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Optimizing Planting Geometry for Growth, quality and Yield of Lupin (*Lupinus perennis* L.) Cut Flower

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ABSTRACT: Lupin (*Lupinus perennis* L.) is an emerging cut flower with enormous potential to be used extensively. Plant spacing plays a vital role in obtaining a better growth and development by manipulating the micro environment. Since there is a little data on impact of plant spacing on growth and flowering of Lupin, present study was carried out to standardize the spacing in order to obtain quality produce of Lupin cut flower. The experiment was laid out in Randomized Block Design (RBD) comprising of 11 treatments which replicated thrice. Results revealed that growth parameters like number of branches per plant (15.43) and number of leaves per plant (113.60) recorded maximum under treatment T_5 (45 × 45 cm). Whereas, T_1 (30 × 30 cm) spacing contributed maximum plant height (77.45 cm) and minimum days for flowering parameters such as days for flower bud initiation (44.21), flower stalk emergence (47.79) and 50 per cent flowering completion (24.08) however, treatment T_5 (45 × 45 cm) recorded maximum duration of flowering (56.74 days), crop duration (175.39 days) and flower quality parameters *viz.*, length of flower stalk (55.71 cm), number of florets per stalk (112.21), diameter of flower (1.35 cm) and yield parameters like number of stalks per plant (8.63), per plot (241.64) and per hectare (4.26 lakhs) while minimum under treatment T_1 (30 × 30 cm) spacing.

Keywords: Lupin, Spacing, Cut flower, Flower yield and Stalk length.

INTRODUCTION

The Lupin (*Lupinus perennis* L.) is a spectacular hardy annual and biennial flowering plant belongs to family Fabaceae from Eastern North America having the chromosome number 2n = 36, 48, or 96 (Naganowska *et al*., 2003). They are mostly grown as cut flowers purpose and in decorative gardening, used as a bedding plant, border plant, edging plant, filler plant and companion crop. It is utilized as a food source in addition to ornamentals. Sundial, blue lupine, Indian beet or old maid's bonnets are some of its common names (Drummond *et al*., 2012). Plants range in height from 30 to 150 cm, with some being annuals and biennials others reaching upto 300 cm. The spectacular flowers are borne on light green to reddish-purple stalks. Flowers that are unique having 5 blue-violet petals measure around 34 inch long (rarely white or pink), a tubular calyx with broad lobes, several stamens, and a single-styled pistil.

Planting geometry is the arrangement of the plants in different rows and columns in an area to efficiently utilize the natural resources. As plants require certain amount of spacing for normal growth and development which manipulate the micro environment, inturn helps to improve flower and seed yield as well as crop quality (Ravindran *et al*., 1986). The number of plants required per unit area is one of the prime considerations, which depends upon the nature of crop, growth habit, bearing and its environment. These numbers can neither be too

less, so that all the production potential will not be utilized nor it can be too large ultimately increased plant population will reduce the overall efficiency of the crop. Closer planting distance accommodates more number of plants per unit area but produces poor quality flowers, whereas, wider spacing accommodates lesser number of plants per unit area and the production is not economical. Thus, proper spacing helps in availability of more nutrients, aeration and light intensity by which the crop can perform better in terms of quality and quantity (Kumar and Singh 2011).

There are many studies which shows the influence of plant spacing on growth and flowering of different ornamental and leguminous crops *viz.,* Rolaniya *et al*. (2017) reported that spacing of 60 × 60 cm recorded maximum plant height (41.75 cm), number of primary branches per plant (11.09) and maximum flower yield (126.73 q) in marigold. Methela *et al*. (2019) stated that spacing of 25 × 30 cm recorded maximum plant height (74.61 cm), maximum number of leaves (7.98), largest number of florets per spike (14.33) and maximum weight of spike (35.60 g) in gladiolus. Bishnoi *et al.* (2021) stated that 45 cm row spacing recorded maximum plant height (119.13 cm), number of leaves (299.73) and number of branches per plant (10.00) in cluster bean. Jena and Mohanty (2021) stated that wider spacing of 60 × 60 cm recorded maximum plant spread (82.65 cm E-W), number of leaves (201.38) and took minimum days for flower bud emergence (26.44) in annual chrysanthemum.

