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Effect of Nitrogen and Spacing on Flowering Parameters of Spider Lily (*Hymenocallis littoralis* L.)

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A B S T R A C T

The present investigation entitled "Effect of nitrogen and spacing on flowering of spider lily (*Hymenocallis littoralis* L.)" was undertaken at College of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during the year 2019-20 and 2020-21 by considering the commercial importance of spider lily under Konkan agro-climatic conditions. The experiment was laid out in a split plot design using four levels of nitrogen and three levels of spacing with three replications along with the common dosage of phosphorous (150 kg ha^{-1}) and potassium (100 kg ha^{-1}). The observations were recorded on various flowering parameters *viz.*, such as days taken for first spike emergence, days taken for first flower emergence, number of spikes per plant, spike length, spike breadth and number of buds per spike. Days taken for first spike emergence (182.04) and first flower emergence (191.02) were recorded as lowest in N_4 (150 kg ha^{-1}). The highest number of spikes per plant (2.73) and flower bud per spike (16.15) were recorded in N_1 (300 kg ha^{-1}). However, with regards to effect of spacing, S_2 (60 × 60 cm) recorded the lowest days taken for first spike (183.86) and first flower emergence (193.25), while the highest number of spikes per plant (2.33) and number of buds per spike (14.25) was noticed in S_3 (30 × 60 cm). Spike length and breadth were found to be non-significant with respect to effect of nitrogen, spacing and their interaction.

Introduction

Flowers always denote purity, strength and nobility. They inspire the entire human race to follow the path of morality. Flowers are also connected with Gods and Goddesses in Indian culture, such as *Brahma, Vishnu, Shiva, Krishna, Lakshmi, Sarasvati*, etc while Lotus represents purity of the body, speech, and mind in Buddhist culture. In India, flowers are important with respect to religion, attire, medicinal use, antagonistic toxins depletion, primitive spirituality, and providing physiological and psychological relaxation effects on office workers (Ikei *et al.*, 2014).

In India, the area under cultivation of flower crops got almost tripled from 106 thousand ha during 2001-02 to 339 thousand ha during 2018-19 (ICAR-DFR Annual Report, 2019). In 2018, annual growth in area and production was 5.8% and 16.4%, respectively, compared to 2016-17 (NHB, 2018). In Maharashtra, the area under floriculture is 11.36 thousand ha with production of loose and cut flowers accounting 57.61 and 0.11 MT, respectively (Kumar *et al.,* 2021) whereas the *Konkan* region having more than 310 ha area under flower cultivation with a production of 376 MT (Patil *et al.*, 2010).

A long floral bud of spider lily is commercially significant and widely planted in West India, notably southern Gujarat, Maharashtra and Karnataka and also has a high standard in the Mumbai flower market and is available to sell at Rs. 6–12 per kg. It is grown commercially in Thane, Dahanu, Vasai, and Ratnagiri districts in the Konkan region, primarily for sale at neighboring markets.

It was also used as a commercial and intercrop in orchards in the early years, and it has about more than 2045 ha of area under flower crops and per cent share of Maharashtra in production of flowers is 3.09 (Patil *et al.*, 2010).

Standardization of agro-techniques for high yield with good quality flowers is of prime importance for the benefits of the farmers who are involved in the cultivation of this crop. Among the various factors, spacing and nutrition plays a major role in flower yield of this crops. It is considered to be a function of nutrients level (Boodley, 1975). Proper nutrition through optimum dose of fertilizer is essential for better growth and development of plant. Realizing the increasing importance of this crop, it was therefore, is much more necessary to work out the optimum dose of fertilizer requirement and spacing to obtain the yield. Spider lily is a new upcoming potential flower crop, so far very little or no research studies are carried out in this crop.

Considering the above attributes, present investigation entitled "Effect of nitrogen and spacing on flowering of spider lily (*Hymenocallis littoralis* L.)" have been planned with the objective to evaluate the effect of nitrogen and spacing on flowering parameters of spider lily.

