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Standardization of plant growth regulators on growth and flowering of spider lily (*Hymenocallis speciosa* L.)

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Abstract
An investigation was conducted on the standardization of plant growth regulators on growth and flowering of spider lily (*Hymenocallis speciosa* L.) in Department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere (Under the University of Agricultural and Horticultural Sciences, Shivamogga) during the academic year 2019-2020. The experiment was laid out in Randomized Completely Block Design (RCBD) and replicated thrice with nine treatments *viz*., Gibberellic acid (150 and 200 ppm), Naphthalene acetic acid (150 and 200 ppm), Chlroemquat Chloride (500 and 1000 ppm) and Benzyl Adenine (100 and 200 ppm) along with the control (water spray). The plants were sprayed with different plant growth regulators thrice at 45, 75 and 105 days after planting. The results revealed that GA_3 @ 200 ppm recorded maximum plant height (69.67 cm), number of leaves (40.92), leaf length (60.67 cm), leaf breadth (6.67 cm), leaf area (5789.51 cm^2), plant spread (E-W) (70.75 cm) and plant spread (N-S) (55.57 cm), minimum days taken for spike emergence (91.33), minimum days taken from bud initiation to harvesting of a flower spike (9.47) and the maximum flowering duration (30.00). The treatment NAA @ 200 ppm recorded maximum chlorophyll a (2.84 mg/g), chlorophyll b (2.87mg/g) and total chlorophyll (5.71 mg/g) content of the leaves.

Keywords: Growth, flowering, spider lily, floriculture, chlorophyll, mudigere

Introduction

Flowers are the loveliest object on the earth. A single flower is a reason for millions of smiles and happiness. In India, flowers are very closely associated with many social and religious activities. Flowers are used in marriage parties, social functions and widely used in religious places like temples, churches and mosques and have high demand during the special days across the world. Flowers being the main ingredient of decoration and prayers which is an integral part of daily life and have economic value as loose and cut flowers, essential oils, natural colours and also making an economical product like scents, gulkand and have wide application in soaps and cosmetic industries, food, textiles, poultry industries and pharmaceuticals. Spider lily (*Hymenocallis speciosa* L.) is the bulbous perennial herb, commonly known as beach spider lily belongs to the family Amaryllidaceae with the chromosome number 2n=22, originated from Latin America. The word 'Hymenocallis' is derived from two Greek words, 'hymen' means membrane and 'kallos' means beauty, referring to the 'membranous beauty' of its delicate flower where the membrane unites and forms the staminal cup. The plants are medium to tall (60-90 cm) and have strap-shaped leaves and white fragrant flowers which are used for loose flower purpose. The flowers have narrow greenish-white petals with large corona. The flowers are fragrant white umbels, each flower with slender recurved petals and elongated stamens emerging from a central cup. The flowers are borne in a cluster (2-12) on around 60 cm long stalk arising from the centre of the leaves. It is rightly called spider lily owing to the shape of petals, which look like legs of the spider. The leaves arise in 'V' shape from the bulbs. Spider lily is used both as a cut flower and loose flower and even in landscapes as it is grown for an ornamental purpose like clumps near the pond along the paths or even in pots.

The gibberellins are involved in several processes including stem extension and flowering. Auxins has an important role in cell elongation and increase cell division in the apical meristems (Sajjad *et al.*, 2014) [15]. The cytokinins influence the process of cell division, biosynthesis of chloroplast pigments and increasing photosynthetic efficiency (Francis and Sorrel, 2001) [4]. Chlromequat chloride is an anti-gibberellin compound that blocks the early stages of gibberellin synthesis and limits the stem elongation in plants and thus creating shorter plants that are more resistant to lodging. Benzyl adenine has an inhibiting effect on the elongation of shoots, both vegetative and flowering ones (Janowska and Stanecki, 2013) [6]. Keeping the above points in view the present study on spider lily entitled standardization of plant growth regulators on growth and flowering of spider lily (*Hymenocallis speciosa* L.) was carried out.

