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Effect of Foliar Application of GA_3 on Flowering, Flower Quality and Yield of Lupin (*Lupinus perennis* L.) under Hill Zone of Karnataka

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ABSTRACT: Gibberellic acid plays a major role in plant growth and development. It has been found to be the best for enhancing both vegetative and flowering attributes in flower crops. With this background, an experiment under Hill Zone of Karnataka was conducted at the Experimental block of Floriculture and Landscape Architecture, College of Horticulture, Mudigere, during the year 2021-2022. The experiment was laid out in Randomized Block Design, comprising seven treatments with three replications. Observations were recorded on various flowering and yield parameters. Among the different treatments, GA_3 @ 350 ppm taken minimum days for first flower bud initiation (46.80), flower stalk emergence (48.60), 50 percent flowering (22.30) and maximum duration of flowering (61.90 days). However, maximum number of florets per spike (120.50), diameter of the floret (1.39 cm), stalk length (59.78 cm), number of stalks per plant (9.10) and vase life (4.98 days) was recorded in the treatment GA_3 @ 300 ppm. While, minimum was recorded in control. Hence, it is concluded that spraying (thrice) of Gibberellic acid @ 300 ppm at an interval of 30, 60 and 90 days after sowing proved to be promising for enhancing the flower quality and yield of lupin under hill zone of Karnataka.

Keywords: Lupin, gibberellic acid, flowering, flower quality and yield.

INTRODUCTION

Lupin (*Lupinus perennis* L.) is a showy hardy annual and biennial flowering plant of Fabaceae with the chromosomal number 2n = 36, 48 or 96 (Naganowska *et al*., 2003), originated from Eastern- North America. The word Lupinus is derived from the Latin word ‘lupus’ meaning ‘wolf”. They are widely cultivated for ornamentals as well as a food source. It is commonly known as a sundial, blue lupine, Indian beet or old maid's bonnets (Drummond *et al.*, 2012). Lupins are mainly grown for cut flowers and food sources. It is also used as bedding plants, border plants, edging or filler plants and companion crop in ornamental gardening.

In order to produce quality plants, flower growers use a variety of cultural practices and chemical products to influence the plant growth. These chemicals are called plant growth regulators (PGRs). It is well established that the growth and development of plants can be modified by exogenous application of growth substances through alteration in the levels of naturally occurring hormones. Gibberellins act at all stages in the plant life cycle, which display a remarkable diversity of physiological processes of plants (Pradeepkumar *et al.*, 2020). Gibberellic acid plays a major role in plant growth and development. It has been found to be the best for enhancing vegetative attributes along with flower initiation. Although studies on effect of GA_3 on different ornamental plants has been done earlier, but information available about its effect on lupin is limited. Hence, the present investigation was conducted to evaluate the effect of GA_3 on flowering, flower quality and yield of lupin.

There are several studies revealing the beneficiary effects of gibberellic acid in improving the growth and flowering of different ornamental plants *viz.*, Maurya *et al.* (2017) observed that plants sprayed with GA_3 @ 150 ppm recorded minimum number of days to first flowering (62.80), maximum number of flowers plant^{-1} (75.73) and flower diameter (5.96 cm) in china aster (*Callistephus chinensis*). Singh *et al.* (2018) reported that maximum flower Size (4.29 cm) and length of flower stalk (8.46 cm) were recorded with the foliar application of GA_3 @ 150 ppm in Chrysanthemum (*Dendranthema grandiflora* Ramat) cv. Birbal Sahni. Foliar application of GA_3 @ 200 ppm recorded maximum flower diameter (6.21 cm) and vase life (8.96 days) in china aster (*Callistephus chinensis* L. Nees) cv. Shashank opined by Sindhuja *et al.* (2018). Prasad *et al.* (2021) found that gibberlins at 3.0 mg l^{-1} was found to be better with respect to broader leaves with taller sporophytes in Staghorn fern (*Platycerium bifurcatum* (Cav.) C.Chr.). Akshitha *et al.* (2022) reported that maximum stalk length (36.25 cm) was recorded with treatment GA_3 at 450 ppm and double spray in Gypsophila (*Gypsophila paniculata* L.) cv. Star World.

