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Effect of plant growth regulators on growth and yield of *Limonium* var. misty white

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Abstract
An experiment was conducted to study the effect of plant growth regulators on growth and yield of *Limonium* var. Misty White during September, 2014 to May, 2015 in Randomized Block Design (RBD) with eleven treatments and three replications. The results revealed that application of gibberellic acid @ 200 mg/l recorded significantly maximum shoots per plant (1.79), weight of inflorescence (77.32 g), inflorescence per plant (5.90), flowering duration (17.33 days) and vase life (5.77 days) with minimum days to flowering (82.31) whereas application of salicylic acid @ 150 mg/l recorded significantly higher plant height (20.60 cm) and inflorescence length (167.53 cm) of *Limonium* flowers var. Misty White.

Keywords: Plant growth regulators, salicylic acid, gibberellic acid and *Limonium*

Introduction
This forms a low mound of large, leathery green leaves, bearing upright branching heads of tiny, pale-blue flowers, giving a misty, cloud-like effect. Plants will produce a number of stems, and the overall effect is billowing and delicate. Very tolerant of hot, dry sites once established. Dislikes being moved or divided. Flowers are attractive to butterflies. To dry, stems should be cut just as the flowers begin to open, and hung upside down in a warm, dark place. *Limonium* or Statice is a best perrenial cut flower crop which is also highly suitable for fillers and making dry flowers. Branches of *Limonium* are essentially used as filler material in bouquets, corsages, baskets and in other flower arrangements. It belongs to family Plumbaginaceae and originated from Easter mediterrranean region. Perennial statices, with their very high utility value, now draw very close attention from many markets all over the world. This forms a low mound of large, leathery green leaves, bearing upright branching heads of tiny, flowers. Plants produce a number of stems, and the overall effect is billowing and delicate. It produces small flowers in colours ranging from white, purple, blue, violet and baby pink. The branches spread out wider at top. The stems are thin and do not take of much space where as the top of the plants have a large volume giving a misty, cloud-like effect. Most of the varieties are cultivated under naturally ventilated green house. Growth and flowering of *Limonium* depends on many factors of which media, fertilizer, growth regulators are important. The growth regulators are used in plants to induce the earliness, increasing duration of flowering, elongation, compact growth, breaking apical dominance and to manipulate the vegetative growth and flowering in diverse conditions. The work on the response of foliar application of gibberellic acid and salicylic acid on *Limonium* is very meagre, thus, this experiment was taken under study.

Materials and Methods
The present investigation was carried out to study the effect of growth regulators on growth and yield of *Limonium* var. Misty Blue during September, 2014 to May, 2015 at Green House Complex, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari. The experiment was laid out in randomized block design with three replications under naturally ventilated poly house on 60 cm wide raised bed with 2 lines of 30 × 30 cm planting distance. Eleven treatments were consisted of various plant growth enhancers *viz.*, GA_3 @ 50, 100, 200, 300, 400, 500 and 600 mg/l, SA @ 50, 100 and 150 mg/l spray and control (water spray). Different plant growth enhancers were sprayed at 40 days after planting. The crop was irrigated through drip system by employing two laterals of 2 lph dripper per bed at a spacing of 30 cm running along the length of the bed.

Misting was carried out by overhead 4 way foggers in summer months to bring down the temperature and maintain humidity at optimum level. Observations were recorded on vegetative and flowering parameters. Five plants were selected randomly from each treatment for recording observations and statistically analyzed as per method suggested by Panse and Sukhatme (1967) [6].

Results and Discussion

The data recorded on different vegetative parameters are presented in Table 1 and it revealed that application of salicylic acid (SA) and gibberellic acid (GA_3) had significant influence on vegetative growth of *Limonium*. Among all treatments of plant growth regulators, spray of salicylic acid @ 150 mg/l proved better for plant height without panicle (20.62 cm) while application of GA_3 recorded maximum shoots per plant (1.79). The effect of gibberellic acid (GA_3) and salicylic acid (SA) on plant spread and leaf area did not differ significantly.

It is possible that SA could be involved in the regulation of cell enlargement and division in synergy with other substances such as auxin, IAA and phenolic which cause stimulatory effect to increase plant height and plant spread. SA also played major role in photosynthesis by affecting chloroplast structure and stomatal closure. It has been also reported by Anwar *et al*. (2014) [2] who observed that the pre harvest treatment of salicylic acid in tuberose at the concentration of 1.0 mg/l significantly increased the plant height and vegetative growth. These results are also in agreement with observations of Swaroop *et al*. (2007) [12] in African marigold, Sable *et al*. (2015) [10] and Aier *et al*. (2015) [1] in gladiolus, Patel *et al*. (2013) in gladiolus cv. American Beauty and Dalal *et al*. (2009) [3] in gerbera.

The increase in shoot production might be due to gibberellic acid which makes plants taller by enhancing cell division in apical meristem of shoot tip and cell elongation of stem (Ramachandrudu and Thangam, 2007) [9]. Growth might also be increased due to osmotic uptake of water and nutrients under the influence of GA_3, which maintain swelling force against the softening of cell wall and thereby increasing the plant height (Sharma *et al*., 2004) [11]. These results are also in similarity to the findings of Umrao *et al*. (2008) [14] in gladiolus, Dhaduk *et al*. (2007) [5] in anthurium and Tyagi and Singh (2006) [13] in African marigold.

