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J Swetha
College of Horticulture, Dr. YSR Horticultural University, Venkataramannagudem. West Godavari, Andhra Pradesh, India

T Suseela
College of Horticulture, Dr. YSR Horticultural University, Venkataramannagudem. West Godavari, Andhra Pradesh, India

AVD Dorajeerao
College of Horticulture, Dr. YSR Horticultural University, Venkataramannagudem. West Godavari, Andhra Pradesh, India

Dr. Salomi Suneetha
College of Horticulture, Dr. YSR Horticultural University, Venkataramannagudem. West Godavari, Andhra Pradesh, India

RV Sujatha
College of Horticulture, Dr. YSR Horticultural University, Venkataramannagudem. West Godavari, Andhra Pradesh, India

Correspondence
J Swetha
College of Horticulture, Dr. YSR Horticultural University, Venkataramannagudem. West Godavari, Andhra Pradesh, India

Effect of spacing and nitrogen on flowering and vase life of Asiatic lily cv. Tressor under shade net condition

J Swetha, T Suseela, AVD Dorajeerao, Dr. Salomi Suneetha and RV Sujatha

Abstract
The present investigation was carried out at College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, West Godavari district, Andhra Pradesh during the crop season of 2016-17. Three levels of spacing (15 cm x 15 cm, 25 cm x 15 cm and 30 cm x 15 cm) with three nitrogen levels (100, 150 and 200 kg ha^{-1}) were used in present study. The experiment compromising of 9 treatment combinations was laid out as factorial randomized block design with three replications. Results showed that the 30 cm x 15 cm and 200 kg N ha^{-1} had a significant effect on days to flower bud emergence, days to colour visibility in bud, days to 50 % flowering, days taken for harvesting of flowers, number of flowering shoots per umbel, flower diameter, flower weight, field vase life and postharvest vase life. Among interaction effects, treatment combination of 30 cm x 15 cm with application of 200 kg N ha^{-1} was found more effective in enhancement of floral attributes.

Keywords: asiatic lily, spacing, nitrogen, flowering, vase life and shade net

Introduction

Lilies are one of the most valuable bulbous ornamental crops that are cultivated and are increasing in poularity as an attractive cut flower crop worldwide. In the language of flowers, lily is the symbol of purity and innocence. Lilies are also considered aristocrats of the world. The genus lilium with approximately 200 species belongs to the largest plant family liliaceae. Lilies are native to the northern hemisphere. Lilies can be grown both as cut flower as well as pot plant. They are also grown as garden plants in subtropical and temperate regions, in borders and woodland areas to add colour and variety. In India, lilium is being commercially cultivated in different parts such as, The Nilgiris (Cooner, Kothagiri and Ooty) in an area of around 40 acres (1,60,000 sq.m), Kodaikanal, Shevroy Hills (Yercad), Kalvarayan Hills (Karumanthurai), Hosur, Himachal Pradesh *i.e.* under Shimla and Kullu condition, North Eastern States and Jammu and Kashmir *etc.*

Nitrogen is the most important macro nutrient for crop plants. It plays a key role in the plant physiology of flower crops. The nutrient element is highly influential on growth and reproductive parameters thus contributing to yield and its attributing traits in crops. Similarly, spacing indicates how much space is available for a plant in a plot to explore its resources from earth as well as air, thus determining the relative advantage or disadvantage of a plant in finding its food for various growth and developmental activities within the plant system. Even though Asiatic lily in the modern times has become one of the most important and highly remunerative flower crop especially grown for its cut flowers.

The cut flower trade of Asiatic lily is lagging behind in this region, owing to the non-availability of quality planting material at larger scale. Therefore keeping in view the economic importance of the crop, the present study was undertaken with the objective *i.e.* study the effect of spacing and nitrogen levels on floral and vase life of Asiatic lily cv. Tressor under shade net condition.

Materials and Methods

The present investigation was conducted at College of Horticulture, Dr. Y.S.R Horticultural University, Venkataramannagudem during 2016-2017. Which is located at 16˚ 63' 120" N latitude and 81˚ 27' 568" E longitude and 34m above MSL. It experiences hot humid summer and mild winters.

