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EFFECT OF N, P AND K ON GROWTH, BULB YIELD AND NUTRIENT CONTENT IN RATOON SPIDER LILY (*Hymenocallis littoralis* L.) CV. LOCAL

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ABSTRACT: A multifactor experiment on ratoon spider lily cv. Local was conducted at Instructional Farm of Horticulture Department, Junagadh Agricultural University during 2011-2012. All the growth parameters were significantly influenced due to different levels of nitrogen. Application of nitrogen @ 400Kg N ha^{-1} with three equal split doses recorded significantly the highest plant height, number of leaves per plant, leaf area, leaf length, diameter and weight of single bulb, number of bulbs per plant, bulb yield ha^{-1}, N content in leaves and bulbs. Phosphorus also played a significant role in improving growth parameters at higher level except, number of leaves per plant, bulb yield, P content in leaves and bulb. Potassium doses were significantly increased the P content in leaves and bulb. The optimum vegetative growth and bulb yield were obtained with combined application of 400Kg N ha^{-1} and 200 Kg P_2O_5 ha^{-1}.

Keywords : *Spider lily, ratoon, vegetative growth, bulb, NPK, nutrient uptake.*

Spider lily (*Hymenocallis littoralis* L.) is an important bulbous flowering ornamental plant, native to South America, belongs to the family Amaryllidaceae. The spider lily is perennial bulbous flower crop and gives economic production up to 7-10 years. The flowers of spider lily are largely used in garland and making *Gajras, mandap* and various flower decorations. Spider lily is now emerging as an important commercial flower crop in Gujarat and Maharashtra. The total area under lily cultivation in Gujarat is about 3209 hectare with production of 127779 bundles during 2010-11. Saurashtra have 79ha area under cultivation of spider lily with production of 400 lakh bundles (Anon, 1). The application of nitrogen enhanced most of growth, flowering and yield of flowers and bulb in spider lily (Ghule *et al.,* 9; Koladiya and Dhaduk, 14). Improper nutrition produces nutrient imbalance in plants which is major obstacle for flower yield of many flowering plants. The nutrient supply should be adjusted to the specific requirements of plant during various stages of growth to achieve the maximum production (Mengel, 16). Nutrient status of the plants can be a pointer to the response of plant to the fertilization and internal content of the nutrients determines the fertilizer requirements. The balanced application of macronutrients plays an important role on growth, flowering, corm and cormel production in gladiolus (Bhattacharjee, 3; Borrelli, 4; Deswal *et al.,* 6; Shah *et al.,* 22; Sindhu and Arora, 23). A very little research work has been done for standardization of agro-techniques like planting, manuring, irrigation, spacing, nutrition, harvesting and post-harvest handling etc. for spider lily. The optimum supply of plant nutrients is an important factor in vegetative growth and bulb production of ratoon crop of spider lily. Therefore, present study was made to standardize NPK doses for ratoon crop of spider lily.

MATERIALS AND METHODS

The experiment was laid out in FRBD with three replications and twenty four treatment combinations which were carried out at Horticulture Instructional Farm, College of Agriculture, Junagadh Agriculture University, Junagadh during the year 2011-12. The experimental site was situated between 21°50' N latitude and 70°50' E longitude at an altitude of 60 m above mean sea level. The soil of experimental plot was clayey in texture, calcareous in nature and slightly alkaline in reaction. The soil was moderate in organic carbon, low in available N and P_2O_5 and medium in available K_2O.The treatments consisted of four levels of nitrogen (0, 200, 300 and 400 kg ha^{-1}), three levels of phosphorus (0, 100 and 200 kg ha^{-1}) and two levels of potash (0 and 100 kg ha^{-1}). Nitrogen in the form of Urea was applied with three equal doses (as basal,and two months and three months after cutting) and full quantity of phosphorus as Single Super Phosphate and potash in form of Muriate of Potash as basal application. FYM 10 ha^{-1} was applied uniformly before first irrigation. The recommended cultural practices were carried out during this investigation. The leaves and bulb were washed firstly in running tap water then with 0.1 N HCl and finally in distilled water. After drying,

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the plant material was ground to fine powder. Nitrogen content was determined by the macro-Kjeldahl method (Jackson, 10). The known quantity of powdered sample was digested in di-acid mixture (nitric acid + perchloric acid) as per method described by Johnson and Ulrich (12) and Phosphorus was determined by Vanadomolybdo phosphate yellow colour method (Jackson, 10). Potash was extracted by normal neutral ammonium acetate (1:40) and then determined by Flame Photometer Method (Jackson, 10). The nutrient uptakes were calculated by following formulae. Data were analyzed statistically as per method given by Panse and Sukhatme (17). Nutrient uptake was estimated as per following formula.