Materials and Methods

The field investigation entitled "Effect of nitrogen and spacing on growth and flowering of spider lily (*Hymenocallis littoralis* L.)" was undertaken at College of Horticulture, Dapoli; Dist. Ratnagiri (MS) during the year 2019-2021.

The experiment details are as followed:

Nitrogen doses: 4 (Through: Urea) -

N_1:- 300 kg/ha

N_2:- 250 kg/ha

N_3:- 200 kg/ha

N_4:- 150 kg/ha

(Whereas, common doses of phosphorus and potash were 150 kg/ha and 100 kg/ha respectively.)

Spacing: 3-

S_1:- 90 × 60 cm^2

S_2:- 60 × 60 cm^2

S_3:- 30 × 60 cm^2

Total No. of treatments: 4×3=12

No. of replications: 3

Block size: 5.4 ×2.4 m. (12.96 sq. m.)

Design: Split plot design

Five plants were selected randomly from each plot in each treatment and tagged for the purpose of recording different visual observations. The number of days taken for emergence of first spike and first flower was recorded by counting the days from the planting date. The length of the spike was measured from the site of emergence to the top of the upper most flowers on a spike. Spike breadth (Thickness) of spikes was taken with the avail of vernier caliper in centimetres at a height of 10 cm from basal end. The number of spikes per plant and buds per spike was counted from each five tagged plants at 60 days of interval after first spike emergence and average was worked out.

The data obtained was analyzed statistically as per the method suggested by Panse and Sukhatme (1989). The standard error of mean (S.E) was worked out and the critical difference (C.D.) at 5 per cent was calculated whereas, the results were found significant. The important results have been supported through graphs and plates.

Results and Discussion

Days taken for first spike emergence

It is evident from perusal of Table 1 that the effect of nitrogen on first spike emergence revealed the significant variation in the emergence of first spike. The lowest days for first spike emergence (182.04) was observed under the treatment N_4, while the highest days (187.93) was noticed under the treatment N_1.

These above results of present findings agreed with Paramagoudar (2015) showed that minimum days taken for first spike emergence (54.40 days) was with the treatment T_1 (150: 100: 100, N: P: K kg/ha), while the highest days (64.53 days) with the treatment T_{12} (250:150: 150, N: P: K kg/ha) in spider lily. Further, Kejakar (2012) in spider lily was also reported that the application of nitrogen @ 400 kg/ha delayed number of days required for first flower stalk emergence (30.4) as compared to other nitrogen levels (0, 200, 300 and 400 kg/ha).

Table 1 also reveals that the difference in emergence of first spike due to different spacing was found significant. The treatment S_2 exhibited lowest days (183.86) required for first spike emergence, whereas highest days (187.53) was observed under the treatment S_1. The results of present findings agreed with Niranjan *et al.,* (2018), Sirohi *et al.,* (2007) and Sharma and Talukdar (2003) in gladiolus.

The treatment combination N_4S_3 recorded lowest days (181.07) for first spike emergence, while highest days (191.27) was recorded in the treatment combination N_1S_1 (Table 1). These results are strongly supported by Koladiya (1995) that the lowest (107.33) number of days required for first floret emergence was found under the S_1N_1 interaction (60 × 20 cm and 0 g N/m^2) in spider lily.

Days taken for first flower emergence

The data revealed that the difference in emergence of first flower due to different nitrogen levels was found significant. The treatment N_4 exhibited lowest days required for first flower emergence (191.02), whereas highest days (198.31) was observed under the treatment N_1 (Table 1).

The delay in flower bud emergence in spider lily have been due to application of nitrogen which encouraged the vegetative growth of the plant and extended the duration required by the plant to enter into reproductive phase from vegetative phase. These findings can be correlated with those of Maske (2014) in spider lily and Khan *et al.,* (2007) in dahlia.