MATERIALS AND METHODS

Studies were carried out at the Department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere, Shivamogga, Karnataka, during 2021- 2022. The soil was prepared to fine tilth and raised beds of 2.5 m × 2.5 m were prepared under open field condition. Seeds of lupin were sowed at a spacing of 45 cm × 30 cm. The experiment was laid out in randomized block design (RBD) with seven treatments and three replications. Treatments included T_1- Control, T_2- GA_3 @ 100 ppm, T_3- GA_3 @ 150 ppm, T_4- GA_3 @ 200 ppm, T_5- GA_3 @ 250 ppm, T_6- GA_3 @ 300 ppm and T_7- GA_3 @ 350 ppm. The GA_3 was sprayed at 3 intervals *viz.*, 30, 60 and 90 days after sowing (DAS). Following observations were recorded at 60, 90 and 120 DAS and were statistically analysed.

RESULTS AND DISCUSSION

The findings were considerably interpreted and listed in Table 1, 2 and Fig. 1 based on the observations recorded in the present research.

Effect of gibberellic acid on flowering parameters

Flower bud initiation and flower stalk emergence (days). Foliar application of gibberellic acid at different concentrations on the lupin plants varied significantly on days taken for first flower bud initiation and flower stalk emergence. Among the different treatments, the spray of GA_3 @ 350 ppm recorded significantly the least number of days for first flower bud initiation (46.80) and flower stalk emergence (48.60) when compared to rest of the treatments and it was on par with GA_3 @ 300 ppm (46.20 and 49.50 days, respectively). Whereas, the treatment control took the maximum number of days for flower bud initiation (58.20) and flower spike emergence (63.81). 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. The similar observations were reported in earlier experiments done by Baskaran *et al*. (2014) in gladiolus, Wagh *et al*. (2012); Sangram *et al*. (2018) in tuberose.

Days taken for 1/4th opening of spike and 50 per cent flowering. The minimum number of days to 1/4th opening of spike and 50 per cent flowering (8.52 and 22.30 respectively) was recorded with GA_3 @ 350 ppm, which was on par with GA_3 @ 300 ppm (9.37 and 22.80 days), Whereas, maximum number of days to 1/4th opening of spike and 50 per cent flowering were observed with control *i.e.,* 13.06 and 33.06 days respectively. This might be due to the effect of GA_3 that might have caused flower bud initiation and lead to early flowering by decreasing the concentration of ABA in plant shoot (Phengphachanh *et al*., 2012). More over as the number of leaves was increased, it resulted in more photosynthates to initiate early flowering and complete life cycle of the plant. The findings are in line with Sharifuzzaman *et al*. (2011) in chrysanthemum.

Duration of flowering. The maximum duration of flowering (61.90 days) was observed with GA_3 @ 350 ppm which was statistically on par with GA_3 @ 300 ppm (61.40 days). In contrast, the minimum days of flowering (49.20) were observed in control (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 results are in conformity with the findings of Kumari *et al*. (2011) in gladiolus, and Wagh *et al*. (2012) in tuberose.

Effect of gibberellic acid on flower quality parameters. Flowering is the reproductive phase of the plant life. It always comes after a defined number of days. However, this period can slightly be affected by the health of plant and climatic conditions prevailing those days. Physiology of plant is affected by the availability of growth substances which are synthesized inside the plant body or it can be apply exogenously.

Number of florets per spike. In the present study the maximum number of florets per spike (120.50) was recorded with the application of GA_3 @ 300 ppm, it was followed by GA_3 @ 250 ppm (117.20). Maximum number of florets per spike from GA_3 treated plants might be due to the availability of optimum quantity of GA_3, which encourages to increased spike length and it is positively correlated to the number of florets per spike, while minimum number of florets per spike (90.27) was recorded in treatment control. This might be due to reduced number of nodes which resulted from reduced plant height and spike length might be resulted to minimum number of florets per spike. These observations and findings in the present investigation are in conformity with earlier reports by Padmalatha *et al*. (2014) in tuberose and Sharma *et al.* (2006) in gladiolus.

