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Research Paper

Growth and flower production of lilium as influenced by precise application of mineral nutrients

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ABSTRACT

Healthy and quality production of cut flower stems is one of the most important factors that determines the decorative and market value of cut flowers being greatly influenced by the type and mode of nutrient application. The productivity of cut flowers varies greatly with the microclimate management as well. Therefore, this study investigated the role of precise nutrient application through fertigation and foliar spray in influencing vegetative and flower characters of lilium. The findings of the study revealed that Nitrogen (10g m^{-2}) through fertigation+ NPK 19:19:19 (1g L^{-1}) as foliar spray produced maximum number of leaves $plant^{-1}$ (84.05), leaf area $plant^{-1}$ (842.30 cm^2) and leaf area index (2.81). The same treatment again played an important role in reducing days to emergence of first bud (43.38 days), colour break stage (55.57 days) and opening of first flower (58.86 days) as compared to control. The quality parameters of lilium viz., number of flowers $plant^{-1}$ (6.41), flower bud length (9.95cm), flower diameter (20.25 cm)and spike length (105.53 cm) were also significantly improved through application of Nitrogen (10g m^{-2}) fertigation+ NPK 19:19:19 (1g L^{-1}) foliar spray.

Key words: Cultivars, Fertigation, Foliar Spray, Formulations, Lilium, NPK

Lilium is a genus of herbaceous flowering plants growing from bulbs with large prominent flowers having colorful tepals having wide variety of colors including white, yellow, orange, red, and pink. Lilies are one of the showiest flowers in the plant world. The lily plant has an important role in culture and literature in much of the world. These are graceful, stylish, and extremely beautiful and are easy to grow. Even though lilies can found growing in the wild in most of the temperate regions of the northern hemisphere, however more than 60 percent of known lily species grow in Eastern Asia, Korea, Manchuria, and Japan. The main production centers of lily bulbs occur in 10 countries with the Netherlands having the largest share in the production area (Anonymous, 2010).

The bulb crops require higher and constant supply of nutrients for achieving higher growth and quality production. However, indiscriminate use of chemical fertilizers is generally associated with the adverse effect on soil health and increased cost of production as well. The recent concept of cost effective and eco-friendly means of nutrient application is to restore the soil productivity and sustainability besides boosting crop production. Integrated nutrient management lays emphasis on the reduction of nutrient losses from applied inorganic fertilizers, retention of soil moisture and improvement in physical, chemical and biological properties of soil. Rationalized management of nutrients to increase assimilatory area in Lilium is very important for maximum production. Water and nutrients are the major inputs vital for crop production, hence their appropriate and timely application can prove beneficial in increasing the production level. The faulty application of fertilizers especially nitrogen results in greater losses through leaching thereby polluting both soil and water bodies. Applying timely doses of small amounts of nutrients to the plant throughout the growing season has significant advantages in terms of crop yield (Wang & Xing, 2016).Out of various nutrient elements, nitrogen is the most important to influence development of not only the leaf area upto anthesis but also the subsequent quantity of photosynthates moving to the growing bulbs. Source of nitrogen (ammonical and nitrate) has also a

bearing on the rate of bulb growth in lilies. Ammonical sources of nitrogen result in low pH that can lead to non-availability of some minor elements such as manganese, iron and low pH can lead to toxicity. Further ammonical sources are known to favour rot problems caused by *Fusarium* (Woltz and Magie, 1983). Besides, supply of nitrogen at critical points in growth cycle of lily plants is very important to maximize the flower production. Keeping in view the importance of nitrogen, time and method of application for sustained crop production, this present investigation was conducted with an aim to determine the amount of an optimum dose of nitrogen required through fertigation and foliar spray for promoting growth and flowering.This will help to develop locally tested nutrition management regime aimed at maximizing the yield as well as quality of the locally produced lily bulbs