Nutrient uptake (kg ha^{-1}) = [Nutrient content (%) x Dry weight (kg ha^{-1})]/100

RESULTS AND DISCUSSION

Effect of Nitrogen

Table 1 reveals that leaf length, leaf area, plant height and number of leaves/plant were enhanced as the nitrogen dose was increased. Application of 400 kg N ha^{-1} (N_3) resulted in significantly the highest leaf length (95.82 cm), while the lowest leaf length (85.22 cm) was recorded at control (N_0) being at par with N_1. Similarly, N_3 level registered significantly the highest leaf area (383.19 cm^2) and the lowest leaf area (324.63 cm^2) was noted with N_0 which remained at par with 200 kg ha^{-1} (N_1). The significantly maximum plant height (99.91cm) was recorded with application of 400kg N ha^{-1} (N_3) at last picking which was at par with N_2. Significantly minimum plant height (89.81cm) was obtained at zero kg N ha^{-1} (N_0) which was at par with N_1. The number of leaves per plant were significantly increased with increasing nitrogen doses where addition of 400kg N ha^{-1} produced distinctly the highest number of leaves per plant (103.98). The minimum number of leaves per plant (85.38) at last picking were registered at zero kg N ha^{-1} being at par with N_1 (200kg N ha^{-1}) level of nitrogen. These results are in conformity with the findings of Koladiya and Dhaduk (14) and Ghule *et al.* (9) in spider lily, Polara *et al.* (20), Rathore and Singh (21) and Patel *et al.* (18) in tuberose, and Kumar *et al.* (15) and Patel *et al.* (19) in gladiolus.

The increased level of nitrogen also enhanced the number of bulbs per plant, diameter of bulbs and average weight of single bulb which might be due to higher nitrogen supply to roots to stimulate the production and export of cytokinins to the shoots. The

Table 1: Effect of NPK on vegetative growth and bulb attributes of ratoon spider lily.

Treatments	Plant height (cm)	Leaf length (cm)	Leaf area (cm^2)	No. of leaves per plant	No. of bulbs per plant	Diameter of bulb (cm)	Weight of single bulb (g)	Bulb yield (t ha^{-1})
N Kg ha^{-1}								
N_0-0	89.81	85.22	324.63	85.38	7.17	4.27	96.25	29.25
N_1-200	93.39	88.47	338.92	88.66	8.33	4.68	107.03	34.39
N_2-300	96.02	91.15	350.38	96.41	9.50	5.07	111.09	38.77
N_3-400	99.91	95.82	383.19	103.98	10.11	5.66	118.32	43.16
C.D. (P=0.05)	5.11	3.71	16.91	6.39	0.75	0.364	10.65	2.72
P_2O_5 Kg ha^{-1}								
P_0-0	90.91	87.98	325.85	90.15	8.23	4.56	97.01	33.92
P_1-100	95.87	90.28	354.71	93.64	8.97	4.96	110.12	37.24
P_2-200	97.58	92.22	367.11	96.89	9.12	5.24	117.42	38.02
C.D. (P=0.05)	4.42	3.21	14.63	NS	0.65	0.315	9.23	2.35
K_2O Kg ha^{-1}								
K_0-0	94.41	90.00	358.41	92.61	8.74	4.85	107.17	35.84
K_1-100	95.16	90.33	375.82	94.50	8.81	4.99	109.18	36.95
C. D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	8.02	6.12	8.58	10.17	12.79	10.88	14.66	11.14
Interaction								
N × P	NS	NS	Sig.	NS	NS	NS	Sig.	Sig.
N × K	NS	NS	NS	NS	NS	NS	NS	NS
P × K	NS	NS	NS	NS	NS	NS	NS	NS
N × P × K	NS	NS	NS	NS	NS	NS	NS	NS