The experimental soil was red sandy loam with good drainage and moderate water holding capacity with sand 70% of sand, silt 20% and clay 10%. The soil pH is 6.32 and E.C. is 0.18 dS m^{-1}. The experiment was conducted in a factorial randomized block design involving four levels of spacing *i.e.* S_1 (15 cm x 15 cm), S_2 (25 cm x 15 cm) and S_3 (30 cm x 15 cm) and three levels of nitrogen *viz.* N_1 (100 kg ha^{-1}), N_2 (150 kg ha^{-1}) and N_3 (200 kg ha^{-1}). Each of these factors were composed at three levels involving totally 9 treatment combinations.

Bulbs of Asiatic lily cv. Tressor with uniform size were used for the experiment. The net size of plot was 3.0 m x 0.6 m, accommodating 40, 24 and 20 plants as per treatments. The field was brought to the fine tilth by ploughing and harrowing. Well decomposed farm yard manure at the rate of 100 kg ha^{-1} was applied at the time of land preparation. The fertilizers *viz*., Urea, Single Super Phosphate and Muriate of Potash were taken as the sources of N, P_2O_5 and K_2O respectively. Entire dose of phosphorus and potassium was given basally and half of the nitrogen at different graded levels are applied before planting and remaining dose of nitrogen applied as top dressing at 30 and 45 days after planting to the respective plots. Bulbs of Asiatic lily cv. Tressor were selected treatment wise and planted in the beds on 20th October, 2016. The various observations on vegetative growth, floral, vase life and bulb parameters were recorded on five plants randomly selected from net plot area and tagged. The data collected for all the characters studied were subjected to statistical analysis by adopting 'Analysis of Variance' (ANOVA) technique for factorial randomized block design as suggested by Panse and Sukhatme (1967) [17].

Results and Discussion

The data pertaining to flowering parameters and vase life revealed that the various levels of spacing and nitrogen significantly affected the flowering and vase life of Asiatic lily cv. Tressor were presented in Table 1, 2 and 3.

The number of days taken for flower bud emergence (Table 1) were minimum (28.46 days) in S_1 (15 cm x 15 cm) and days taken for flower bud emergence were maximum (36.40 days) in S_3 (30 cm x 15 cm). Number of days taken for flower bud emergence were minimum (31.95 days) with lower dose of nitrogen (100 kg ha^{-1}) whereas plants with higher level of nitrogen (200 kg ha^{-1}) recorded maximum days (35.64 days) to flower bud emergence. Among interaction effects, combination of S_1N_1 recorded minimum days to flower bud emergence (27.46 days) which was on par with S_1N_2 (27.80 days) whereas, maximum delay in flower bud emergence (38.86 days) was observed in S_3N_3. Similar results were found by Vedavathi *et al.* (2014) [22] in Asiatic lily (*Lilium spp*.).

Based on the results obtained, it could be concluded that number of days taken to flower bud appearance was found to be more in plants which are widely spaced. The reason might be due to the fact that, reduction in growth at narrow spaces directed the plants towards the reproductive phase earlier than the plants that have more vegetative growth at wider spaces (Sheoran *et al.,* 2015) [20]. The present results are in conformity with the earlier findings of Mohanty *et al.* (2002) [14] in tuberose and Ahmed *et al.* (2010) [10] in gladiolus.

The present results indicate that, plants supplied with higher doses of nitrogen take more number of days to initiate flower buds when compared to the lower doses of nitrogen applied. The fact behind the delayed initiation of flower buds was mainly due to the prolonged vegetative phase because nitrogen had synergistic effect (Sheoran *et al.,* 2015) [20]. These results are in agreement with the findings of Kumar *et al.* (2002) [11] in tuberose cv. Single and Kumar *et al.* (2009) [10] in tuberose cv. Pearl double.