There was a significant enhancement recorded in flowering parameters with the application of plant growth regulators as compared to control. However, both the plant growth regulators (GA_3 and SA) significantly influence all floral and yield characters of *Limonium* var. Misty White. The data on floral and yield parameters are depicted in Table 2 which showed that minimum days to flowering (82.31) with maximum flowering duration (17.33 days), weight of inflorescence per plant (77.32 g), inflorescence per plant (5.90) and vase life (5.77 days) were recorded with the application of gibberelic acid @ 200 mg/l in whereas maximum inflorescence length (167.53 cm) was recorded in treatment containing spray of salicylic acid @ 150 mg/l *Limonium* var. Misty White.

Earliness in flowering by GA_3 treatment might be due to increase in endogenous level of GA_3 that increased photosynthesis area and respiration which enhanced CO_2 fixation and increase N ratio in plant that associated with early flowering (Patil, 2001) [8]. Thus, GA_3 is quite effective for reducing juvenile period of plant for early flowering (Singh and Barad, 2002). The early floret opening in GA_3 treated plants can be attributed to the rise in endogenous GA_3 level and it might also be due to increase in efficiency of GA_3 treated plants with respect to synthesis of metabolites.

Length of inflorescences was increased because of the growth-promoting effects of SA which could be related to changes in the hormonal status or by improvement of photosynthesis, transpiration and stomatal conductance. Application of GA_3 might increase the auxin content in tissue as it was involved in auxin synthesis and greater amount of carbohydrate by accumulation which increased metabolic activities. This was noted by Tyagi and Singh (2006) [13] in tuberose. The increase of flower is might be due to the decreasing of photosynthesis to flower as a consequence of intensification of sink increase in flower diameter (Patil, 2004) [7]. GA_3 increased flower which increased stored food material in the tissue, which cause increase in vase life of flower indirectly. The positive effect of GA_3 on extending the vase life in the present study are in consonance with the finding of Devadanam *et al.* (2007) [4] and Umrao *et al.* (2008) [14] in gladiolus.

Table 1: Effect of plant growth regulators on vegetative characters of *Limonium* var. Misty White

Treatments	Plant height (cm)	Plant spread (cm)	Shoot per plant	Leaf area (cm^2)
T_1: Salicylic acid 50 mg/l	16.02	26.89	1.07	68.84
T_2 : Salicylic acid 100 mg/l	18.30	27.57	1.13	68.86
T_3 : Salicylic acid 150 mg/l	20.62	28.19	1.66	68.62
T_4 : Gibberellic acid 50 mg/l	17.89	27.97	1.46	69.68
T_5 : Gibberellic acid 100 mg/l	19.26	27.54	1.73	69.41
T_6 : Gibberellic acid 200 mg/l	20.60	27.89	1.79	70.17
T_7 : Gibberellic acid 300 mg/l	18.51	27.39	1.73	69.38
T_8 : Gibberellic acid 400 mg/l	18.42	27.79	1.60	68.52
T_9 : Gibberellic acid 500 mg/l	18.03	27.33	1.53	67.82
T_{10} : Gibberellic acid 600 mg/l	17.41	26.64	1.46	66.58
T_{11} : Control	16.95	26.56	1.26	67.49
C. D. at 5%	2.48	NS	0.19	NS

Table 2: Effect of plant growth regulators on flowering characters of *Limonium* var. Misty White

Treatments	Days to flowering	Flowering duration (days)	Inflorescence length (cm)	Weight of inflorescence (g)	Inflorescence per plant	Vase life (days)
T_1: Salicylic acid 50 mg/l	90.07	15.73	164.67	48.07	4.23	5.17
T_2 : Salicylic acid 100 mg/l	87.79	15.67	165.08	51.19	4.30	5.43
T_3 : Salicylic acid 150 mg/l	82.41	16.80	167.53	74.40	5.37	5.60
T_4 : Gibberellic acid 50 mg/l	88.80	15.53	159.86	63.62	4.90	5.43
T_5 : Gibberellic acid 100 mg/l	86.31	15.70	163.47	70.06	5.17	5.60
T_6 : Gibberellic acid 200 mg/l	82.31	17.33	167.15	77.32	5.90	5.77
T_7 : Gibberellic acid 300 mg/l	84.78	16.50	161.53	73.14	5.50	5.73
T_8 : Gibberellic acid 400 mg/l	86.63	16.43	160.67	69.12	5.00	5.43
T_9 : Gibberellic acid 500 mg/l	88.80	15.80	161.26	63.01	4.90	5.43
T_{10} : Gibberellic acid 600 mg/l	90.29	15.30	160.58	61.86	4.73	5.43
T_{11} : Control	91.14	14.20	158.48	47.52	4.13	5.20
C. D. at 5%	3.28	1.49	5.74	7.79	0.58	0.30

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