However there is always demand for new flowers over existing ones. Therefore, need to identify best production technology aspects to improve crop growth and development hence, an investigation 'Optimizing planting geometry for growth, quality and yield of Lupin (*Lupinus perennis* L.) cut flower'.

MATERIAL AND METHODS

The research was carried out at the experimental plot of the Department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga during Rabi-Summer of 2021-22under open field condition with the objective to evaluate the effect of spacing on growth, flower quality and yield parameters of Lupin. Experiment was laid out in RBD with eleven treatments *viz.,* T_1- 30×30 cm, T_2- 30×45cm (check), T_3- 30×60cm, T_4- 30×75 cm, T_5– 45×45 cm, T_6- 45×60 cm, T_7- 45×75 cm, T_8- 60×30 cm, T_9- 60×45 cm, T_{10}- 60×60cm and T_{11}- 60×75 cm with three replication and data were recorded on vegetative and Flower parameters.

The experimental plots were prepared using tractor and field area was divided into 33 plots of 3.0 × 2.0m of flatbeds and 0.5m width path kept for irrigation channel. Beds were incorporated with well-decomposed Farm Yard Manure at the rate of 2.5 kg per m^2 and 75:25:45 kg of NPK/ha. Seeds are soaked in water overnight and seeds were sown directly in the plots at a depth of 2 to 3 cm, later light irrigation was given immediately after sowing. The cultural operations like irrigation, weeding, plant protection measures are done during the experimentation as and when required. Observations like vegetative characters were recorded at 90 DAS.

RESULT AND DISCUSSION

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

Effect of spacing on growth parameters of Lupin

Plant height (cm). A perusal of data presented in Table 1 indicates the performance of Lupin for different growth parameters as influenced by different spacing levels. Results shows that treatments T_1 - 30×30 cm recorded maximum plant height of 77.45cm whereas, minimum plant height (62.33 cm) recorded in treatment T_{11}- 60× 75 cm. Jadhav *et al*. (2014) in calendula cited that less space available for plant spreading under closer spacing results in intense competition for sunlight, nutrients and soil moisture that leads to increased internodal length and attain maximum height compared to widely spaced plants. These results are in agreement with Sudhagar *et al*. (2019) in tuberose, Jena and Mohanty (2021) in annual chrysanthemum.

Number of branches per plant and leaves per plant. During the course of investigation, Table 1 shows that treatment T_5- 45×45 cm recorded maximum number of branches per plant (15.43) whereas, plants spaced at 30×30 cm (T_1) recorded minimum (8.26) branches per plant. This might be due to that optimum spacing lessened the competition among plants to derive sufficient amount of nutrients, soil moisture and sunlight which ultimately favored for translocation of assimilates into storage organs results in proliferation of more number of branches. These results are supported with Desai and Mamatha (2016) in tuberose and Badaway *et al.* (2011) in helichrysum. In context of leaves, the maximum number of leaves per plant (113.60) observed under the treatment T_5- 45 ×45 cm while minimum inT_1 - 30×30 cm. The main reason for this might be due to that under this treatment availability of optimum spacing for plants helps to absorb maximum solar radiation and nutrients from soil by individual plant which ultimately helps in more photosynthetic activities and storage of carbohydrates over other spacings thus influenced more number of leaves per plant. Similar results are confirmed in tuberose Sudhagar *et al*. (2019) in tuberose and Darwesh *et al*. (2011) in monstera.

