Plant Archives Vol. 14 No. 1, 2014 pp. 197-204 ***ISSN 0972-5210***

UPTAKE OF NITROGEN AND PHOSPHORUS AS INFLUENCED BY GRADED LEVELS OF NITROGEN AND PHOSPHORUS ON GLADIOLUS (*GLADIOLUS GRANDIFLORUS* L.) CV. WHITE PROSPERITY IN COASTAL A.P., INDIA

K. Chandana and A. V. D. Dorajeerao

Department of Floriculture & Landscaping, Horticultural College and Research Institute, Venkataramannagudem (via Tadepalligudem) – 534 101, West Godavari Dt. (Andhra Pradesh), India.

Abstract

A study was undertaken to find out the uptake of nitrogen and phosphorus versus the application of graded doses to gladiolus cv. White prosperity at Horticultural College and Research Institute, Venkataramannagudem (A.P.), India in the year 2012-13. The spike yield was maximum with nitrogen dose of 300 kg ha^{-1}, phosphorus dose of 200 ha^{-1} both individually and in combination. The total weight of corm per plant was maximum with the treatment combination of nitrogen at 400 kg ha^{-1} plus phosphorus at 200 kg ha^{-1}. The highest dry weight of whole plant was registered with the application of nitrogen at 400 kg ha^{-1} plus phosphorus at 250 kg ha^{-1} and the same treatments resulted in the highest dry weight of spike. However, the increase over 300 kg ha of nitrogen and 200 kg ha of phosphorus was not statistically significant. The uptake of nitrogen and phosphorus was recorded highest with a dose of nitrogen at 300 kg ha^{-1} plus phosphorus at 200 kg ha^{-1}.

Key words : Gladiolus, nitrogen, phosphorus, uptake.

Introduction

Gladiolus belongs to the family Iridaceae. The crop is a native to South Africa and was introduced into India during early part of 19th century (Apte, 1959). Gladiolus being highly responsive crop to nutrition, requires large doses of macro nutrients *viz*., nitrogen, phosphorus and potassium (Shankar and Dubey, 2005).

Materials and Methods

The soils of Venkataramannagudem area are red loams, which are graded as high in nitrogen (186 kg ha^{-1}), high in phosphorus (32.5 kg ha^{-1}) and medium to high in potassium (215 kg ha^{-1}). The area receives an average of 900 mm rain fall, a major proportion of which is received during June to October *i.e*., by S-W monsoon. The experiment on the effect of graded levels of nitrogen and phosphorus on growth, yield and quality of gladiolus was conducted at Horticultural College and Research Institute, Venkataramannagudem (A.P.), India, with an objective of finding out the best combination of nitrogen and phosphorus dose that would result in superior performance in respect of growth, yield and quality of gladiolus flowers. The experiment was conducted with four levels of nitrogen (100, 200, 300 and 400 kg ha^{-1}) and four levels of phosphorus in terms of P_2O_5 (100, 150, 200 and 250 kg ha^{-1}) making sixteen treatment combinations in Factorial Randomised Block Design with three replications. The net plot size was 2.7 m × 1.8 m with a spacing of 30 cm × 20 cm.

Results and Discussion

Leaf area (cm^2)

There were significant differences in leaf area due to the graded levels of nitrogen and phosphorus and their interaction at different stages of crop growth (table 1). The mean leaf area increased from 185.85 cm^2 at 30 DAP to 915.14 cm^2 90 DAP. At 90 DAP maximum leaf area was obtained by N_3 (993.66 cm^2) followed by N_2 (933.61 cm^2), P_3 (960.90 cm^2) followed by P_4 (921.90 cm^2) and N_3P_3 (1120.90 cm^2) followed by N_3P_4 (993.20 cm^2). The corresponding minimum values were recorded by N_1 (804.83 cm^2), P_1 (884.10 cm^2) and N_1P_1 (780.6 cm^2) followed by N_1P_2 (796.70 cm^2).

A comparative examination of leaf area and number of leaves per plant indicated that more the number of leaves per plant more was the leaf area both being lesser at lower nutrient doses as compared to higher nutrient doses. The number of leaves per plant and leaf area was constantly increasing in the plants receiving N_3P_3. As compared to higher levels of nitrogen and phosphorus significant increase in both these parameters was found to record only up to this level clearly establishing the optimum degree of these levels under local agro-climatic conditions. Similar findings were reported by Shaukat *et al*. (2012), Kumar and Misra (2011), Patel *et al*. (2010), Mahgoub *et al*. (2006), Hattibura and Misra (1999), Parthiban and Khadar (1991) in gladiolus.