Regarding colour visibility in bud (Table 1), minimum number of days (58.48 days) taken for colour visibility in bud was observed in S_1 (15 cm x 15 cm) while maximum number of days (65.75 days) was recorded by S_3 (30 cm x 15 cm). Days to colour visibility in bud was earlier (60.99 days) in N_1 (100 kg ha^{-1}) and the maximum delay in colour visibility in bud (64.53 days) was recorded by N_3 (200 kg ha^{-1}). Interaction effect was found to be highest in the combination of S_1N_1 (57.66 days) which was on par with S_1N_1 (58.53 days). On the other side, maximum delay for colour visibility in bud was observed in S_3N_3 (67.73 days).

Delay in colour visibility in bud with wider levels of spacing and nitrogen was reported by Vedavathi *et al.*, 2014 [22] in Asiatic lily (*Lilium* spp.).

With respect to days for 50% flowering (Table 1)**,** lowest number of days taken to 50% flowering (60.48 days) was recorded at the spacing of S_1 (15 cm x 15 cm) whereas, highest number of days taken to 50% flowering (71.29 days) was observed by the S_3 spacing (30 cm x 15 cm). Lowest number of days taken to 50% flowering (64.71 days) was observed with the application of nitrogen (N_1) at the rate of 100 kg ha^{-1} whereas, highest number of days taken to 50% flowering (68.85 days) was observed with the application of nitrogen (N_3) at the rate of 200 kg ha^{-1}. Among interaction effects, lowest number of days taken to 50% flowering (59.34 days) was observed with combination of S_1N_1 and was on par with S_1N_2 and S_1N_3 (60.48 and 61.61 days) whereas, highest number of days taken to 50% flowering (73.33) was recorded by S_3N_3.

Days to 50% flowering was earlier with narrow spacing and also lower levels of nitrogen doses in Asiatic lily (Vedavathi *et al.*, 2014) [22].

Data showed that different levels of spacing and nitrogen significantly affected flowering shoots per umbel (Table 2). Maximum number of flowering shoots per umbel (3.17) were recorded by S_3 (30 cm x 15 cm) and the minimum number of flowering shoots per umbel (1.42) was observed in S_1 (15 cm x 15 cm). Maximum number of flowering shoots per umbel (2.62) was observed in N_3 (200 kg ha^{-1}) and the minimum number of flowering shoots per umbel (2.17) was noted in N_1 (100 kg ha^{-1}). With respect to interactions, the combination of S_3N_3 was found to show the maximum number of flowering shoots per umbel (3.53) followed by S_3N_2 (3.13), while the minimum number of flowering shoots per umbel (1.33) was recorded by S_1N_1. Similar results were found by Sheoran *et al.* (2015) [20] in tuberose cv. Prajwal.

Based on the results obtained, it can be concluded that number of flowering shoots produced per umbel increased with the wider levels of spacing. This might be due to the fact that, closer spacing hampered intercultural operations and as such, more competition arises among the plants for nutrients, air and light, as a result of which plants had become weaker, thinner and consequently lagged behind in term of growth parameters (Sheoran *et al.,* 2015) [20]. These results are in agreement with the findings of Mane *et al.* (2006) [12] in tuberose cv. Single and Nagappa *et al.* (2006) [16] in tuberose cv. Shringar.

Maximum number of flowering shoots per umbel was obtained with the higher doses of nitrogen application which might be the fact that, applied nitrogen had significantly increased the growth parameters and synthesized more plant metabolites ultimately leading to increased flower production

(Chan, 1959) [3]. Similar kind of results were earlier reported by Chawla *et al.* (2007) [4] in chrysanthemum cv. Nilima.

With respect to flower diameter (Table 2), S_3 (30 cm x 15 cm) level recorded the maximum flower diameter (14.64 cm), whereas lowest flower diameter (13.64 cm) was observed in S_1 (15 cm x 15 cm). Maximum flower diameter (15.06 cm) was recorded with the application of nitrogen at 200 kg ha^{-1} (N_3) while minimum flower diameter (12.80 cm) was recorded with the application of nitrogen at 100 kg ha^{-1} (N_1). Among interaction effects, highest flower diameter (15.86 cm) was observed with the combination of S_3N_3 followed by S_3N_2 (14.97 cm) whereas, lowest flower diameter (12.46 cm) was recorded by S_1N_1. Similar results were found by Singh and Singh (2005) [21] in tuberose cv. Double.