perusal of data in Table 1 showed that bulb diameter was increased with increasing levels of nitrogen and it was significantly maximum (5.66 cm) with application of nitrogen at 400kg N ha^{-1} (N_3) which was followed by N_2 and N_1. The shortest diameter (4.27cm) was registered under zero kg N ha^{-1} (N_0). Similarly, higher dose of nitrogen (400kg N ha^{-1})significantly improved weight of a bulb (118.32g) but it was at par with N_1 (300kg N ha^{-1}). The lowest average weight of single bulb (96.25g) was recorded at zero kg N ha^{-1} (N_0). The bulb yield per hectare was significantly increased with addition of nitrogen from 0 to 400 kg ha^{-1}. Nitrogen @ 400kg ha^{-1} (N_3) recorded significantly maximum bulb yield (43.16 t ha^{-1}) as compared to 300kg N ha^{-1} and 200kg N ha^{-1}. The lowest bulb yield of 29.25 t ha^{-1} was recorded with N_0. This might be due to better availability of nutrients to plant that ultimately leads to quite better vegetative growth of plant which results more accumulation of food in bulbs. The results are closely agreed with the reports of Dahiya *et al.* (5) and Rathore and Singh (21) in tuberose, and Patel *et al.* (19) in gladiolus. Similarly, Devi and Singh (7) also reported that the increased levels of nitrogen produced maximum diameter bulbs.

Addition of nitrogen @ 400kg ha^{-1} resulted in significantly highest nitrogen content (1.95%) in leaves but it was at par with 300kg N ha^{-1} (N_2). The lowest nitrogen content (1.69%) in leaves was registered with zero kg N ha^{-1} (N_0) which was at par with N_1. The nitrogen content of bulb increased significantly at harvest and that too increasing magnitude as nitrogen application rates increased from N_0 to N_3. The highest nitrogen content (1.46 per cent) in bulb was observed with addition of 400 kg N ha^{-1} (N_3) which was at par with 300 kg N ha^{-1} (N_2), while the lowest nitrogen content (1.21 per cent) of bulb was noted under N_0 (Table 2). These results are in the accordance with findings of Jana *et al.* (11) in tuberose. Bankar and Mukhopadhyay (2) also reported increased nitrogen content in leaf of tuberose with higher doses of nitrogen.

Effect of Phosphorus

The data summarized in Table 1 showed that phosphorus levels had significantly increased the plant height at flowering. The application of phosphorus @ 200kg P_2O_5 ha^{-1} (P_2) resulted in significantly the highest plant height (97.58cm) being at par with P_1 (100kg ha^{-1}). Whereas, the lowest plant height (90.91cm) was measured at zero level of phosphorus. Plant height was also significantly increased with various phosphorus levels at last picking. Results are in accordance with Ghule *et al.* (9) in spider lily and Bankar and Mukhopadhyay (2) in tuberose. The leaf length was significantly maximum (92.22 cm) with higher level of phosphorus (200 kg P_2O_5 ha^{-1}) but it was at par with 100kg P_2O_5 ha^{-1}. The minimum length of leaf was recorded at zero kg P_2O_5 ha^{-1} (P_0) confirming to reports of Patel *et al.* (19). Similarly, application of phosphorus at 200 kg P_2O_5 ha^{-1} (P_2) resulted in maximum leaf area (367.11 cm^2) which was at par with P_1 level of phosphorus, which supports to the findings of Gangwar *et al.* (8). The lowest leaf area (325.85 cm2) was found with P_0 (control).

The phosphorus fertilization @ 200kg P_2O_5 ha^{-1} (P_2) resulted significantly the highest number of bulbs per plant (9.12) being at par with P_1. Significantly lowest number of bulbs/plant (8.23) were noted with zero kg P_2O_5 ha^{-1} (P_0). The application of phosphorus @ 200kg P_2O_5 ha^{-1} (P_2) produced significantly the largest sizes bulbs having 5.24 cm diameter and 117.42g weight, but it maximum diameter (5.24cm) and weight (117.42 g) being at par with P_1 level of phosphorus. The lowest diameter (4.56cm) and weight of single bulb (97.01g) were noted under P_0. The highest level of phosphorus *i.e.,* 200 kg P_2O_5 ha^{-1} resulted in significantly maximum bulb yield (38.02 t ha^{-1}) being at par with 100kg P_2O_5 ha^{-1} (P_1). The minimum yield of bulbs (33.92 t/ha) was observed under treatment of zero kg P_2O_5 ha^{-1} (P_0). The results are in accordance with Gangwar *et al.* (8).