Dry weight of leaves (g) at 30, 60 and 90 DAP

Dry weight of leaf differed significantly due to nitrogen, phosphorus as well as their interaction at all growth stages except at 30 DAP (table 2). The mean dry weight of leaves increased from 5.70 g at 30 DAP to 15.60 g at 90 DAP. At 60 DAP the highest dry weight of leaves was obtained with N_4 (16.53 g), which was on par with N_3 (15.83 g), but significantly different from N_2 (12.92 g). The dry weights of leaves at 90 DAP was maximum in N_4 (19.60 g), which was on par with N_3 (18.26 g) and among phosphorus levels highest dry weight of leaves was obtained in P_3 (17.88 g), which was on par with P_4 (17.74 g). The combination of N_3P_3 registered the highest leaf dry weight (22.43 g), which was on par with N_4P_3 (22.08 g) and N_3P_4 (21.19 g). The lowest dry weight of leaves was recorded by N_1 (9.40 g), P_1 (12.98 g) and N_1P_1 (8.0 g).

Dry weight of stem at 90 DAP

The data on dry weight of stem at 90 DAP as influenced by various levels of nitrogen and phosphorus are presented in table 3. The highest dry weight of stem was registered in N_4 (4.97 g), P_4 (4.50 g) and N_4P_3 (5.46 g) whereas, the lowest dry weight was recorded by N_1 (2.62 g), P_1 (3.54 g) and N_1P_1 (2.33 g).

Dry weight of florets at 90 DAP

The dry weights of flower significantly differed due to various levels of nitrogen and phosphorus and their interaction (table 3). The maximum dry weight of the flower (0.07 g) was recorded in N_3 among nitrogen levels which was on par with N_4 (0.06 g) and P_3 (0.065 g) among phosphorus levels. With respect to interactions, N_3P_3 recorded the height dry weight of the flower (0.078 g).

Dry weight of whole plant and spike at final harvest

The data on total dry weight of whole plant as influenced by various levels of nitrogen and phosphorus are presented in table 4. The highest dry weight of whole plant was registered in N_4 (24.48 g), P_4 (23.38 g) and N_4P_3 (27.89 g) whereas, the lowest dry weight was recorded by N_1 (12.45 g), P_1 (16.60 g) and N_1P_1 (10.87 g). N_4 was on par with N_3 (24.32 g) and P_4 was on par with P_3 (23.10 g).

The highest dry weight of spike was registered in N_4 (5.04 g), P_4 (4.57 g) and N_4P_3 (5.52 g) whereas, the lowest dry weight was recorded by N_1 (2.67 g), P_1 (3.60 g) and N_1P_1 (2.38 g). N_4 was on par with N_3 (4.59 g) and P_4 was on par with P_3 (4.42 g).

The results obtained on total dry weight and spike dry weight recorded at periodic intervals made it clear that the plants receiving higher levels of nutrients could produce more dry weights as compared to those supplied with lower doses. In most of the parameters, the highest values were recorded by N_3P_3 levels as compared to other lower and higher levels. While the lower levels were failing to fulfill the plants requirements, higher levels could have led to non-synchronous growth functions and ultimately reducing the systems efficiency beyond N_3P_3.

These findings are in confirmation with the results of Vijayakumar *et al*. (1988), Sharma *et al*. (2003), Mahgoub *et al*. (2006), Yousif and Mahmoud (2006) in gladiolus, Dorajee rao (2010) in chrysanthemum and Patel *et al*. (2010) in gladiolus.

Spike yield per plot

The highest spike yield per plot (56.34) was recorded by N_4, which was on par with N_3 (54.27) (table 5). Among the phosphorus levels P_3 recorded the highest spike yield (52.92) followed by P_4 (48.78). Among the interactions N_3P_3 registered the highest spike yield per plot (66.60), which was on par with N_4P_3 (62.64) followed by N_4P_4 (57.60). The least spike yield per plot was recorded in N_1 (38.52), P_1 (44.46) and among interactions N_1P_1 registered the least spike yield per plot (36.72).