The present results indicated that, plants with widest spacing recorded the highest flower diameter which might be due to the fact that wider spacing provides sufficient space between the plants resulting in absorption of optimum amount of nutrients with sufficient light leading to better photosynthesis and translocation of assimilates in the storage organs. These changes in plant system resulted in better quality flower production in gladiolus cv. White Prosperity (Ram *et al.*, 2012) [18].

The flower diameter was found to be maximum with an increased level of nitrogen doses (Khalaj *et al.*, 2012) [8, 9]. Similar results were reported by Bijimol and Singh (2001) in gladiolus and Munikrishnappa *et al.* (2004) [15] in tuberose.

Regarding flower weight (Table 2), maximum weight of flower (12.37 g) was recorded by S_3 (30 cm x 15 cm) and the minimum flower weight (11.75 g) was observed in S_1 (15 cm x 15 cm). Maximum weight of flower (13.01 g) was observed in N_3 (200 kg ha^{-1}) and the minimum weight of flower (10.77 g) was recorded in N_1 (100 kg ha^{-1}). The interaction effect was also found to be significantly superior in the combination of S_3N_3 (13.66 g) followed by S_2N_3 (12.77 g) and S_3N_2 (12.47 g) whereas, least value for flower weight (10.58 g) was recorded by S_1N_1. Similar results were found by Sheoran *et al.* (2015) [20] in tuberose cv. Prajwal.

Based on the results obtained, it may be concluded that an increase in the weight of flower with wider level of spacing might be due to the fact that wider spaced plants have less competition for nutrients, water and light without any shedding effect resulting in increased flower weight (Sheoran *et al.*, 2015) [20]. These results are supported by the findings of Mane *et al.* (2007) [13] in tuberose and Khalaj *et al.* (2012) [8, 9] in tuberose.

Plants supplied with higher nitrogen doses recorded the highest flower weight which might be due to the reason that, supply of abundant nitrogen helped in increasing assimilates that are necessary for increase in the flower weight (Sheoran *et al.*, 2015) [20]. Similar kind of an increase in flower weight with the application of higher doses of fertilizers were reported by Kadu *et al.* (2009) [7], Kabir *et al.* (2011) [6], Gomaa *et al.* (2011) [5] and Khalaj *et al.* (2012) [8, 9] in tuberose.

Data shown in Table 3 reveals that different spacing and nitrogen doses significantly affected harvesting of flowers. S_1 (15 cm x 15 cm) recorded minimum number of days (69.17 days) taken for harvesting of flowers while maximum delay in flower harvesting was observed in S_3 (30 cm x 15 cm) (79.06 days). Number of days taken for flower harvesting were minimum (73.46 days) with lowest dose of nitrogen i.e. N_1 (100 kg ha^{-1}) whereas days taken for flower harvesting were maximum (76.71 days) with highest dose of nitrogen i.e. N_3 (200 kg ha^{-1}). Among interaction effects, combination of S_1N_1 recorded minimum value (67.46 days) for number of days to flower harvesting followed by S_1N_2 (69.66 days) while, maximum delay in harvesting of flowers was observed in S_3N_3 (81.00 days). Similar results were found by Vedavathi *et al.* (2014) [22] in Asiatic lily (*Lilium spp*.).

Based on the results obtained, it could be concluded that delay in number of days taken for harvesting of flowers at wider spacing might be due to the fact that, reduction in growth at narrow spaces directed the plants towards the reproductive phase earlier than the plants that have more vegetative growth at wider spaces (Sheoran *et al.,* 2015) [20]. Similar kind of observations were reported by Mohanty *et al.* (2002) [14] in tuberose and Ahmed *et al.* (2010) [10] in gladiolus.