Phosphorus is essential for plant growth by affecting cell division, root growth and lengthening. It is an important constituent of ADP, ATP, nucleoproteins, purines, pyrimidine and co-enzymes etc. It is also one of structural component of cell membrane, chloroplast and mitochondria which resulted significantly the largest plant height, length and width of leaf, chlorophyll content at full bloom stage, leaf area, fresh and dry weight of bulbs.

Nitrogen and phosphorus content of leaves was significantly affected due to various phosphorus levels. It was observed that nitrogen and phosphorus content of leaves was increased with increasing phosphorus levels. Addition of phosphorus @ 200kg ha^{-1} resulted in significantly the highest nitrogen and phosphorus content (1.92 and 0.474 per cent, respectively) and it

Table 2: Effect of NPK on nutrient content in leaves and bulbs of ratoon spider lily.

Treatments	Content in leaves (%)			Content in bulb (%)		
	Nitrogen	Phosphorus	Potash	Nitrogen	Phosphorus	Potash
Nitrogen (Kg ha^{-1})						
N_0-0	1.691	0.426	1.46	1.21	0.286	7.28
N_1-200	1.778	0.432	1.48	1.37	0.316	7.09
N_2-300	1.888	0.439	1.51	1.38	0.320	6.96
N_3-400	1.955	0.465	1.52	1.46	0.326	6.71
C. D. P=0.05)	0.12	NS	NS	0.098	NS	NS
Phosphorus (Kg ha^{-1})						
P_0-0	1.75	0.399	1.49	1.28	0.283	6.79
P_1-100	1.80	0.449	1.52	1.35	0.315	6.93
P_2-200	1.92	0.474	1.53	1.44	0.339	7.34
C. D. (P=0.05)	0.11	0.026	NS	0.085	0.028	0.42
Potash (Kg ha^{-1})						
K_0-0	1.86	0.436	1.40	1.32	0.308	6.58
K_1-100	1.79	0.445	1.59	1.39	0.316	7.44
C. D. (P=0.05)	NS	NS	0.072	NS	NS	0.34
C. V. %	11.39	10.01	10.13	10.79	15.53	10.34
Interaction						
N × P	NS	NS	NS	Sig.	NS	NS
N × K	NS	NS	NS	NS	NS	NS
P × K	NS	NS	NS	NS	NS	Sig.
N × P × K	NS	NS	NS	NS	NS	NS

was found at par with 100kg P_2O_5 ha^{-1} (P_1) in case of phosphorus content in leaves.Whereas, the lowest nitrogen and phosphorus (1.75 and 0.399 per cent) content of leaves was analyzed under P_0 level and it was at par with P_1 in case of nitrogen content of leaves. The nitrogen, phosphorus and potassium content of bulbs were significantly affected due to various phosphorus levels and it was increased with increasing phosphorus levels as compared with P_0 and P_1 level.

The significantly highest N, P and K contents of bulbs (1.44, 0.339 and 7.34 per cent, respectively) were found with 200kg P_2O_5 ha^{-1} (P_2) level of phosphorus and it was at par with P_1 level with respect to phosphorus and potassium content of bulb. While, the lowest N, P and K content of bulbs (1.28, 0.283 and 6.79 per cent, respectively) were noted with zero kg P_2O_5 ha^{-1} (P_0) and found at par with P_1 in case of nitrogen content. These findings are closely agreement with Polara *et al.* (20) in tuberose.

Effect of Potash

The vegetative growth and bulb yield parameters as well as N and P content were remained non significant with increased dose of potash. The percent potassium content in leaves (1.59 per cent) and bulb (7.44 per cent) were significantly increased with increasing dose of potash. These results are in line with findings of Karetha (13) in gaillardia.

