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Impact of salicylic acid and humic acid on flowering of *Lilium* asiatic hybrid cv. Tresor

Pooja Pahare and Dr. S Beura

Abstract
The present investigation the Study the impact of salicylic acid and humic acid on flowering of Lilium cv. Tresorwas carried out during the year 2018-19 and 2019-20, rainy season under the poly shade net structure of RKVY project, Department of Floriculture & Landscaping at Biotechnology-cum-Tissue Culture Centre, O.U.A.T., Bhubaneswar. The trial was conducted separately for each cultivar with fourteen treatments and the treatments comprised of foliar application of Salicylic acid at T_1 (control), T_2 (250 ppm Humic acid), T_3 (500ppm HA), T_4 (750ppm HA), T_5 (1000ppm HA), T_6 (1250 ppm HA), T_7 (1500ppm HA), T_8 (50ppm Salicylic acid), T_9 (75 ppm SA), T_{10} (100ppm SA), T_{11} (125ppm SA), T_{12} (150ppm SA), T_{13} (175ppm SA), T_{14} (200 ppm SA). The whole experiment was carried out following Randomized Block Design with four replications. Results revealed that T_{14} 200 ppm SA recorded significantly flower growth Days for opening of first flower, number of flower per plant, length of flower (cm), petal weight (g), petal width (cm), petal length (cm) and stalk length (cm).

Keywords: Humic acid, salicylic acid, flower growth and ppm

Introduction
Flower is one of the God's beautiful creation in the world. They are symbol of beauty, love, passion and tranquillity. They are the soul of garden and convey the message of nature to mankind. Flowers have a very important role in our life. The importance is not only restricted to beautification but also hold an influential role in the worldwide economy. In India floriculture is a high growth industry and the government has identified this section as a sunrise industry which claim to be 100% export-oriented status.

Lilium is an important ornamental bulbous plant. It is known for ages as evident from Shekels stamped by Palestinian coin marker in 143 BC (Bose *et al*., 2003) [2]. Lilium is a symbol of fertility, clarity, chastity and utility. In Christianity lily is a symbol of love that the Archangel Gabrid and the parents Virgin Mary are often depicted holding a lily (Anon, 2005). Romans and Greeks crowned their bride with lilies. Lilium is one of the six major genera of flower bulbs produced worldwide (Hertogh and Le Nard, 1993) [16]. They are produced both as potted and cut flowers and are used in landscaping (Dole & Wilkins, 1999) [4]. It is a species of great economic importance in production and commercialization of cut flower in the international market (Jiménez *et al.*, 2012) [9]. Due to its size, beauty and longevity Lilium is one of the ten most superior cut flowers in the world (Thakur *et al.*, 2005) [22].

Lily has been used for different purposes including bouquet formation, decoration of hotels, houses, luxury buildings, marriages and religious ceremonies for over 2000 years (Ramsay *et al.*, 2003) [18]. Besides having ornamental value they also have medicinal properties. Bulb are used for treating tumors, ulcers and inflammations. Dioscorides of ancient Greek signified that lily leaves are emplaced around burns, injury and snake bite. White lily was also used as a cosmetic.

Lilium is native of northern hemisphere upto South Canada and Siberia and their southern limit is Florida and India. At present 100 species of lilium are found in temperate and sub-tropical zone of northern India (Nhut, 1998) [17]. The genus lilium belongs to family Liliaceae and comprises over 80 species (Lim *et al.*, 2003) [13]. They are excellent as cut flowers and occupy 4th position followed by Rose, Carnation and Chrysanthemum in the international market. Asiatic hybrids are derived from hybridization of at least 12 species (*viz., Lilium amabile.* L. *bulbiferum,* L. *concolor,* L. *dauricum,* L. *davidii,* L. *hollandicum,* L. *maculatum,* L. *leichtlinii,* L. *pumilum* and L. *tigrinum)* of hybrid lily. (Sheikh 2015) [19].

