T_9 – Silicon – 400 mg/l	23.92	25.80	10.29	11.20	10.62	13.77
T_{10} - Control	26.77	28.55	11.64	12.87	7.55	11.35
S.Em. ±	1.24	1.75	0.56	0.60	0.91	1.12
C.D.	3.65	3.16	1.65	1.77	2.68	3.30

Flowering and Flower Quality Parameters

Spermine showed significant effect on flowering and flower quality of *Euphorbia milii* plants (Table 4, 5 and 6). Foliar application of spermine at 30 mg/l (T_3) showed earliness in flower bud initiation (19.35 and 20.46 days) and flower bud opening (7.60 and 7.85 days) with improved flowering period (170.48 and 182.35) during first and second year, respectively. Conjugated polyamines are known to be associated with the physiology of flowering metabolite synthesis [Slocum and Galston (1985)] [33]. High levels of endogenous polyamines and their conjugates have been found in apical shoots and meristems prior to flowering [Cabanne *et al*. (1981)] [4] and flower parts of many plants [Martin-Tanguy (1985)] [25]. Polyamines have been known to influence many biochemical and physiological processes such as cell division, cell elongation, flowering, flower development and senescence [Bouchereau *et al.* (1999), Kakkar and Sawhney (2002)] [3, 13] and are closely associated with carbohydrate biosynthesis in plants [Mahgoub *et al.* (2011)] [24]. Delay in flower senescence (16.77 and 18.59 days) with improved *in situ* flower longevity was observed with foliar application of spermine at 30 mg/l (T_3) during experiment. Spermine has been reported to delay the senescence in cut carnation flowers by reducing ethylene production [Lee *et al.* (1997) [21]. Spermine has well established role in the stimulation of cell division and in the delay of senescence [Kitada *et al.* (1979)] [19] and is known for its anti-senescence effects during ageing sequence of plant tissue [Kaur-Sawhney and Galston (1991)] [16]. Significant role of polyamines in delaying flower senescence has been also been suggested by Cavaiuolo *et al.* (2013) [6].

Plants sprayed with salicylic acid at 3.0 mg/l (T_6) recorded maximum number of inflorescence per plant at 30 DAS (5.79, 5.35), at 60 DAS (6.41, 6.96) and at 90 DAS (7.80, 8.66) as well as highest inflorescence diameter at 30 DAS (7.68, 7.36), at 60 DAS (8.68, 9.79) and at 90 DAS (9.29, 11.28) during first and second year respectively. Maximum number of flowers per inflorescence at 30 DAS (6.91, 6.71), at 60 DAS (8.69, 9.33) and at 90 DAS (10.85, 12.02) with improved flower size at 30 DAS (3.18, 3.20), at 60 DAS (4.39, 3.51) and at 90 DAS (5.17, 4.32) was achieved with foliar application of 3.0 mg/l salicylic acid (T_6) during first and second year. Flower promotion with salicylic acid application has been elucidated to be an indirect effect as SA alters the synthesis and/or signalling pathways of other plant hormones including jasmonic acid, ethylene and auxin [Vlot *et al.* (2009), Pacheco *et al.* (2013)] [35, 27]. In addition to this, exogenous application of SA raises the content of endogenous bioactive GA in response, changes the hormonal status of the plant [Mukherjee and Kumar (2007)] [26] and there by influence flowering [Kim *et al.* (2009) [18]. Other scientists have also reported beneficial effect of SA on flower quality in marigold [Pacheco *et al.* (2013)] [27] and in *Euphorbia* [Saadawy and Abdel-Moniem (2015)] [30].

Table 4: Effect of plant growth enhancing substances on flowering and flower quality of *Euphorbia milii* var. 'Pink Bold Beauty'