Material and Methods

The present investigation was carried out in an open field condition at the Department of Floriculture and Landscape Architecture in the College of Horticulture, Mudigere, University of Agricultural and Horticultural Sciences, Shivamogga during the academic year 2019-20. The experiment was laid out in Randomized Completely Block Design with 9 treatments and 3 replications i.e., [(T_1- GA_3 @ 150 ppm), (T_2- GA_3 @ 200 ppm), (T_3- NAA @ 150 ppm), T_4-NAA @ 200 ppm), (T_5- CCC @ 500 ppm), (T_6- CCC @ 1000 ppm), (T_7- BA @ 100 ppm), (T_8- BA @ 200 ppm) and (T_9-Control)]. The bulbs were planted at spacing of 45 cm X 45 cm in a unit plot of 1.25 m X 2.75 m. Fertilizer was incorporated at the rate of 20:20:20 g NPK per meter square. The intercultural operations like weeding, hoeing and irrigation was done as and when necessary. Foliar application was done @ 45, 75 and 105 days after planting and the observations were recorded during 60, 90, 120, 150 and 180 days after planting to know the response of spider lily to different plant growth regulators at different concentration and it was statistically analysed by the method suggested by Panse and Sukhatme, 1967 [10].

Results and Discussion

In the present analysis, the plant height was significantly influenced by the use of plant growth regulators (Table1). The maximum plant height (69.67 cm) was recorded in GA_3 @ 200 ppm which was followed by GA_3 @ 150 ppm (59.33 cm). The minimum plant height (45.33 cm) was recorded with BA @ 200 ppm. The maximum plant height with GA_3 @ 200 ppm, might be due to rapid cell division and cell elongation, which resulted in a greater number of cells and increase in cell length as reported by Greulach and Haeshloop (1958) [5]. The minimum plant height with the application of BA might be due to the inhibiting effect on the elongation of shoots at both vegetative and flowering. Similar results have been reported by Parmar *et al.* (2009) [13] in spider lily, Paramaveer and Desai (2013) [11] in Tuberose,

The maximum number of leaves per plant (40.92) were recorded in the plants sprayed with GA_3 @ 200 ppm which was on par with GA_3 @ 150 ppm (39.15). The minimum number of leaves (27.52) was observed in BA @ 200 ppm. It might be due to the effects of GA_3 in relation to the elongation and increase in number of cells and thereby increase in a number of leaves. The minimum number of leaves in BA may be due to inhibitory action by retardation of cell elongation. The above findings are in close agreement with the results of Parmar *et al.* (2009) [13] and Parekh *et al.* (2018) [12] in Spider lily, Wagh *et al.* (2012) [16] in Tuberose.

The maximum plant spread (E-W) and (N-S) (70.75 cm and 55.57 cm respectively) were obtained in GA_3 @ 200 ppm which was statistically on par with GA_3 @ 150 ppm (69.17 cm and 54.05 cm), while BA @ 200 ppm recorded the minimum plant spread in E-W and N-S direction, *i.e.* 47.36 cm and 33.55 cm respectively. An increase in plant spread by GA_3 was due to its effect on stem elongation by increasing the cell elongation in sub-apical meristem. The rapid vegetative growth is a result of both, a greater number of cells formed and increased elongation of the individual cells. The result is in conformity with Parekh *et al.* (2018) [12] in Spider lily and Misra *et al.* (2000) [8] in Football lily.

The plant growth regulators showed a significant difference with respect to leaf length and leaf breadth (Table 1). The maximum leaf length (60.77 cm) and leaf breadth (6.67 cm) was observed in the plants sprayed with GA_3 @ 200 ppm which was statistically on par with GA_3 @ 150 ppm i.e., 58.87cm and 6.50 cm leaf length and leaf breadth respectively. While the minimum leaf length and leaf breadth, i.e. 43.69 cm and 5.33 cm respectively were observed in BA @ 200 ppm. This might be due to gibberellic acid, which rapidly increases the cell division and cell expansion which might have supervened in a greater number of cells and increase in cell length, which ultimately affects the length and breadth of leaves and also may be due to more availability of food material. The reduced leaf length was obtained from BA since BA is accountable for lateral growth instead of axillary growth. These results are in conformity with the findings of Acharjee *et al.* (2015) [1] in Oriental lilium, Ragini *et al.* (2019) [14] in Asiatic lily.