Quality of flower bud production is limited due to soil conditions that are not favourable in many arid and semi-arid parts of the world. High PH values of soil which hinder the

absorption of nutrients, and protect to abiotic stress also pose a problem for quality flower production. Foliar application is one of the methods to overcome this problem by providing nutrients necessary for optimal growth. Soil health is a crucial factor for obtaining higher yields of floricultural crops. Poor soil health and structure reduced microbial activities may result in poor crop stand, reduced plant growth and development. Among various management practices followed for higher yield and quality of flowers, nutritional management plays a significant role. Apart from micronutrient (B, Fe, Zn, Cu, Cl, Mn, Mo, Na, I and Co.) and macronutrient (N, P, K, Ca, Mg and S) are equally important which are involved in all metabolic and cellular functions influencing various growth and floral characters plants Macronutrients and micronutrient are to be necessarily taken up by the plants from soil or supplemented through foliar application for good growth and yield of crops and maximizing the efficient use of applied N, P and k. Most of the acid have been found to act as growth regulators. Humic acid (HA) may facilitate plant growth and there were relatively large responses at foliar application by improving the nutrient uptake as well as through hormonal effect in Lilium (Chang 2012) [3]. Salicylic acid (SA) increases the plants response to tolerance and resistance to various diseases affecting plants as it is found that increasing its internal concentration activates the protective role of pathogenic pathogens. (Raskin 1992).

Materials and Methods

The experiment was conducted in the poly shade net structure of RKVY project, Dept. of Floriculture & Landscaping at Biotechnology-cum-Tissue Culture Centre, O.U.A.T., Bhubaneswar during the year 2018-19 and 2019-20, inrainy season. The experiment was conducted on Lilium Cv. Tresor with 14 treatment and four replication in Randomized block design. The experiment were space at 20 cm x 20 cm.

One gram each of active substance of salicylic acid was dissolved in 10 ml of alcohol (C_2H_5OH) and final volume was made upto 1000 ml by adding distilled water and thus Stock solution of 1000 ppm salicylic acid was prepared. The stock solution thus prepared was used by adding distilled water to prepare the required concentration of salicylic acid as per the treatments (SA-50, 75, 100, 125, 150, 175 and 200 ppm) for foliar spray. Care has been taken that all the foliage parts of the plants got uniform application.

Stock solution of desired quantity of HA (5300mg) was dissolved directly in 5300 ml of distilled water. After that stock solution was made into different parts (0.25, 0.5, 0.75, 1, 1.25 and 1.5 ml) as it is readily soluble in 1000 ml water to make the required concentrations of HA (250, 500, 750, 1000, 1250 and 1500 ppm). These prepared solutions were also applied on plants as foliar spray. Care has been taken that all the foliage parts of the plants got uniform application. Foliar spray of salicylic acid and humic acid in prescribed concentration of the treatments was undertaken on 30th day of planting of bulbs. The growth substances were sprayed with the help of hand sprayer. The whole plant was sprayed completely by taking precaution to avoid the mixing of sprays from one treatment to another.

Statistical analysis was done by using method of analysis of variance (ANOVA) for randomized block design (RBD) by Fischer and Yates (1963). Whenever 'F' test was found significant for comparing the means of two treatments, critical difference (C.D. at 5%) was worked.

Results and Discussion

The data on presented in Table1the days for opening of first flower day after planting, days taken for opening of first flower ranged from 56.65 to 80.55 during first year, 60.85 to 78.45 in second year and 57.25 to 74.00 in pooled analysis. The minimum days for days taken for opening of first flower was recorded under treatment T_{14} (56.65, 60.85 and 57.25in first and second year as well as on pooled mean, respectively) were recorded in SA @ 200 ppm (T_{14}) followed by T_{13} (59.45, 62.80 and 59.13in first and second year as well as on pooled mean, respectively) were recorded in SA @ 175 ppm (Dole and Wilkins 1999). However, the maximum days for days taken for opening of first flower (80.55in first year, 78.45in second year and 74.00 in pooled mean) was observed in the treatment control (T_1).

The number of flowers per plant, number of flowers per plant ranged from 2.10 to 4.15during first year, 3.35 to 4.88 in second year and 2.73 to 4.60in pooled analysis. The maximum number of flowers per plant was recorded under treatment T_{14} (4.15, 4.88 and 4.60 in first and second year as well as on pooled mean, respectively) were recorded in SA @ 200 ppm (T_{14}) followed by T_{13} (4.10, 4.80 and 4.58in first and second year as well as on pooled mean, respectively) were recorded in SA @ 175 ppm (Sindhu and Pathania 2003) [20]. However, the minimum number of flowers per plant (2.10in first year, 3.35 in second year and 2.73 in pooled mean) was observed in the treatment control (T_1).