The present results indicate that, plants supplied with higher dose of nitrogen took more number of days for flower harvesting when compared to the lower doses of nitrogen applied which might be due to the prolonged vegetative phase because nitrogen has synergistic effect (Sheoran *et al.,* 2015) [20]. The present findings are in accordance with the earlier findings of Kumar *et al.* (2002) [11] in tuberose cv. Single and Kumar *et al.* (2009) [10] in tuberose cv. Pearl double.

Regarding field life (Table 3), maximum longevity of flowering shoots (6.37days) was observed with 30 cm x 15 cm (S_3) and 15 cm x 15 cm (S_1) recorded minimum field life (5.31 days). Nitrogen at 200 kg ha^{-1} (N_3) recorded the maximum longevity (6.24 days) while, minimum value (5.51days) for field life was observed in N_1 (100 kg ha^{-1}). The combination of S_3N_3 recorded maximum longevity (6.66 days) of Asiatic lily flowers and it was on par with S_3N_2 (6.53 days) whereas, S_1N_1 recorded least value (5.06 days) in terms of field life.

Maximum longevity of flower in the field was observed with wider plant spacing and application of higher doses of nitrogen (Vedavathi *et al*., 2014) [22] in Asiatic lily.

Data showed that different levels of spacing and nitrogen significantly affected postharvest vase life (Table 3). Maximum vase life of flowers (9.66 days) was recorded in S_3 (30 cm x 15 cm) and minimum value (7.66 days) for vase life was registered by S_1 (15 cm x 15 cm). Maximum vase life (9.11 days) was recorded in N_3 (200 kg ha^{-1}) and it was on par with N_2 (150 kg ha^{-1}) (8.55 days) whereas, least value (8.11 days) for vase life was recorded by N_1 (100 kg ha^{-1}). The interaction effect of spacing and nitrogen was found not significant with respect to vase life of flowers.

The widest spacing recorded the maximum vase life of flowers (Mane *et al*., 2007) [13] in tuberose cv. Single. Similar results were also obtained by Khalaj *et al.* (2012) [8, 9] in tuberose.

Maximum vase life of flowers was observed with the application of higher nitrogen doses which might be due to the fact that, more number of flower buds were produced per spike with higher nitrogen doses, and those were also bolder in size as well as heavier in weight promoting the spikes to show an extended length of vase life (Khalaj and Edrisi, 2012) [8, 9]. These results are in line with the findings of Rathore and Singh in tuberose and Vedavathi *et al.* (2015) in Asiatic lily cv. Gironde.

Table 1: Days to flower bud emergence, days to colour visibility in bud and days to 50 % flowering as influenced by spacing, nitrogen levels and their interaction in Asiatic lily cv. Tressor under shade net condition

Nitrogen (kg ha^{-1})	Days to flower bud emergence				Days to colour visibility in bud				Days to 50 % flowering			
	Spacing (cm)			Mean	Spacing (cm)			Mean	Spacing (cm)			Mean
	S_1	S_2	S_3		S_1	S_2	S_3		S_1	S_2	S_3	
N_1	27.46	33.80	34.60	31.95	57.66	62.00	63.33	60.99	59.34	66.26	68.53	64.71
N_2	27.80	35.66	35.73	33.06	58.53	64.13	66.20	62.95	60.48	69.40	72.00	67.29
N_3	30.13	37.93	38.86	35.64	59.26	66.60	67.73	64.53	61.61	71.60	73.33	68.85
Mean	28.46	35.80	36.40	33.55	58.48	64.24	65.75	62.82	60.48	69.09	71.29	66.95
	S Em±		CD at 5%		S Em±		CD at 5%		S Em±		CD at 5%	
S	0.17		0.51		0.19		0.58		1.38		4.14	
N	0.17		0.51		0.19		0.58		1.38		4.14	
Interaction (S x N)	0.30		0.88		0.34		1.01		2.72		8.15	

N_1 = Nitrogen @ 100 kg ha^{-1} S_1 = 15 cm x 15 cm
N_2 = Nitrogen @ 150 kg ha^{-1} S_2 = 25 cm x 15 cm
N_3 = Nitrogen @ 200 kg ha^{-1} S_3 = 30 cm x 15 cm