The spike yield per plot was found to increase with every increase in the nitrogen level up to N_4 level. Supply of phosphorus could bring about an improvement in these parameters up to P_3 level only. Interaction effect was found to be highest at the combination of N_3 and P_3. It can also be pointed out here that the increase in these parameters after N_3 level was not statistically significant. Therefore, it can be summarized that better spike yield per plant and per plot was recorded by the treatments N_3 and P_3 individually and in combination. Insignificant increase at higher doses of nitrogen and decrease at higher doses of phosphorus is indicative of negative interaction among themselves and with other nutrients, which might have led to overall inefficiency of the plant-soil-environment system beyond the combination of N_3P_3 under the local conditions of Venkataramannagudem. This

Table 1: Leaf area (cm^2) as influenced by nitrogen, phosphorus and their interactions in gladiolus cv. White prosperity

Treatment	30 DAP					60 DAP					90DAP				
	P_1	P_2	P_3	P_4	mean	P_1	P_2	P_3	P_4	mean	P_1	P_2	P_3	P_4	mean
N_1	161.20	172.90	177.80	179.00	172.70	540.10	590.00	619.20	635.20	596.10	780.60	796.70	806.34	835.60	804.83
N_2	179.80	185.00	194.90	196.10	188.90	678.40	698.80	780.10	745.60	725.70	915.30	932.60	956.40	930.00	933.61
N_3	180.90	193.10	201.20	197.20	193.10	695.30	775.60	894.50	814.30	794.90	914.10	946.20	1120.90	993.20	993.66
N_4	183.80	180.80	194.90	184.20	185.90	712.90	643.10	781.10	736.10	718.30	926.20	898.90	959.90	928.70	928.49
Mean	176.40	182.90	192.20	189.10	185.15	656.70	676.90	768.70	732.80	708.70	884.10	893.60	960.90	921.90	915.14
	SEm±			**CD at 5%**		**SEm±**			**CD at 5%**		**SEm±**			**CD at 5%**	
N	1.19			3.44		2.01			5.82		5.94			17.18	
P	1.19			3.44		2.01			5.82		5.94			17.18	
N × P	2.38			6.88		4.03			11.65		11.88			34.37	

Table 2: Dry weight (g) of leaves as influenced by nitrogen, phosphorus and their interactions in gladiolus cv. White prosperity

Treatment	30 DAP					60 DAP					90 DAP				
	P_1	P_2	P_3	P_4	mean	P_1	P_2	P_3	P_4	mean	P_1	P_2	P_3	P_4	mean
N_1	2.62	2.86	3.05	3.28	2.95	6.92	7.43	8.93	10.07	8.338	8.00	8.520	9.97	11.12	9.40
N_2	3.52	4.50	5.08	7.60	5.17	10.76	11.37	13.47	16.08	12.92	12.03	13.08	17.06	18.52	15.17
N_3	5.10	5.62	9.30	8.54	7.14	11.71	12.63	19.70	19.31	15.83	13.92	15.50	22.43	21.19	18.26
N_4	6.40	6.82	9.03	8.02	7.56	14.62	15.13	18.46	17.92	16.53	17.97	18.20	22.08	20.15	19.60
Mean	4.41	4.95	6.61	6.86	5.70	11.00	11.64	15.14	15.84	13.40	12.98	13.82	17.88	17.74	15.60
	SEm±			**CD at 5%**		**SEm±**			**CD at 5%**		**Sm±**			**CD at 5%**	
N	0.14			0.42		0.28			0.81		0.22			0.64	
P	0.14			0.42		0.28			0.81		0.22			0.64	
N × P	0.29			0.84		0.56			1.62		0.44			1.29	

Table 3 : Dry weight (g) of stem and flower at 90 DAP as influenced by nitrogen, phosphorus and their interactions in gladiolus cv. White prosperity

Treatment	Dry weights of stem (g)					Dry weights of flower (g)				
	P_1	P_2	P_3	P_4	mean	P_1	P_2	P_3	P_4	mean
N_1	2.33	2.45	2.72	2.98	2.62	0.04	0.05	0.05	0.05	0.05
N_2	3.26	3.86	4.42	4.78	4.08	0.05	0.05	0.06	0.05	0.05
N_3	4.05	4.20	4.84	5.03	4.53	0.06	0.06	0.08	0.07	0.07
N_4	4.53	4.67	5.46	5.24	4.97	0.06	0.07	0.06	0.06	0.06
Mean	3.54	3.79	4.36	4.50	4.05	0.05	0.06	0.06	0.06	0.06
	SEm±			CD at 5%		SEm±			CD at 5%	
N	0.11			0.33		0.0004			0.001	
P	0.11			0.33		0.0004			0.001	
N × P	0.22			N.S.		0.0008			0.002	

Table 4 : Total dry weight of plant and spike at final harvest as influenced by nitrogen, phosphorus and their interactions in gladiolus cv. White prosperity.