Table 1: Effect of plant growth regulators on growth parameters of spider lily

Treatments	Plant height (cm)	No. of leaves	Leaf length (cm)	Leaf breadth (cm)	Plant spread (E-W) (cm)	Plant spread N-S (cm)
T_1- GA_3 @ 150 ppm	59.33	39.15	58.87	6.50	69.17	54.05
T_2- GA_3 @ 200 ppm	69.67	40.92	60.77	6.67	70.75	55.57
T_3- NAA @ 150 ppm	56.33	38.62	55.70	6.47	64.17	53.33
T_4- NAA @ 200 ppm	59.00	37.67	57.67	6.40	68.17	52.79
T_5- CCC @ 500 ppm	52.67	31.33	57.88	5.87	59.27	43.41
T_6- CCC @ 1000 ppm	47.33	30.67	51.80	5.73	57.48	41.61
T_7- BA @ 100 ppm	47.00	29.81	44.97	5.53	51.59	38.17
T_8- BA @ 200 ppm	45.33	27.52	43.69	5.33	47.36	33.55
T_9- Control (water spray)	51.67	34.33	51.50	6.23	66.28	46.65
S.Em±	1.38	0.68	0.76	0.11	0.85	1.38
CD @ 5%	4.13	2.05	2.29	0.32	2.56	4.13

Leaf area is the critical attribute since it has direct relevance with the interception of light and photosynthesis and ultimately the growth and development. In the current investigation, the leaf area was significantly influenced by the foliar application of plant growth regulators. The highest leaf area per plant (5789.51 cm^2) was observed in the plants sprayed with GA_3 @ 200 ppm. The minimum leaf area (4424.27 cm^2) was observed in the treatment BA @ 200 ppm. This might be due to the active growth of spider lily encouraged by gibberellic acid through cell division, cell enlargement and cell expansion. The other reason may be due to the increased length and breadth of the leaves. The minimum leaf area from the spray of BA might be due to reduced leaf length and breadth from the treatment. These results are in correlation with the results Padaganur *et al.* (2005) and Wagh *et al.* (2012) [9, 16] in Tuberose.

The treatment NAA @ 200 ppm recorded maximum chlorophyll a, b and total chlorophyll content of the leaves (2.84, 2.87, 5.71 mg/g fresh weight, respectively) Whereas the minimum chlorophyll content [chlorophyll-a (1.09), chlorophyll-b (0.77) and total chlorophyll (1.87) mg/g fresh weight] were recorded in treatment Control. The maximum chlorophyll content from NAA treatment might be due to the slow rate of chlorophyll degradation by possibly delaying the breakdown of protein. These results are in conformity with earlier findings of Emami *et al*. (2011) and Ragini *et al.* (2019) [3, 14] in lily.

Table 2: Effect of plant growth regulators on leaf area and chlorophyll content of spider lily

Treatments	Leaf area (cm^2)	Chlorophyll a (mg/g fr.wt.)	Chlorophyll b (mg/g fr.wt.)	Total chlorophyll (mg/g fr.wt.)
T_1- GA_3 @ 150 ppm	5673.94	1.88	2.11	3.99
T_2- GA_3 @ 200 ppm	5789.51	2.60	2.81	5.41
T_3- NAA @ 150 ppm	5581.60	1.62	1.96	3.58
T_4- NAA @ 200 ppm	5730.10	2.84	2.87	5.71
T_5- CCC @ 500 ppm	4696.34	2.27	2.60	4.87
T_6- CCC @ 1000 ppm	4792.77	2.01	2.53	4.54
T_7- BA @ 100 ppm	4627.03	1.49	1.61	3.10
T_8- BA @ 200 ppm	4424.27	1.45	1.38	2.83
T_9- Control (water spray)	4942.25	1.09	0.77	1.87
S.Em±	97.00	0.03	0.01	0.01
CD @ 5%	290.81	0.08	0.02	0.02