MATERIALS AND METHODS

The present study was conducted at the Research Farm of SKUAST-K, Shalimar India during 2019. Two lilium cultivars (Pavia, Archachon) were used in the study. Pavia is yellow and Archachon is white in colour and both belong to LA hybrid group. Both of the varieties were grown in field under shade environment. The experiment consists of four levels of nitrogen fertigation doses applied with and without NPK (19:19:19) at 1g L^{-1} as foliar spray. A basal dose of well decomposed FYM (5 Kgm^{-2}) was added to the soil three weeks before planting of bulbs. P and K nutrients were also applied at a constant level of 20 gm^{-2} in all treatments uniformly as basal dose. Bulbs of the two cultivars having uniform size and healthy and vigorous growth were planted at a depth of 7cm within a spacing of 15 x 15 cm in 1 m^2 beds. A prefabricated bamboo structure was erected over the field at 30 days after planting and green shade net of 50% was spread over it. All the intercultural operations such as hoeing, weeding, irrigation were carried out uniformly in all the treatments. Nitrogen was applied through fertigation in the form of water soluble fertilizer Ca $(NO_3)_2$ in five split doses at fortnightly intervals till flower bud formation. NPK (19:19:19) at concentration of 1g $Litre^{-1}$ water was applied fortnightly as foliar spray till droplet formation on foliage. All treatments were initiated at 15 days after planting of bulbs. The leaf area $plant^{-1}$ was recorded with the help of a non-portable type (L.A 211, Systronics) leaf area meter. The data recorded were subjected to statistical analysis using FRBD (Factorial Randomized Block Design) with three replications as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of nitrogen fertigation through calcium nitrate and NPK (19:19:19) foliar sprays on growth of lilium: Application of nitrogen through fertigation and NPK (19:19:19) as foliar sprays had significant effect on vegetative growth except leaf area index (Table 1).

Table 1: Effect of nitrogen fertigation through calcium nitrate and NPK (19:19:19) sprays on vegetative growth of lilium

Treatment (T)		Number of leaves $plant^{-1}$			leaf area (cm^2) $plant^{-1}$			Leaf area index (LAI)		
		Pavia	Arcachon	Mean	Pavia	Arcachon	Mean	Pavia	Arcachon	Mean
T_1	N (0 gm^{-2})	68.80	70.52	69.66	436.98	547.45	492.22	1.46	1.82	1.64
T_2	N (10 gm^{-2})	69.72	72.90	71.31	473.50	574.43	523.97	1.58	1.91	1.75
T_3	N (20 gm^{-2})	70.74	74.57	72.65	549.75	635.07	592.41	1.83	2.12	1.98
T_4	N (30 gm^{-2})	72.17	75.30	73.74	574.35	745.64	660.00	1.91	2.49	2.20
T_5	N (0 gm^{-2}) + NPK 1g L^{-1}	74.55	78.41	76.48	642.95	758.72	700.84	2.14	2.53	2.34
T_6	N (10 gm^{-2}) + NPK 1g L^{-1}	81.79	86.32	84.05	731.79	952.81	842.30	2.44	3.18	2.81
T_7	N (20 gm^{-2}) + NPK 1g L^{-1}	76.84	88.78	82.81	664.49	845.88	755.19	2.21	2.82	2.52
T_8	N (30 gm^{-2}) + NPK 1g L^{-1}	75.60	81.32	78.46	655.71	768.03	711.87	2.19	2.56	2.37
Mean		68.80	70.52		591.19	728.51		1.97	2.42	
CD ($P \leq 0.05$)		Treatment (T): 0.36			Treatment (T): 8.31			Treatment (T): NS		
		Cultivar (C) : 0.18			Cultivar (C) : 4.16			Cultivar (C) : NS		
		T x C : 0.51			T x C : 1.75			T x C : NS		

N = Nitrogen in the form of calcium nitrate; NPK (19:19:19) as foliar spray (grams per litre water); C = cultivar (Pavia and Arcachon)

T_6 (Nitrogen 20 g m^{-2} through calcium nitrate and NPK 1g L^{-1} as foliar spray) significantly enhanced number of leaves $plant^{-1}$ (84.05) and leaf area (842.30 cm^2) as compared to control. It was observed that vegetative growth was positively correlated with increase in the dosage of nitrogen from 0 grams m^{-2} to 20 grams m^{-2}. However, further increase in the concentration of nitrogen beyond 20 grams m^{-2} did not cause any significant effect on growth parameters which remain nearly constant. In fertigation, calcium nitrate fertilizer releases nitrogen in nitrate form which is readily available to plant and probably enhanced leaf area at early stages of plant development. The results are in conformity with the findings of Salazar *et al*. (2011) who reported improved leaf area under calcium nitrate application regime in lilium cv. 'Rio Negro'. Monda *et al.* (2014) observed in orchid, that all the vegetative parameters increased at higher doses of nutrients, specifically through NPK spray during vegetative period. Zhou *et al.* (2010) found the positive correlation between nitrogen availability and leaf area. The cultivars were also found to differ significant in all the vegetative characters of lilium except leaf area index. Cultivar Arcachon showed better performance in vegetative growth as compared to Pavia. This may be due to the genetic make-up of plant. Among various treatment combinations, application of Nitrogen (20g m^{-2}) as fertigation + NPK (19:19:19) 1g L^{-1} as foliar spray in Arcachon was found to improve all the vegetative characters of lilium. Similar results were also obtained by Vinod *et al.* (2016).