Interaction effect of N × P

The data presented in Table 3 showed that significantly the maximum leaf area of 408.75 cm^2 was found at combination N_3P_1 (400kg N ha^{-1} + 100kg P_2O_5 ha^{-1}) and it was at par with N3P2 (400kg N ha-1 + 200kg P_2O_5 ha^{-1}). The significantly lowest leaf area was (307.93 cm^2) was recorded with N_0P_0 combination which was at par with combinations N_1P_0, N_2P_0, N_3P_0 and N_0P_1. Interactions between nutrients occur when the supply of one nutrient affects the absorption, distribution or functions of another nutrient. Thus, depending upon nutrients supply, interactions between nutrients can either induce deficiencies or toxicities and can modify the growth response. The appraisal data shown in Table 3 revealed that combined application of $N_2 \times P_2$ produced the heaviest bulb (123.58g) which was at par with N_3P_1, N_3P_2, N_3P_0, N_1P_1 and N_0P_2. Significantly the lowest weight of single bulb (84.03g) was registered with control which remained at par with N_1P_0, N_2P_0 and N_0P_1. Significantly the highest bulb yield (45.84 t ha^{-1}) was observed in N_3P_2 combination

Table 3: Interaction effects of nitrogen and phosphorus (N x P) on leaf area and weight of bulbs of ratoon spider lily.

Nitrogen (Kg ha^{-1})	Phosphorus (Kg ha^{-1})					
	Leaf Area (cm^2)			Leaf Area (cm^2)		
	P_0 - 0	P_1 - 100	P_2 - 200	P_0 - 0	P_1 - 100	P_2 - 200
N_0-0	307.93	316.75	349.22	84.03	97.61	107.16
N_1-200	322.93	340.25	353.60	86.17	118.33	116.57
N_2-300	336.45	353.82	360.91	94.75	114.96	123.58
N_3-400	336.10	408.75	404.73	109.46	123.15	122.35
C.D. (P=0.05)	29.28			18.45		

Table 4: Interaction effects of nitrogen and phosphorus (N x P) on bulb yield and nitrogen content in bulbs in ratoon spider lily.

Nitrogen (Kg ha^{-1})	Phosphorus (Kg ha^{-1})					
	Bulb Yield (t/ha)			Nitrogen Content in Bulb (%)		
	P_0 - 0	P_1 - 100	P_2 - 200	P_0 - 0	P_1 - 100	P_2 - 200
N_0-0	27.01	28.31	32.44	1.11	1.21	1.31
N_1-200	29.53	40.12	33.52	1.39	1.45	1.28
N_2-300	37.83	38.22	40.28	1.35	1.32	1.47
N_3-400	41.31	42.33	45.84	1.27	1.42	1.71
C.D. (P=0.05)	4.71			0.17		

which was at par with treatment combination of N_3P_1 and N_3P_0 (Table 4). The treatment combination of N_0P_0 (control) recorded the lowest bulb yield (27.01 t ha^{-1}) which was at par with treatment combination N_0P_1 and N_1P_0 (Table 4).

It is apparent from Table 4 that the application of nitrogen at 400 kg in combination with 200kg P_2O_5 ha^{-1} (N_3P_2) recorded significantly highest nitrogen content (1.71 per cent) in bulb which was followed by N_2P_2 and N_2P_1. Significantly the lowest nitrogen content (1.11 per cent) was observed in treatment combination N_0P_0 which was at par with by N_0P_1 and N_1P_2.

Table 5: Interaction effects of nitrogen and phosphorus (N x P) on bulb yield and nitrogen content in bulbs in ratoon spider lily.

Phosphorus (Kg ha^{-1})	Potash (Kg ha^{-1})	
	K_0-0	K_1-100
P_0-0	6.33	7.25
P_1-100	6.81	6.99
P_2-200	6.58	8.09
C.D. (P=0.05)	0.59	

Interaction effect of P × K

A perusal of Table 5 revealed that the interaction between levels of phosphorus and potash (P × K) was found significant on potash content in bulb after harvest. The treatment combination of P_2K_1 registered the significantly highest potassium content (8.09 per cent) in bulb followed by P_0K_1. Significantly the lowest potassium content (6.33 per cent) was noted in control (P_0K_0) which was at par with treatment combination P_1K_0 and P_2K_0.

It may be concluded that the higher doses of nitrogen and phosphorus and their interactions increased plant growth, bulb production, and N and P contents in leaves and bulbs of ratoon spider lily cv. Local. The higher levels of nitrogen and phosphorus are beneficial to increase economical age of ratoon spider lily.

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