Length of flower (cm) at was significantly improved by all the levels of Salicylic Acid and Humic Acid during year 2018-19, 2019-20 and in pooled mean as compared to control. However out of 14 treatment combinations studied, the minimum length of flower (cm) during first year (9.78 cm), second year (9.39 cm) and in pooled mean (9.22 cm) was obtained under control T_1 treatment during both the years of study as well as in pooled mean. Among the different concentrations of Salicylic Acid and Humic Acid, the maximum length of flower (14.31, 13.71 and 13.48 cm in first and second year as well as on pooled mean.

Table 1: Impact of salicylic acid and humic acid on flowering of *Lilium* asiatic hybrid cv. Tresor

		2018-2019 Rainy Season			2019-2020 Rainy Season			Pooled Rainy Season		
Treatment	Character	Days for opening of first flower	No. of flower per plant	Length of flower(cm)	Days for opening of first flower	No. of flower per plant	Length of flower(cm)	Days for opening of first flower	No. of flower per plant	Length of flower(cm)
T_1	Control	80.55	2.10	9.78	78.45	3.35	9.39	74.00	2.73	9.22
T_2	250 ppm Humic Acid	74.30	2.80	11.65	75.50	3.80	11.16	72.90	3.30	10.97
T_3	500 ppm HA	69.30	2.95	11.94	71.65	3.70	11.46	69.97	3.33	11.25
T_4	750 ppm HA	68.25	3.00	12.36	70.10	4.00	11.90	67.18	3.50	11.67
T_5	1000 ppm HA	66.25	3.15	12.60	69.70	4.20	12.11	65.48	3.68	11.88
T_6	1250 ppm HA	65.45	3.95	12.86	68.10	4.20	12.51	62.28	3.88	12.20
T_7	1500 ppm HA	62.50	3.95	13.09	64.25	4.80	12.28	60.88	4.28	12.20
T_8	50 ppm Salicylic	69.00	3.20	12.49	74.90	2.50	11.98	69.45	2.75	11.77

	Acid									
T_9	75 ppm SA	68.85	3.39	12.84	70.50	2.50	12.39	67.18	2.85	12.14
T_{10}	100 ppm SA	67.40	3.55	13.02	69.55	3.60	12.60	65.48	2.98	12.32
T_{11}	125 ppm SA	64.70	3.75	13.46	66.20	3.85	12.87	62.45	3.05	12.66
T_{12}	150 ppm SA	62.35	3.80	13.63	63.80	4.40	13.10	60.57	4.10	12.85
T_{13}	175 ppm SA	59.45	4.10	14.06	62.80	4.80.	13.38	59.13	4.58	13.20
T_{14}	200 ppm SA	56.65	4.15	14.31	60.85	4.88	13.71	57.25	4.60	13.48
S.Em+		1.02	0.16	0.40	1.54	0.32	0.34	1.28	0.24	0.18
C.D. 5%		2.92	0.46	1.15	4.40	0.93	0.98	3.66	0.70	0.49

respectively) were recorded in SA @ 200 ppm (T_{14}) at which was found significantly superior in improving length of flower to rest of humic acid and salicylic acid concentrations except its lower (75 ppm) and higher concentration (200 ppm) (Singh *et al*., 2008) [21]. However, the minimum length of flower (9.78 cm in first year, 9.39 cm in second year and 9.22 cm in pooled mean) was observed in the treatment control (T_1).

Data on petal weight (g), petal width (cm), petal length (cm) and stalk length (cm) are presented in Table 2. Data indicated that the different levels of humic acid and salicylic acid influence the petal weight (g), petal width (cm), petal length (cm) and stalk length (cm) during both the years of investigation as well as in pooled mean. The data also revealed that the petal weight (g), was significantly affected due to humic acid and salicylic acid during both the years and in pooled. The maximum petal weight (g), (2.93 g during 2018-19, 2.93 g during 2019-20 and 2.93 g in pooled mean) were noted in SA @ 200 ppm (T_{14}) which was found significantly better for obtaining higher petal weight (g), than rest of the humic acid and salicylic acid except SA 175 ppm (T_{13}) and 150 ppm (T_{12}) during both the years as well as in pooled mean. However, the minimum petal weight (g), 1.96 g during 2018-19, 1.96 g during 2019-20 and 1.96 g in pooled mean) was observed in treatment control (T_1) during both the years as well as in, pooled, mean.