Effect of spacing on flowering parameters. The earliest flower bud initiation (44.21 days), flower stalk emergence (47.79 days) and 50 per cent flowering completion (24.08 days) was recorded under treatment T_1 - 30×30 cm while maximum days taken to flower bud initiation (52.69), flower stalk emergence (56.36) and 50 percent flowering (36.88) recorded under

treatment T_{11} -60 × 75 cm. Jadhav *et al.* (2014) in calendula and Sushma *et al*. (2012) in heliconia stated that due to early physiological maturity which encourages the translocation of phytohormones to the shoots and driving the plant towards an earlier reproductive phase. These results are ascribed with research findings of Rahman *et al*. (2020) in pea, Dorajeerao *et al*. (2012) in garland chrysanthemum. However, maximum duration of flowering (56.74 days) and crop duration (175.39) observed under treatment T_5 -45 × 45 cm while minimum duration of flowering (47.87 days) and crop duration (77.45 days) in T_1 - 30×30 cm. This might be due to that carbohydrate reserves in the flower and spike probably keep a reservoir of dry matter and repairable material, especially in the petals, encouraging respiration and prolonged the flowering period. Similar results were seen in Malam *et al.* (2010) in tuberose, Nain *et al.* (2017) in African marigold, Rana *et al.* (2005); Kumar *et al*. (2015) in gladiolus.

Effect of spacing on cut flower quality parameters. It is evident from the data presented in Table 2. That maximum flower stalk length (55.71 cm), number of florets per stalk (112.21), diameter of flower (1.35 cm) recorded under treatment T_5 -45 × 45 cm whereas, minimum stalk length (42.25 cm), number of florets per plant (82.69) and diameter of flower (1.06 cm) recorded in treatment T_1 -30 × 30 cm. This might be due to under optimum spacing, absorption of water, nutrients and the use of more sunlight allows plant to grow better that encourage plant to synthesize more carbohydrates, hormones that increased longitudinal growth of stalk from Akalde *et al.* (2016) in heliconia. Vase life shows there is no significant difference among treatments as influenced by different spacing levels. Production of more number of lateral branches results in maximum number of flower stalks per plant (8.63), per plot (241.64) and per hectare (4.26 lakhs). Treatment T_1 -30 × 30 cm shows minimum number of stalks per plant (3.08), stalks per plot (184.8) and per hectare (3.42 lakhs).

Table 1: Effect of spacing on growth and flowering of Lupin (*Lupinus perennis* L.).

Treatments	Plant height (cm)	Number of branches per plant^{-1}	Number of leaves plant^{-1}	Days to flower bud initiation	Flowering duration (days)	Crop duration (days)
T_1- 30×30 cm	77.45	8.26	92.86	44.11	37.21	145.33
T_2-30×45cm(check)	75.13	12.52	106.79	45.65	51.32	165.87
T_3- 30×60 cm	60.14	13.44	108.53	49.53	53.65	168.40
T_4- 30×75 cm	67.29	11.86	100.52	51.31	47.54	157.12
T_5- 45×45 cm	74.38	15.43	113.60	46.22	56.74	175.39
T_6- 45×60 cm	72.67	14.16	109.82	48.77	54.23	170.61
T_7- 45×75 cm	69.31	12.01	102.18	50.92	49.36	160.45
T_8- 60×30 cm	71.06	12.21	103.46	50.43	50.97	162.87
T_9- 60×45 cm	65.57	11.34	98.35	51.86	45.61	155.33
T_{10}- 60×60 cm	63.64	11.27	97.48	52.18	44.28	152.56
T_{11}- 60×75 cm	62.33	10.84	95.34	52.69	42.34	150.39
S.Em. +	0.55	0.12	1.26	0.65	0.73	1.58
CD @ 5 %	1.63	0.35	3.72	1.91	2.16	4.65

Table 2: Effect of spacing on cut flower quality and yield of Lupin (*Lupinus perennis* L.).