Treatments	Number of inflorescence per plant						Inflorescence diameter (cm)						Number of flowers per inflorescence					
	2015-2016			2016-2017			2015-2016			2016-2017			2015-2016			2016-2017		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1 – Spermine – 10 mg/l	3.84	3.10	5.44	2.69	3.81	6.40	6.01	5.60	6.50	4.03	6.54	7.54	5.18	4.94	7.94	4.06	5.12	8.40
T_2 – Spermine – 20 mg/l	4.21	4.26	5.73	3.03	4.20	6.68	6.21	5.99	6.85	4.45	6.94	8.01	5.37	5.41	8.30	4.39	5.65	8.85
T_3 – Spermine – 30 mg/l	4.57	4.42	6.03	3.36	4.59	6.96	6.41	6.38	7.20	4.86	7.35	8.47	5.56	5.87	8.67	4.72	6.18	9.30
T_4 – Salicylic acid – 1.0 mg/l	4.98	5.91	6.91	4.76	5.78	7.81	7.02	7.52	8.24	6.11	8.57	9.87	6.20	7.28	9.76	5.72	7.75	10.66
T_5 – Salicylic acid – 2.0 mg/l	5.42	6.24	7.50	5.02	6.57	8.37	7.46	8.29	8.94	6.94	9.38	10.81	6.67	8.22	10.49	6.38	8.81	11.57
T_6 – Salicylic acid – 3.0 mg/l	5.79	6.41	7.80	5.35	6.96	8.66	7.68	8.68	9.29	7.36	9.79	11.28	6.91	8.69	10.85	6.71	9.33	12.02
T_7 – Silicon – 200 mg/l	4.14	4.93	6.32	3.70	4.98	7.24	6.16	6.76	7.54	5.28	7.76	8.94	5.76	6.34	9.03	5.05	6.70	9.76
T_8 – Silicon – 300 mg/l	4.31	5.15	6.62	4.02	5.38	7.43	6.42	7.14	7.90	5.70	7.96	9.41	5.77	6.81	9.40	5.38	7.23	10.21
T_9 – Silicon – 400 mg/l	5.58	6.07	6.21	4.89	6.17	8.09	7.23	7.91	8.59	6.53	8.97	10.34	6.43	7.75	10.12	6.05	8.28	11.12
T_{10} – Control	3.47	4.94	5.14	2.36	3.41	6.11	5.82	5.22	6.15	3.62	6.13	7.07	5.00	4.47	7.58	3.72	4.59	7.94
S.Em. ±	0.37	0.32	0.35	0.22	0.37	0.40	0.39	0.52	0.42	0.40	0.59	0.49	0.35	0.45	0.50	0.40	0.48	0.54
C.D.	1.09	0.93	1.03	0.66	1.10	1.17	1.16	1.53	1.23	1.18	1.75	1.45	1.03	1.33	1.46	1.17	1.41	1.58

Table 5: Effect of plant growth enhancing substances on flowering and flower quality of *Euphorbia milii* var. 'Pink Bold Beauty'

Treatments	Flower diameter (cm)						*In situ* flower longevity (days)						Flowering period (days)	
	2015-2016			2016-2017			2015-2016			2016-2017			2015-2016	2016-2017
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS		
T_1 – Spermine – 10 mg/l	2.30	3.02	3.34	2.18	2.68	3.15	8.99	14.06	17.64	10.03	15.64	19.53	163.11	171.79
T_2 – Spermine – 20 mg/l	2.41	3.19	3.69	2.31	2.79	3.30	9.30	14.45	18.32	10.45	16.08	20.35	166.30	176.99
T_3 – Spermine – 30 mg/l	2.52	3.36	4.04	2.44	2.89	3.44	9.61	14.86	18.99	10.87	16.52	21.16	170.48	182.35
T_4 – Salicylic acid – 1.0 mg/l	2.69	3.87	4.45	2.78	3.20	3.88	8.07	11.90	15.63	8.77	13.31	17.09	153.50	156.94
T_5 – Salicylic acid – 2.0 mg/l	2.97	4.22	4.82	3.07	3.41	4.17	8.18	12.28	16.30	9.19	13.75	17.90	158.90	161.76
T_6 – Salicylic acid – 3.0 mg/l	3.18	4.39	5.17	3.20	3.51	4.32	8.69	13.66	16.97	9.61	15.19	18.72	159.08	164.71
T_7 – Silicon – 200 mg/l	2.53	3.54	4.11	2.61	2.89	3.59	7.14	11.76	13.62	7.50	12.97	14.64	147.31	153.21
T_8 – Silicon – 300 mg/l	2.74	3.83	4.49	2.69	2.99	3.77	7.45	12.13	14.29	7.92	13.42	15.46	152.71	157.69
T_9 – Silicon – 400 mg/l	2.96	4.04	4.75	2.94	3.30	4.02	7.76	12.51	14.96	8.35	13.86	16.27	155.69	157.26
T_{10} – Control	2.19	2.85	2.98	2.06	2.58	3.01	6.83	11.38	12.94	7.08	12.53	13.83	131.92	138.90
S.Em. ±	0.17	0.19	0.34	0.20	0.19	0.20	0.46	0.69	0.86	0.50	0.84	0.94	6.05	9.26
C.D.	0.61	0.57	0.72	0.57	0.58	0.58	1.35	2.04	2.53	1.48	2.46	2.77	10.80	17.33