From the data pertaining to effect of spacing on first flower emergence, it was revealed that the spacing had a significant influence on first flower emergence. The treatment S_2 recorded lowest days for first flower emergence (193.25), while highest days (197.55) was recorded in the treatment S_3 (Table 1).

It was clear from that closer spacing enhanced the flowering due to the tough competition of nutrients which hindered the vegetative growth and plant itself moved earlier towards reproductive stage.

Swetha *et al.,* (2018) evaluated that spacing of 15 × 15 cm took lowest days (28.46) for flower bud emergence. The results of present finding are in accordance with Singh (1996) in tuberose and Koladiya (1995) in spider lily. The treatment combination N_4S_3 exhibited lowest days required for first flower emergence (189.80), whereas highest days (202.80) was observed under the treatment combination N_3S_3 (Table 1).

The present results indicate that, higher doses of nitrogen took a greater number of days for first flower bud emergence as compared to lower doses of nitrogen applied. The fact behind the prolonged initiation of flowers because of extended vegetative phase and due to this nitrogen had synergistic effect (Sheoran *et al.,* 2015).

Swetha (2018) studied that among the interaction effects, combination of S_1N_1 (15 × 15 cm and 100 kg N/ha) recorded lowest days to flower bud emergence (27.46 days), whereas, highest delay in flower bud emergence (38.86 days) was recorded in S_3N_3 (30 × 15 cm and 200 kg N/ha). The similar result was also reported by George (1997) and Koladiya and Dhaduk (1995) in spider lily.

Spike length (cm)

During 2019-20 and 2020-21; spike length differed non-significantly and was in the range of 54.86 (N_4) to 59.38 (N_1) and 57.33 (N_4) to 63.62 (N_2), respectively (Table 2). Pooled data also exhibited a non-significant difference in the spike length of spider lily, which was in the range of 56.10 (N_4) to 60.83 (N_2).

Even though, the highest spike length (64.28) was noticed in N_2S_1 i.e. 250 kg nitrogen/ha and 90 × 60 cm spacing while the lowest spike length (55.37) was observed in N_4S_1 i.e. 150 kg nitrogen/ha and 90 × 60 cm spacing. Khalaj and Edrisi (2012) put out the same results where he evaluated that the application of 200 kg N/ha resulted enhanced flower stalk height in tuberose as compared to 250 kg N/ha.

Hence, as per above study given by scientist, there were no effect on length of spike while the dose of nitrogen increases.

Spike length affected by different spacing also showed non-significant variation during both the years of experimentation as well as in pooled data.

Present findings are more or less in conformity with Parekh (2018) in spider lily, Nagaraja *et al.,* (1999) in tuberose, George (1997) and Koladiya and Dhaduk (1995) in spider lily. The interaction effect of nitrogen and spacing on spike length of spider lily for two succeeding years including pooled data exhibited non-significant variation.

Spike breadth (mm)

Spike breadth increases due to lateral meristems which consist of vascular cambium and cork cambium. It is also called culm diameter. During 2019-20 and 2020-21; spike breadth varied non-significantly and was in the range of 25.88 (N_1) to 27.48 (N_4) and 30.33 (N_1) to 31.23 (N_4), respectively. With regards to pooled data, spike breadth differed non-significantly and varied from 28.48 (N_1) to 28.90 (N_4) (Table 3). Thus, spike breadth found non-significant with different nitrogen levels, which indicated that there is no specific effect in between nitrogen and spike breadth.

These results are not in accordance with Kumar *et al.,* (2006) who reported that the highest spike breadth was recorded with increasing level of nitrogen in gladiolus. Bijimol and Singh (2001) stated that the nitrogen level @ 200 kg/ha resulted in increased diameter of the spike among four nitrogen rates *viz.,* 0, 100, 200 and 300 kg/ha in gladiolus which was according to the results.