Treatments	Stalk length (cm)	Number of florets per stalk	Diameter of flower (cm)	Vase life (days)	Number of flower Stalks plant^{-1}	Number of flower stalks plot^{-1}	Number of flower stalks hectare^{-1}(lakhs)
T_1- 30×30 cm	42.25	82.69	1.06	3.89	3.08	184.8	3.42
T_2- 30×45 cm(check)	51.42	105.56	1.28	4.44	5.71	228.4	4.22
T_3- 30×60 cm	52.17	108.32	1.30	4.43	6.54	196.2	3.63
T_4- 30×75 cm	48.17	97.25	1.23	3.52	4.56	136.80	2.02
T_5- 45×45 cm	55.71	112.21	1.35	4.74	8.63	241.64	4.26
T_6- 45×60 cm	53.26	109.47	1.32	4.66	7.28	160.16	2.69
T_7- 45×75 cm	49.54	100.96	1.24	4.61	6.23	99.68	1.84
T_8- 60×30 cm	50.25	103.54	1.26	4.38	6.62	198.6	3.67
T_9- 60×45 cm	48.68	93.64	1.20	4.33	5.34	110.88	1.97
T_{10}- 60×60 cm	47.36	90.45	1.17	4.20	5.16	77.86	1.13
T_{11}- 60×75 cm	46.32	88.73	1.12	4.15	5.10	53.69	0.89
S.Em. +	0.67	0.90	0.02	0.04	0.09	2.55	0.04
CD @ 5 %	1.97	2.64	0.06	NS	0.26	7.59	0.11

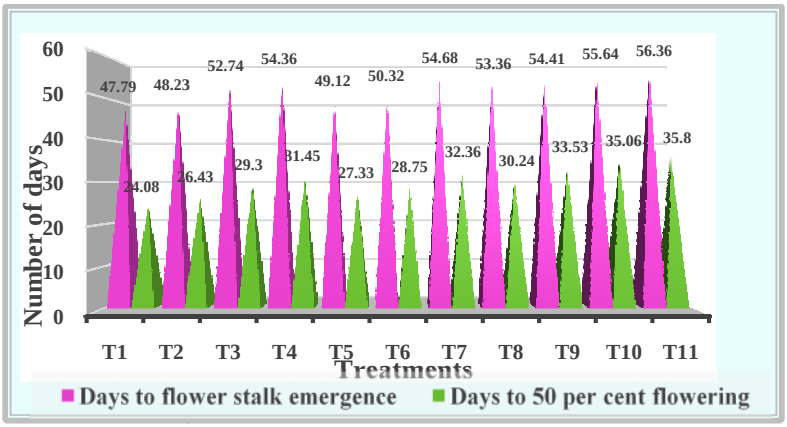

Fig. 1. Effect of spacing on days for flower stalk emergence and 50% flowering completion of Lupin.

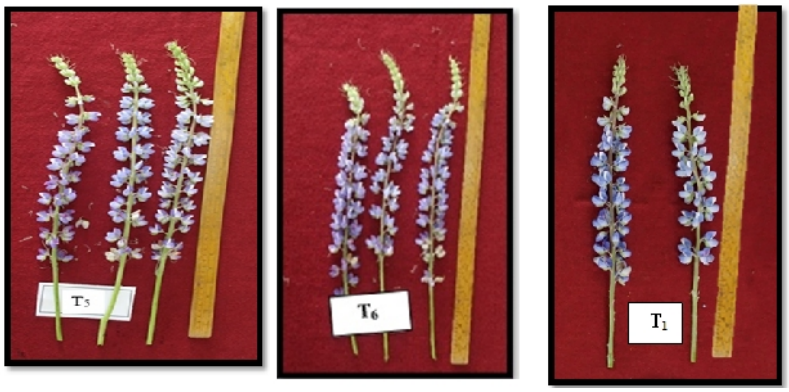

Plate 1. Stalks length of Lupin cut flower.

Which may be related to the fact that plants grow efficiently in terms of biomass production and produce more number of branches per plant when there is enough space between them which increase the number of flowers per plant and flower yield per plot and hectare in the process. Same results were reported in Mali *et al*. (2016) in chrysanthemum, Naik *et al*. (2019) in marigold, Kumar *et al*. (2020) in marigold.

CONCLUSION

On the basis of results obtained and facts mentioned in this chapter, among the different spacing levels which influenced plant growth, flowering, cut flower quality and yield of Lupin, it can be concluded that treatment T_5 (45×45 cm) may be recommended for commercial cultivation of Lupin for cut flower production.

FUTURE SCOPE

Further scope for experiment need to be carried out with different combinations of biofertilizers and weed intensity in order to study the effect of spacing on crop growth, flowering and yield parameters of Lupin.

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Conflict of interest. None.

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