Table 3: Effect of plant growth regulators on flowering parameters on spider lily

Treatments	Days taken for spike emergence	Days taken for bud initiation to harvesting of flower spike	Flowering duration (days)
T_1 - GA_3 @ 150 ppm	94.67	9.67	29.33
T_2 - GA_3 @ 200 ppm	91.33	9.47	30.00
T_3 - NAA @ 150 ppm	99.67	11.00	27.83
T_4 - NAA @ 200 ppm	97.33	11.50	29.23
T_5 - CCC @ 500 ppm	107.33	13.33	20.67
T_6 - CCC @ 1000 ppm	110.00	14.00	23.00
T_7 - BA @ 100 ppm	114.33	14.33	24.67
T_8 - BA @ 200 ppm	118.33	15.00	21.00
T_9 - Control (water spray)	103.00	12.63	16.00
S. Em±	0.71	0.37	0.65
C.D @5%	2.12	1.12	1.95

Foliar application of different plant growth regulators at the different concentrations on the spider lily plants varied significantly on days taken for spike emergence. Among the different treatments, the spray of GA_3 @ 200 ppm recorded (91.33) significantly the least number of days for spike emergence when compared to rest of the treatments and it was followed by GA_3 @ 150 ppm (94.67). Whereas the treatment BA @ 200 ppm took the maximum number of days for spike emergence (118.33). This might be due to the early completion of the vegetative phase by rapid cell division and cell elongation and GA_3 is truly effective in reducing the juvenile period of plants. Similar findings were obtained by Wagh *et al.* (2012) [16]. BA induces multiple shooting rather than cell elongation. This might be the reason for the delay in the spike emergence. The similar observations were reported in earlier experiments done by Acharjee *et al.* (2015) [1] in oriental lilium, Arhip and Draghia (2015) [2] in *Zantedeschia* and Jithendra *et al.* (2009) [7] in Tuberose.

The data revealed that GA_3 @ 200 ppm recorded (9.47) significantly least number of days for bud initiation to the harvesting of flowers which was statistically on par with the treatment GA_3 @ 150 ppm (9.67) whereas the treatment BA @ 200 ppm took the maximum number of days for bud initiation to the harvesting of flower spike (15.00). It might due to the early production of florigen in GA_3 treated plants, as GA_3 is a component of florigen, which is required for the formation of flowers in plant system (Devadanam *et al.*, 2005). And the delay in days taken from bud initiation to harvesting of flower spike might be due to multiple shooting rather than cell elongation. Similar findings were recorded by Acharjee *et al.* (2015) [1] in Oriental lilium, Arhip and Draghia (2015) [2] in *Zantedeschia*.

The data on the duration of flowering reveals that the maximum duration of flowering (30.00) was observed with GA_3 @ 200 ppm which was statistically on par with GA_3 @ 150 ppm (29.33). In contrast, the minimum days of flowering (16.00) were observed in control, i.e., (water spray). This might be due to the reason that GA_3 increases the photosynthetic and metabolic activities causing more transportation and utilization of photosynthetic products, producing a higher yield and good quality spikes which turn might have helped the spikes to last longer on the plant in the field. The result is in the conformity with the findings Wagh *et al.* (2012) [16] in Tuberose.

Conclusion

The study revealed that among the different plant growth regulators GA_3 @ 200 ppm showed the best results in all growth characteristics of spider lily and exhibited minimum days for spike emergence, minimum days for bud initiation to harvesting of flowers and maximum flowering duration and NAA @ 200 ppm recorded maximum chlorophyll content.

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