The data also revealed that the petal width (cm) was significantly affected due to humic acid and salicylic acid during both the years and in pooled. The maximum petal width (cm) (2.96 cm during 2018-19, 2.95 cm during 2019-20 and 2.96 cm in pooled mean) were noted in SA @ 200 ppm (T_{14}) which was found significantly better for obtaining higher petal width (cm), than rest of the humic acid and salicylic acid except SA 175 ppm (T_{13}) and 150 ppm (T_{12}) during both the years as well as in pooled mean. However, the minimum petal width (cm), (2.02 cm during 2018-19, 1.99 cm during 2019-20 and 2.00 cm in pooled mean) was observed in treatment control (T_1) during both the years as well as in, pooled mean.

The data also revealed that the petal length (cm) was significantly affected due to humic acid and salicylic acid during both the years and in pooled. The maximum petal length (cm), (9.57 cm during 2018-19, 9.55 cm during 2019-20 and 9.56 cm in pooled mean) were noted in SA @ 200 ppm (T_{14}) which was found significantly better for obtaining higher petal length (cm), than rest of the humic acid and salicylic acid except SA 175 ppm (T_{13}) and 150 ppm (T_{12}) during both the years as well as in pooled mean. However, the minimum petal

Table 2: Impact of Salicylic Acid (SA) and Humic Acid (HA) on flowering of *Lilium* asiatic hybrid cv. Tresor

		2018-2019 Rainy Season				2019-2020 Rainy Season				Pooled Rainy Season			
Character / Treatment		Petal weight (g)	Petal width (cm)	Petal length (cm)	Stalk length (cm)	Petal weight (g)	Petal width (cm)	Petal length (cm)	Stalk length (cm)	Petal weight (g)	Petal width (cm)	Petal length (cm)	Stalk length (cm)
T_1	Control	1.96	2.02	6.70	5.33	1.96	1.99	6.80	5.26	1.96	2.00	6.75	5.29
T_2	250 ppm HA	2.08	2.15	7.23	5.64	2.08	2.11	7.21	5.66	2.08	2.13	7.22	5.65
T_3	500 ppm HA	2.15	2.17	7.50	5.87	2.15	2.16	7.45	5.84	2.15	2.16	7.47	5.85
T_4	750 ppm HA	2.20	2.24	7.58	6.03	2.19	2.21	7.55	6.00	2.19	2.22	7.57	6.02
T_5	1000 ppm HA	2.23	2.30	7.70	6.19	2.23	2.28	7.73	6.17	2.23	2.29	7.71	6.18
T_6	1250 ppm HA	2.32	2.38	7.94	6.32	2.31	2.36	7.96	6.35	2.31	2.37	7.95	6.33
T_7	1500 ppm HA	2.40	2.46	8.30	6.49	2.39	2.42	8.28	6.52	2.39	2.44	8.29	6.51
T_8	50 ppm SA	2.19	2.24	7.75	5.75	2.19	2.21	7.69	5.71	2.19	2.22	7.72	5.73
T_9	75 ppm SA	2.23	2.38	8.33	5.90	2.23	2.35	8.30	5.87	2.23	2.36	8.32	5.89
T_{10}	100 ppm SA	2.36	2.58	8.51	6.07	2.36	2.53	8.47	6.04	2.36	2.55	8.49	6.06
T_{11}	125 ppm SA	2.54	2.72	8.80	6.33	2.59	2.68	8.78	6.30	2.56	2.70	8.79	6.31
T_{12}	150 ppm SA	2.68	2.80	9.02	6.54	2.67	2.77	8.97	6.52	2.68	2.78	8.99	6.53
T_{13}	175 ppm SA	2.76	2.92	9.20	6.65	2.75	2.87	9.17	6.64	2.76	2.89	9.18	6.64
T_{14}	200 ppm SA	2.93	2.96	9.57	6.88	2.93	2.95	9.55	6.86	2.93	2.96	9.56	6.87
S.E(m) +		0.12	0.12	0.40	0.27	0.05	0.03	0.07	0.06	0.08	0.07	0.23	0.17
C.D. at 5%		0.33	0.35	1.14	0.78	0.13	0.08	0.19	0.16	0.23	0.21	0.67	0.47

length (cm), (6.70 cm during 2018-19, 6.80 cm during 2019-20 and 6.75 cm in pooled mean) was observed in treatment control (T_1) during both the years as well as in, pooled mean.