Effect of nitrogen fertigation through calcium nitrate and NPK (19:1919) foliar spray on induction of flowering in lilium: Days taken to appearance of first flower bud, colour break and opening of first flower (Table 2) were significantly affected by T_6 (Nitrogen 10 gm^{-2} through fertigation + NPK 1g L^{-1} as foliar spray). All treatments of Nitrogen through calcium nitrate fertigation along with NPK (1g L^{-1}) as foliar spray were significantly effective in inducing early flowering in lilium as compared to control. Fertigation with Nitrogen (10 gm^{-2}) along with foliar sprays with NPK (1g L^{-1}) recorded lowest number of days to appearance of flower bud (43.38 days), colour break (55.57 days) and opening of first flower (58.86 days). On the other hand plants that were not supplied with fertigation and nutrient sprays took greater number of days to appearance of first flower bud (47.61 days), colour break (62.44 days) and opening of first flower (67.39 days).Thus it is evident that higher dosage of fertigation, resulted in the production of better quality flowers due to continuous supply of nutrients. Kumar *et al*. (2017) also reported early induction of flowering in gladiolus through application of nitrogen fertilizers. It was also observed that increasing the dosage of nitrogen beyond a particular level, days to bud appearance, colour break and flower opening stages got delayed. This delay in bud emergence and flowering in the plants supplied with the higher levels of nitrogen may be due to the fact that nitrogen induces higher vegetative growth and cause inhibitory effect on reproductive growth. Similar results were also recorded by Zhang *et al.* (2021)

Table 2: **Effect of nitrogen fertigation through calcium nitrate and NPK (19:19:19) sprays on induction of flowering inlilium**

Treatment		Days taken to appearance of first flower bud			Days taken to colour break			Days taken to first flower opening		
		Pavia	Arcachon	Mean	Pavia	Arcachon	Mean	Pavia	Arcachon	Mean
T_1	N (0 gm^{-2})	45.88	49.35	47.61	60.80	64.09	62.44	65.90	68.87	67.39
T_2	N (10 gm^{-2})	45.69	48.42	47.05	60.30	62.90	61.60	65.32	67.76	66.54
T_3	N (20 gm^{-2})	44.41	48.33	46.37	58.75	62.45	60.60	63.53	66.75	65.14
T_4	N (30 gm^{-2})	44.49	47.29	45.89	58.49	61.13	59.81	63.07	65.24	64.16
T_5	N (0 gm^{-2}) + NPK 1g L^{-1}	43.32	47.09	45.21	57.19	60.64	58.92	61.58	64.66	63.12
T_6	N (10 gm^{-2}) + NPK 1g L^{-1}	41.48	45.28	43.38	53.56	57.59	55.57	57.39	60.32	58.86
T_7	N (20 gm^{-2}) + NPK 1g L^{-1}	42.42	47.52	44.97	57.69	61.11	57.70	59.62	63.69	61.66
T_8	N (30 gm^{-2}) + NPK 1g L^{-1}	43.44	46.58	45.01	57.69	61.15	57.69	61.08	62.49	61.79
Mean		43.89	47.48		44.96	49.26		62.18	64.97	
CD ($P \leq 0.05$)		Treatment (T): 0.42			Treatment (T) : 0.61			Treatment (T) : 0.73		
		Cultivar (C) : 0.21			Cultivar (C) : 0.30			Cultivar (C): 0.36		
		T x C : 0.60			T x C: 0.86			T x C :1.04		

Cultivar Pavia reached flower bud formation, colour break and first flower opening significantly earlier than cultivar Arcachon. These variations may be attributed to genetic make-up and physiological differences among the genotypes as suggested earlier by Sindhu (2006) and Pandey *et al.* (2010). Fertigation with Nitrogen (10 gm^{-2}) along with foliar sprays with NPK (19:19:19) 1g L^{-1} was significantly effective in recording lowest number of days to appearance of flower bud, colour break and opening of first flower in both cultivars.