Diameter of the floret (cm)

Significant differences were observed among different treatment with respect to diameter of the floret. The maximum diameter of the floret (1.39 cm) was recorded with the application of GA_3 @ 300 ppm, it was followed by GA_3 @ 250 ppm (1.33 cm), while minimum diameter of the floret (1.08 cm) was recorded with control. Increased diameter of floret from gibberellins might be due to increased cell division and cell elongation. These observations and findings in the present investigation are in conformity with earlier reports by Faraji and Basaki (2013); Aier *et al.* (2015); Sable *et al.* (2015) in gladiolus.

Stalk length (cm). Stalk characters are most important with regard to quality of cut flower. It is evident that the maximum stalk length (59.78 cm) was recorded with GA_3 @ 300 ppm which was significantly superior over other treatments and it was followed by treatment GA_3 @ 350 ppm (58.38 cm), Whereas, minimum stalk length was observed with control (47.27 cm). The increased stalk length with GA_3 treatment might be due to rapid inter nodal elongation as a results of rapid cell division and cell elongation in the intercalary meristem. Similar results were recorded by Dhumal *et al.* (2018) in tuberose, Jayashree *et al.* (2020) in asiatic lily and Dogra *et al.* (2012); Prinyanka *et al.* (2018) in gladiolus.

Vase life (Days). Vase life was highest (4.98 days) in the treatment GA_3 @ 300 ppm which was statistically on par with the treatment GA_3 @ 350 ppm (4.57 days). In comparison, the minimum vase life (2.64 days) was recorded in the treatment control. This might be due enhanced biomass in GA_3 treated plants, better partitioning of these assimilates into the reproductive parts results in increased flower fresh and dry weight. Increased carbohydrate sources within the plants were used after harvesting of the cut stems for their metabolic reactions. In case of untreated plants having lower fresh weight with less food reserves might be leads to early senescence of the cut flowers compared to GA_3 treated flowers. Increased membrane leakage was observed with untreated plants compared to GA_3 treated plants leads to earlier senescence of untreated flowers. Similar results were also found by Islam *et al.* (2012) in gladiolus and Jadhav *et al.* (2020) in black gram.

Effect of gibberellic acid on yield parameters. The highest number of spikes per plant (9.50 stalks), per plot (380.00 stalks) and per hectare (6.08 lakhs) was obtained in GA_3 @ 300 ppm which was followed by GA_3 @ 350 ppm (9.10 stalks, 364.00 stalks and 5.82 lakhs, respectively). Whereas, the minimum was recorded in treatment Control (4.80 stalks, 192.00 stalks and 3.02 lakhs, respectively). This might be due to the increased number of leaves which is vital for the production of abundant carbohydrates in the plant and consequently, the carbohydrates are translocated towards the reproductive part of the plants for the initiation of spikes. The results were similar to the results obtained by Munikrishnappa and Chandrashekar (2014) in china aster, Parmar *et al.* (2015) in dutch rose and Mahananda *et al.* (2015) in chrysanthemum.

Table 1: Effect of foliar application of GA_3 on flowering parameters of Lupin (*Lupinus perennis* L.)

Tr. No.	Treatments	Days taken for first visible flower bud initiation	Days taken For flower stalk emergence	Days taken for 1/4 th opening of spike	Days taken for 50% flowering
T_1	Control (water spray)	58.20	63.81	13.06	33.06
T_2	GA_3 @ 100 ppm	54.42	57.60	11.15	30.28
T_3	GA_3 @ 150 ppm	52.53	55.70	10.92	28.50
T_4	GA_3 @ 200 ppm	50.08	53.40	10.29	26.70
T_5	GA_3 @ 250 ppm	48.60	51.60	9.88	24.40
T_6	GA_3 @ 300 ppm	46.20	49.50	9.37	22.80
T_7	GA_3 @ 350 ppm	46.80	48.60	8.52	22.30
S.Em±		0.75	0.89	0.30	0.25
C.D@ 5%		2.30	2.73	0.87	0.77

Note: GA_3- Gibberellic acid

Table 2: Effect of foliar application of GA_3onflower quality and yield of Lupin (*Lupinus perennis* L.).