Table 6: Effect of plant growth enhancing substances on pigment and Overall appearance as pot plant (on visual basis) of *Euphorbia milii* var. 'Pink Bold Beauty'

Treatments	Chlorophyll Content (mg/g)		Anthocyanin content in petals (mg/g)		Overall appearance as pot plant (on visual basis)	
	2015-2016	2016-2017	2015-2016	2016-2017	2015-2016	2016-2017
T_1 – Spermine – 10 mg/l	20.17	20.13	2.04	2.00	2	3
T_2 – Spermine – 20 mg/l	21.33	21.28	2.13	2.08	3	3
T_3 – Spermine – 30 mg/l	23.18	23.11	2.14	2.10	3	3
T_4 – Salicylic acid – 1.0 mg/l	22.48	22.44	2.00	1.98	3	3
T_5 – Salicylic acid – 2.0 mg/l	23.06	23.03	2.06	2.03	4	4
T_6 – Salicylic acid – 3.0 mg/l	24.36	24.33	2.21	2.18	5	5
T_7 – Silicon – 200 mg/l	21.38	21.32	2.08	2.06	3	3
T_8 – Silicon – 300 mg/l	25.10	25.06	2.15	2.12	4	4
T_9 – Silicon – 400 mg/l	26.24	26.20	2.16	2.14	4	4
T_{10} - Control	19.34	19.31	1.98	1.90	2	2
S.Em. ±	0.23	0.21	0.02	0.02	-	-
C.D.	0.67	0.62	0.06	0.06	-	-

Pigments

Plants sprayed with silicon at 400 mg/l (T_9) recorded significantly higher chlorophyll content in the leaves of variety 'Pink Bold Beauty' (26.24, 26.20 and 26.21 mg/g) which was followed by treatment T_8 (silicon at 300 mg/l) during both the years. Inclusion of Si has been reported to increase chlorophyll content in leaves by improving the cell ultrastructure of leaves [Lee *et al.* (2010)] [22]. Higher chlorophyll content with silicon application has been earlier reported in Kentucky bluegrass [Bae *et al.* (2012)] [1] and in marigold [Sivanesan *et al.* (2010)] [32]. In addition, application of salicylic acid at 3.0 mg/l (T_6) resulted significantly higher anthocyanin content in petal tissue (2.21, 2.18 and 2.20 mg/g) which was at par with treatment T_9 and T_8 during first year and second year. Anthocyanin belong to a parent class of flavonoids which synthesized via the phenylpropanoid pathway. Kim *et al.* (2009) [18] achieved similar type of results in plants of *Taraxacum officinale* in response to the application of salicylic acid which demonstrating its effect on the biosynthesis of secondary metabolites. Increased endogenous levels of SA can trigger cell signalling pathways which regulate the expression of genes encoding enzymes related to the phenylpropanoid pathway for anthocyanin production [Ghasemzadeh *et al.* (2012), Pacheco *et al.* (2013)] [9, 27]. Untreated plants (T_{10}) exhibited minimum chlorophyll content in leaves and anthocyanin content in petals during the experiment.

Overall appearance as a pot plant (on visual basis)

Euphorbia milii plants sprayed with salicylic acid at 3.0 mg/l (T_6) showed excellent quality score (5) on 5-point scale basis followed by salicylic acid at 2.0 mg/l (T_5), silicon at 400 mg/l (T_9) and silicon at 300 mg/l (T_8) during first year and second year (Table 6). Minimum score (2) was recorded in untreated plants (T_{10}) and in spermine application at 10 mg/l (T_1) during both the years. Improved plant height with thicker stems, good plant spread and branches, greener leaves (due to high chlorophyll content), with higher number of inflorescence, improved inflorescence size and colour added visual appeal to *Euphorbia* potted plants.

Foliar application of salicylic acid at 3.0 mg/l and silicon at 400 mg/l can be effectively used to develop improved plant architecture with regard to good plant canopy with branching and leaves with more number of quality inflorescence, prolonged flowering period with enhanced flower longevity and higher pigment content in *Euphorbia milii* as pot plant.

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