Effect of nitrogen fertigation through calcium nitrate and NPK (19:1919) foliar spray on flower quality of lilium: Nitrogen fertigation through calcium nitrate and NPK sprays significantly affected number of flower buds $stem^{-1}$, flower bud length and diameter and spike length. The results (Table 3) revealed that with each incremental increase in dosage of nitrogen fertigation, an improvement in quality parameters was observed upto T_6 after which the flower characters showed a decline trend. T_6 (fertigation with nitrogen 10 gm^{-2} + NPK 1g L^{-1}foliar spray) produced higher number of flower buds $stem^{-1}$ (6.41), flower bud length (9.95 cm) and flower diameter (21.94 cm) as compared to control. On the other hand T_7 statistically at par with T_6 recorded maximum spike length (84.53 cm) as compared to control. The lowest number of flower buds $stem^{-1}$ (4.63), flower bud length (8.52 cm) and diameter (17.38) and spike length (80.00 cm) was observed in treatment that received no nitrogen fertigation and NPK foliar sprays. It became clear from the experiment that increasing nutrient supply resultedan increase in calcium and nitrogen levels within the aerial organs of the plant. Based on the fact that the calcium helps in the overall improvement of cellular membrane, therefore the plant is expected to produce larger flower diameters. Nitrogen is also a constituent of protein, nucleic acids and nucleotides that are essential to the metabolic function of the plants (Khalaj and Edrisi (2012). So, plants receiving proper dosage of nitrogen have more utilization of nutrients, water and light which in turn induces better quality flower production. Similar types of observations have also been reported lilium (Pahare and Mishra, 2020). Neima *et al.* (2020) also reported that NPK (1.5 g/L and 1 g/L) fertigation increased the flower yield and quality significantly in rose.

Table 3: **Effect of nitrogen fertigation through calcium nitrate and NPK (19:19:19) sprays on flower quality characteristics of lilium**

Treatment		Number of flower buds $plant^{-1}$			Flower bud length (cm)			Flower diameter (cm)			Spike length (cm)		
		Pavia	Arcachon	Mean	Pavia	Arcachon	Mean	Pavia	Arcachon	Mean	Pavia	Arcachon	Mean
T_1	N (0 gm^{-2})	4.25	4.53	4.39	8.51	8.52	8.52	16.84	17.92	17.38	79.33	80.67	80.00
T_2	N (10 gm^{-2})	4.41	4.85	4.63	8.57	8.90	8.74	17.07	19.33	18.20	79.76	81.47	80.62
T_3	N (20 gm^{-2})	4.50	5.02	4.76	8.64	9.02	8.83	18.05	19.67	18.86	81.26	81.73	81.50
T_4	N (30 gm^{-2})	4.97	5.71	5.34	8.61	9.92	9.26	18.24	20.45	19.35	81.91	82.50	82.21
T_5	N (0 gm^{-2}) + NPK 1g L^{-1}	5.29	5.73	5.51	8.85	9.86	9.35	18.02	20.85	19.43	82.56	82.67	82.62
T_6	N (10 gm^{-2}) + NPK 1g L^{-1}	5.98	6.83	6.41	9.42	10.47	9.95	18.56	21.94	20.25	83.34	84.56	83.95
T_7	N (20 gm^{-2}) + NPK 1g L^{-1}	5.69	6.58	6.14	9.28	10.49	9.88	18.47	21.45	19.96	83.80	85.26	84.53
T_8	N (30 gm^{-2}) + NPK 1g L^{-1}	4.49	7.22	5.86	9.07	10.42	9.74	18.06	21.15	19.60	83.06	83.48	83.27
Mean		4.94	5.80		8.87	9.70		17.91	20.35		81.76	82.79	
CD (P≤ 0.05)		Treatment (T) : 0.33			Treatment (T) : 0.26			Treatment (T) : 0.35			Treatment (T) : 1.02		
		Cultivar (C) : 0.16			Cultivar (C) : 0.13			Cultivar (C) : 0.51			Cultivar (C) : 0.51		
		T x C : 0.47			T x C : 0.36			T x C : 0.88			T x C :1.45		

N = Nitrogen in the form of calcium nitrate; NPK (19:19:19) as foliar spray (grams per litre water); T= Treatment; C = cultivar (Pavia and Arcachon)

The cultivars differ significantly in terms of flower bud length and diameter and number of flower buds $stem^{-1}$. Arcachon was found to perform better in terms of number of flower buds $stem^{-1}$, flower bud length and diameter in comparison to Pavia. The genetic make-up of the cultivars results in the variation among the flowers and the results are in accordance with the findings of Vikas (2009), Pandey *et al*. (2010) and Rajivkumar *et al.* (2010).

CONCLUSION

Application of Nitrogen (10g m^{-2}) in the form of calcium nitrate through fertigation along with NPK (19:19:19) as foliar spray (1g L^{-1}) is optimum for improving growth and quality flower production of lilium.

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