Tr. No.	Treatments	Number of florets per stalk	Diameter of flower (cm)	Stalk length (cm)	Vase life (days)	Number of stalks per Plant	Number of stalks per Plot	Number of stalks per hectare (Lakh)
T_1	Control (water spray)	90.27	1.08	47.27	2.64	4.80	192.00	3.02
T_2	GA_3 @ 100 ppm	101.21	1.15	51.59	3.21	6.70	268.00	4.29
T_3	GA_3 @ 150 ppm	106.51	1.20	53.68	3.51	7.80	312.00	4.70
T_4	GA_3 @ 200 ppm	110.20	1.26	55.40	3.79	8.30	332.00	5.20
T_5	GA_3 @ 250 ppm	117.20	1.33	57.47	4.33	8.76	350.40	5.65
T_6	GA_3 @ 300 ppm	120.50	1.39	59.78	4.98	9.50	380.00	6.08
T_7	GA_3 @ 350 ppm	114.53	1.31	58.38	4.57	9.10	364.00	5.82
S.Em±		1.04	0.02	0.44	0.15	0.10	3.70	0.07
C.D@ 5%		3.02	0.05	1.30	0.45	0.30	11.40	0.22

Note: GA_3- Gibberellic acid

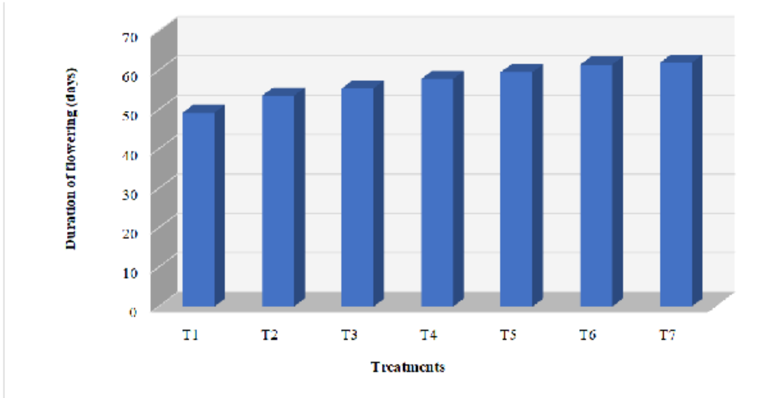
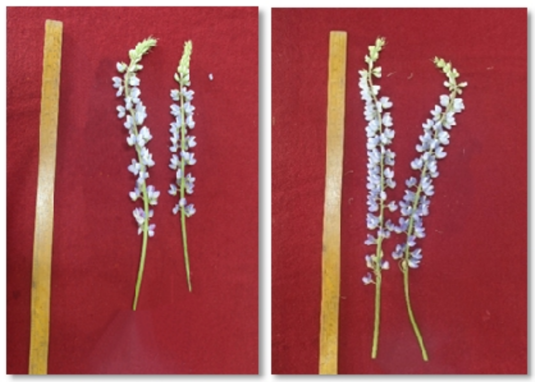


Fig. 1. Effect of GA_3 on duration of flowering of Lupin (*Lupinus perennis* L.)



T_1-Control T_6-GA_3 @ 300 ppm

Plate 1. Stalk length of lupin cut flower.

CONCLUSION

On the basis of the result obtained in the present investigation it is concluded that, foliar application of GA_3 @ 300 ppm proved significant for improving the flowering, flower quality and yield of lupin under open field condition. Hence, the treatment GA_3 @ 300 ppm may be recommended for commercial cultivation of lupin under hill zone of Karnataka.

FUTURE SCOPE

Future studies need to be carried out with different plant growth regulators in order to study effect of combination of different growth regulators on growth, flowering and yield of lupin.

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Conflict of interest. None.

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