The effect of spacing on spike breadth of spider lily for two succeeding years including pooled data also exhibited similar trend and it varied non-significantly during the experimental period as well as in pooled data. Similar finding has been confirmed with the present study which was given by Bijimol and Singh (2001) in gladiolus and they concluded that increase in diameter of spike was obtained in the spacing of 25 × 30 cm as compared to other three (15 × 30, 20 × 30 and 30 × 30 cm).

Table.1 Effect of nitrogen and spacing on number of days taken for first spike emergence & first flower emergence of spider lily

	Days taken for first spike emergence					Days taken for first flower emergence				
Spacing	Nitrogen					Nitrogen				
	N1	N2	N3	N4	MEAN	N1	N2	N3	N4	MEAN
S1	191.27	187.20	188.33	183.33	**187.53**	201.93	196.93	197.60	191.53	**197.00**
S2	186.07	182.53	184.07	182.80	**183.86**	195.33	193.67	192.27	191.73	**193.25**
S3	186.47	189.33	189.67	181.07	**186.63**	197.67	199.93	202.80	189.80	**197.55**
MEAN	**187.93**	**186.36**	**187.36**	**182.04**		**198.31**	**196.84**	**197.56**	**191.02**	

	N	S	N×S		N	S	N×S
F test	SIG	SIG	SIG	**F test**	SIG	SIG	**SIG**
S.Em.±	0.36	0.57	1.14	**S.Em.±**	0.42	0.53	**1.07**
CD@ 5%	1.26	1.71	3.42	**CD@ 5%**	1.45	1.60	**3.20**

Treatment details:-	Nitrogen		Spacing	
	N_1	300kg/ha	S1	90×60 cm
	N_2	250kg/ha	S2	60×60 cm
	N_3	200kg/ha	S3	30×60 cm
	N_4	**150kg/ha**	*Number of plants as per spacing are 24 (90×60 cm), 36 (60×60 cm)and 72(30×60cm)in 12.96sq.m.area	

Table.2 Effect of nitrogen and spacing on spike length (cm) of spider lily

	Spike length (cm)														
	Nitrogen														
	2019-20					2020-21					Pooled				
Spacing	**N1**	**N2**	**N3**	**N4**	**MEAN**	**N1**	**N2**	**N3**	**N4**	**MEAN**	**N1**	**N2**	**N3**	**N4**	**MEAN**
S1	61.71	61.11	58.87	52.93	**58.65**	62.88	67.46	58.19	57.81	**61.58**	62.29	64.28	58.53	55.37	**60.11**
S2	60.81	56.72	53.75	55.22	**56.62**	62.00	64.38	61.94	57.98	**61.57**	61.40	60.55	57.84	56.60	**59.10**
S3	55.63	56.31	56.73	56.43	**56.27**	60.36	59.03	61.47	56.21	**59.26**	58.00	57.67	59.10	56.32	**57.77**
Mean	**59.38**	**58.05**	**56.45**	**54.86**		**61.75**	**63.62**	**60.54**	**57.33**		**60.57**	**60.83**	**58.49**	**56.10**	

	N	**S**	**N×S**		**N**	**S**	**N×S**		**N**	**S**	**N×S**
Ftest	NS	NS	NS	**Ftest**	NS	NS	NS	**Ftest**	NS	NS	**NS**
S.Em.±	1.12	1.24	2.47	**S.Em.±**	2.42	2.29	4.58	**S.Em.±**	1.33	1.30	**2.60**
CD@5%	-	-	-	**CD @5%**	-	-	-	**CD @5%**	-	-	**-**

Treatment details: -	**Nitrogen**		**Spacing**	
	N_1	300kg/ha	**S1**	**90×60 cm**
	N_2	250kg/ha	**S2**	**60×60 cm**
	N_3	200kg/ha	**S3**	**30×60 cm**
	N_4	**150kg/ha**	***Number of plants as per spacing are 24 (90×60 cm), 36(60×60cm) and 72(30×60cm)in 12.96 sq.m.area**	