The stalk length (cm), stalk length ranged from 5.33 to 6.88 cm during first year, 5.26 to 6.86 cm in second year and 5.29 to 6.87 cm in pooled analysis. Plants spray with SA @ 200 ppm (T_{14}) recorded significantly higher stalk length (cm) in first year (6.88 cm), second year (6.86 cm) as well as in pooled data (6.87 cm) followed by T_{13} (6.65, 6.64 and 6.64 cm in first and second year as well as on pooled mean, respectively) were recorded in SA @ 175 ppm as compared to untreated plants control. (T_1) (5.33, 5.26 and 5.29 cm respectively).

Humic acid is a potential compound that can be used for increasing nutrient availability and crop production. It plays a vital role in the transport and availability of micronutrients, which are otherwise fixed in soils with higher pH. Many beneficial effects of HA have been documented by the researchers on different crops. Generally, it is absorbed through plant roots, and translocated to shoots and other plant

parts and enhances plant growth responses (Lulakis and Petsas, 1995). Hence application of all those nutrient have land mark effect on bud development and growth in cv. Nashville. Hence application of all those nutrients have land mark effect on vegetative growth in cv. Nashville. Li and Evens (2000), who reported better seedling growth with HA application. Among cultivars, earlier sprouting in might be due to differential genetic make-up of the cultivars or HA interaction with the environmental conditions and/or different cultivars that helped plants supplied with HA sprout earlier compared to untreated plants. Humic acid not only promoted the vegetative growth but also floral growth was improved as higher number of florets per spike were produced by plants provided with three application of HA and NPK. These results are in line with the findings of Kaya *et al*. (2005) [10]; Nikbakht *et al*. (2008) and Baldotto and Baldotto (2013) [1], who reported that HA increased flowering and yield of common bean, gerbera and gladiolus, when applied at higher concentrations and Haghighi *et al*. (2012) [6] who reported improved lettuce yield by stimulating N metabolism and photosynthetic activity, which ultimately increased yield. For stem length of gladiolus, two or three applications of HA and NPK produced longer stems.

Salicylic acid (SA) or ortho-hydroxy benzoic acid and other salicylates are known to affect various physiological and biochemical activities of plants and may play a key role in regulating their growth and productivity and in the responses to environmental stresses (Hayat *et al*., 2010) [10]. Further, its role is evident in seed germination, fruit yield, glycolysis, flowering in thermogenic plants (Klessig and Malamy, 1994) [12], ion uptake and transport (Harper and Balke, 1981) [7], photosynthetic rate, stomatal conductance and transpiration (Khan *et al*., 2003) [11]. SA has been reported to induce flowering in a number of plants. Different plant species including ornamental plant *Sinningia speciosa* flowered much earlier as compared to the untreated control, when they received an exogenous foliar spray of SA (Martin-Max *et al*., 2005) [15]. SA plant growth regulator during application on plants affects a variety of physiological processes, such as stomatal closure, flowering induction and other processes. The inner salicylic acid of the plant improves the flowering process in the plants. In addition, the external application of this plant growth regulator in the culture medium also results in the flowering of the Lemna. Also spraying this hormone leads to a significant increase in leaf area, length and diameter of flower buds, stalk length, and also increase the fresh and dry weight of the plant and improve the quality of rose cut flowers (Mansouri *et al*., 2015) [14].

Conclusion

The results of the present investigation revealed that the all the levels of salicylic acid and humic acid showed significantly affecting flower growth performance and quality. The Impact of salicylic acid 200 ppm (T_{14}) were found superior for on flower growth. Spray of salicylic acid 200 ppm (T_{14}) was found the better to Days for opening of first flower, number of flower per plant and length of flower (cm), petal weight (g), petal width (cm), petal length cm) and stalk length (cm) as compared to control (T_1).

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