Table 2: Number of flowering shoots per umbel, flower diameter and flower weight as influenced by spacing, nitrogen levels and their interaction in Asiatic lily cv. Tressor under shade net condition

Nitrogen (kg ha^{-1})	Number of flowering shoots per umbel				Flower diameter (cm)				Flower weight (g)			
	Spacing (cm)			Mean	Spacing (cm)			Mean	Spacing (cm)			Mean
	S_1	S_2	S_3		S_1	S_2	S_3		S_1	S_2	S_3	
N_1	1.33	2.33	2.86	2.17	12.46	12.84	13.10	12.80	10.58	10.74	10.99	10.77
N_2	1.40	2.53	3.13	2.35	13.82	14.15	14.97	14.31	12.07	12.14	12.47	12.23
N_3	1.53	2.80	3.53	2.62	14.64	14.68	15.86	15.06	12.60	12.77	13.66	13.01
Mean	1.42	2.55	3.17	2.38	13.64	13.89	14.64	14.05	11.75	11.88	12.37	12.00
	S Em±		CD at 5%		S Em±		CD at 5%		S Em±		CD at 5%	
S	0.03		0.11		0.06		0.17		0.04		0.12	
N	0.03		0.11		0.06		0.17		0.04		0.12	
Interaction (S x N)	0.05		0.17		0.09		0.29		0.07		0.20	

N_1 = Nitrogen @ 100 kg ha^{-1} S_1 = 15 cm x 15 cm
N_2 = Nitrogen @ 150 kg ha^{-1} S_2 = 25 cm x 15 cm
N_3 = Nitrogen @ 200 kg ha^{-1} S_3 = 30 cm x 15 cm

Table 3: Days taken for harvesting of flowers, field vase life and postharvest vase life as influenced by spacing, nitrogen levels and their interaction in Asiatic lily cv. Tressor under shade net condition

Nitrogen (kg ha^{-1})	Days taken for harvesting of flowers (d)				Field vase life (d)				Postharvest vase life (d)			
	Spacing (cm)			Mean	Spacing (cm)			Mean	Spacing (cm)			Mean
	S_1	S_2	S_3		S_1	S_2	S_3		S_1	S_2	S_3	
N_1	67.46	75.60	77.33	73.46	5.06	5.53	5.93	5.51	7.00	8.00	9.33	8.11
N_2	69.66	76.53	78.86	75.01	5.26	5.86	6.53	5.88	7.66	8.33	9.66	8.55
N_3	70.40	78.73	81.00	76.71	5.60	6.46	6.66	6.24	8.33	9.00	10.00	9.11
Mean	69.17	76.95	79.06	75.06	5.31	5.95	6.37	5.87	7.66	8.44	9.66	8.59
	S Em±		CD at 5%		S Em±		CD at 5%		S Em±		CD at 5%	
S	0.09		0.29		0.03		0.10		0.19		0.57	
N	0.09		0.29		0.03		0.10		0.19		0.57	
Interaction (S x N)	0.17		0.51		0.06		0.18		0.33		NS	

N_1 = Nitrogen @ 100 kg ha^{-1} S_1 = 15 cm x 15 cm
N_2 = Nitrogen @ 150 kg ha^{-1} S_2 = 25 cm x 15 cm
N_3 = Nitrogen @ 200 kg ha^{-1} S_3 = 30 cm x 15 cm

Conclusion

Different nitrogen doses and plant spacing significantly affected some flowering and vase life characters in Asiatic lily cv. tressor. A rise in plant spacing and nitrogen rate increased days to flower bud emergence, days to colour visibility in bud, days to 50% flowering, days taken for harvesting of flowers, number of flowering shoots per umbel, flower diameter, flower weight, field vase life and postharvest vase life. From these results it can be concluded that Asiatic lily cv. tressor should be sown at spacing of 30 x 15 cm with a nitrogen application rate of 200 kg/ha N was found more effective in enhancement of floral attributes.

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