Table.3 Effect of nitrogen and spacing on spike breadth (mm) of spider lily

Spike breadth (mm)															
Nitrogen															
Spacing	2019-20					2020-21					Pooled				
	N1	N2	N3	N4	MEAN	N1	N2	N3	N4	Mean	N1	N2	N3	N4	MEAN
S1	25.70	27.67	26.53	28.75	**27.16**	27.20	33.20	31.64	30.65	**30.67**	26.45	30.44	29.09	29.70	**28.91**
S2	25.00	24.47	26.19	24.70	**25.09**	34.62	28.97	28.63	30.55	**30.69**	29.81	26.72	27.41	27.63	**27.89**
S3	26.93	25.80	28.18	28.98	**27.47**	31.41	31.52	31.13	29.80	**30.96**	29.17	28.66	29.66	29.39	**29.21**
Mean	**25.88**	**25.98**	**26.97**	**27.48**		**31.08**	**31.23**	**30.47**	**30.33**		**28.48**	**28.61**	**28.72**	**28.90**	

	N	S	N×S		N	S	N×S		N	S	N×S
Ftest	NS	NS	NS	**Ftest**	NS	NS	NS	**Ftest**	NS	NS	**NS**
S.Em.±	0.79	0.87	1.73	**S.Em.±**	1.42	0.82	1.63	**S.Em.±**	0.81	0.60	**1.19**
CD@5%	-	-	-	**CD @5%**	-	-	-	**CD@5%**	-	-	-

Treatment details: -	**Nitrogen**		**Spacing**	
	N_1	300kg/ha	**S_1**	**90×60cm**
	N_2	250kg/ha	**S_2**	**60×60cm**
	N_3	200kg/ha	**S_3**	**30×60cm**
	N_4	**150kg/ha**	***Number of plants as per spacing are 24 (90×60 cm), 36 (60×60cm) and 72(30×60 cm) in12.96 sq.m. area**	

Table.4 Effect of nitrogen and spacing on number of flower buds per spike of spider lily

Number of flower buds per spike															
Nitrogen															
Spacing	2019-20					2020-21					Pooled				
	N1	N2	N3	N4	MEAN	N1	N2	N3	N4	MEAN	N1	N2	N3	N4	MEAN
S1	11.37	12.19	10.69	10.33	**11.15**	20.67	17.05	14.35	13.57	**16.41**	16.02	14.62	12.52	11.95	**13.78**
S2	11.92	10.55	10.25	9.93	**10.66**	17.25	15.56	15.44	13.92	**15.54**	14.59	13.05	12.85	11.93	**13.10**
S3	14.11	11.09	10.71	9.85	**11.44**	21.60	15.13	12.83	18.67	**17.06**	17.85	13.11	11.77	14.26	**14.25**
Mean	**12.47**	**11.28**	**10.55**	**10.04**		**19.84**	**15.92**	**14.20**	**15.39**		**16.15**	**13.60**	**12.38**	**12.71**	

	N	S	N×S		N	S	N×S		N	S	N×S
F test	SIG	NS	NS	**F test**	SIG	NS	SIG	**F test**	SIG	NS	**SIG**
S.Em.±	0.33	0.27	0.55	**S.Em.±**	0.66	0.59	1.18	**S.Em.±**	0.37	0.33	**0.65**
CD@5%	1.13	-	-	**CD @5%**	2.27	-	3.54	**CD@5%**	1.60	-	**1.87**

Treatment details:-	**Nitrogen**		**Spacing**	
	N_1	300kg/ha	**S_1**	**90×60cm**
	N_2	250kg/ha	**S_2**	**60×60cm**
	N_3	200kg/ha	**S_3**	**30×60cm**
	N_4	**150kg/ha**	***Number of plants as per spacing are 24(90×60 cm), 36(60×60cm) and 72(30×60 cm) in 12.96 sq.m. area**	

It is evident from the data presented in Table 3, that the interaction of nitrogen and spacing had a non-significant effect on spike breadth of spider lily for two succeeding years as well as on pooled mean. During 2019-20 and 2020-21; spike breadth differed non-significantly and was in the range of 24.47 (N_2S_2) to 28.98 (N_4S_3) and 27.20 (N_1S_1) to 34.62 (N_1S_2), respectively. Pooled data also exhibited non-significant variation and was in the range of 26.45 (N_1S_1) to 30.44 (N_2S_1) (Table 3).

Number of flower buds per spike

During 2019-20 and 2020-21; the highest number of flower buds per spike was 12.47 and 19.84 was observed in N_1, respectively and it was significantly superior over all the nitrogen levels. During 2019-20; the lowest number of flower buds per spike (10.04) was noticed in N_4 while the lowest number of flower buds per spike (14.20) was observed in N_3 during 2020-21 (Table 4). In pooled data, the highest number of flower buds per spike (16.15) was found in N_1 which was significantly superior over rest of the nitrogen levels, while the lowest number of flower buds per spike (12.38) was observed in N_3 (Table 4). Paramagoudar (2015) recorded more number of flowers per spike (17.27) in spider lily in the treatment T_{12} (250: 150: 150, N: P: K kg/ha) and this treatment had highest dose of NPK, while the lowest number of flowers per spike (13.60) was recorded in the treatment T_1 (150: 100: 100). Similar result was also noted that highest (15.41) number of flowers per stalk with higher level of nitrogen (400 kg/ha) in spider lily (Maske, 2014). Results of present findings agreed with Koladiya (1995) in spider lily, Gopalkrishnan *et al.,* (1995) and Sharma *et al.,* (1994) in tuberose.

The effect of spacing on number of flower buds per spike exhibited non-significant trend for the year 2020-21, 2019-20 and in pooled data also (Table 4). The results are more or less in conformity with Koladiya (1994) who found the non-significant effect of different spacing on number of florets per stalk in spider lily. He recorded highest number of florets per stalk (11.72) in treatment with closer spacing *i.e.,* 60 × 20 cm, while the treatment having wider spacing *i.e.,* 60 × 40 cm recorded lowest (10.95) number of florets per spike of spider lily. George (1997) also reported that spacing had a non-significant effect on number of florets per spike. She also revealed that closer spacing (60 × 30 cm) produces slightly more number of florets/spike (10.28) as compared to wider spacing (60 × 45 and 60 × 60 cm) in spider lily.

The effect of interaction (N × S) on number of flower buds per spike showed non-significant trend for the year 2020-21. However, significant variation was observed in the year 2019-20 and in pooled data also (Table 4). During 2020-21; the highest number of flower buds per spike (21.60) was noticed in N_1S_3 and it was significantly superior over all the treatment combinations, whereas treatment combination N_3S_3 recorded the lowest number of buds per spike (12.83) (Table 4). In pooled data, number of flower buds per spike varied significantly. The highest number of flower buds per spike (17.85) was noted in N_1S_3 and it was found significantly superior, whereas treatment combination N_3S_3 recorded the lowest number of flower buds per spike (11.77) (Table 4). The present findings are similar with Koladiya (1995) revealed that significantly highest *i.e.,* 15.07, 15.27, 15.40 and 15.80 number of florets per spike was recorded in treatment combination with closer spacing and higher nitrogen *i.e.,* (60 × 20 cm and 40 g N/m^2) at first, second, third and fourth flowering, respectively. This might be due to interaction of higher dose of nitrogen which is known to play important role in plant metabolism due to its constitutional role in various important protein molecules and competition due to closer spacing which favored reproductive growth rather than vegetative growth.

The present investigation that the spider lily planted at the spacing of 30×60 cm with the application of 300 kg nitrogen per ha along with common dose of 150 kg phosphorus and 100 kg potassium per ha recorded the best results with respect to flowering parameters under Konkan agro-climatic condition**s.**

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