Treatment	Total dry weight of plant (g)					Dry weight of spike at final harvest (g)				
	P_1	P_2	P_3	P_4	mean	P_1	P_2	P_3	P_4	mean
N_1	10.87	11.56	13.00	14.39	12.45	2.38	2.50	2.77	3.03	2.67
N_2	14.90	18.22	22.60	25.24	20.24	3.31	3.91	4.48	4.83	4.13
N_3	17.90	23.05	28.93	27.4	24.32	4.11	4.26	4.91	5.10	4.59
N_4	22.76	20.80	27.89	26.48	24.48	4.59	4.74	5.52	5.30	5.04
Mean	16.60	18.40	23.10	23.38	20.37	3.60	3.85	4.42	4.57	4.10
	SEm±			CD at 5%		SEm±			CD at 5%	
N	0.16			0.46		0.11			0.33	
P	0.16			0.46		0.11			0.33	
N × P	0.32			0.92		0.22			N.S.	

Table 5: Spike yield and corm yield as influenced by nitrogen, phosphorus and their interactions in gladiolus cv. White prosperity

Treatment	Spike yield per plot					Number of corms produced per plot				
	P_1	P_2	P_3	P_4	mean	P_1	P_2	P_3	P_4	mean
N_1	36.72	38.16	38.88	40.32	38.52	36.00	36.00	39.60	36.00	36.90
N_2	42.12	43.20	43.56	45.36	43.56	43.20	39.60	36.00	39.96	39.69
N_3	48.24	50.40	66.60	51.84	54.27	36.00	43.20	55.08	46.80	45.27
N_4	50.76	54.36	62.64	57.60	56.34	36.00	44.28	48.24	42.84	42.84
Mean	44.46	46.53	52.92	48.78	48.17	37.80	40.77	44.73	41.40	41.17
	SEm±			CD at 5%		SEm±			CD at 5%	
N	1.32			3.82		1.27			3.68	
P	1.32			3.82		1.27			3.68	
N × P	2.64			7.65		2.54			7.36	

combination could have encouraged the plant to put up more dry matter by increased photosynthetic surface or leaf area leading to better outturn of photosynthates which might have stimulated more floral buds and leading to a better number of spikes per plant and per plot. Not only more number of floral buds were stimulated but also the expansion of spikes and their axes was found to be more at the said combination of nitrogen and phosphorus, as conformed by the results on spike length and rachis length. Similar results were reported by Khan *et al.* (2012), Shaukat *et al.* (2012) and Dalvi *et al.* (2008) in gladiolus.

Corm yield per plot

The data pertaining to the number of corms produced per plot was significantly influenced by different levels of nitrogen, phosphorus and their interactions (table 5). The maximum number of corms per plot (45.27) among nitrogen doses was registered in N_3 which was on par with N_4 (42.84) and among phosphorus levels highest number of corms per plot (44.73) was recorded in P_3

Table 6: Nitrogen content in leaf, stem and flower as influenced by nitrogen, phosphorus in gladiolus cv. White prosperity

Treatment	Leaf (%)					Stem (%)					Flower (%)				
	P_1	P_2	P_3	P_4	Mean	P_1	P_2	P_3	P_4	Mean	P_1	P_2	P_3	P_4	Mean
N_1	1.98	2.02	2.09	2.18	2.06	1.14	1.19	1.21	1.24	1.19	0.43	0.50	0.54	0.62	0.52
N_2	2.22	2.30	2.64	2.53	2.42	1.25	1.28	1.42	1.36	1.32	0.65	0.73	0.85	0.83	0.76
N_3	2.48	2.75	3.56	2.94	2.93	1.53	1.64	2.10	1.92	1.79	0.83	0.94	1.19	1.02	0.99
N_4	2.80	3.14	3.32	2.83	3.02	1.71	1.84	1.91	1.83	1.82	0.99	1.05	1.09	0.98	1.02
Mean	2.37	2.55	2.90	2.62	2.61	1.40	1.48	1.66	1.58	1.53	0.72	0.80	0.91	0.86	0.82
		SEm±			**CD at 5%**		**SEm±**			**CD at 5%**		**SEm±**			**CD at 5%**
N		0.03			0.09		0.02			0.08		0.007			0.02
P		0.03			0.09		0.02			0.08		0.007			0.02
N × P		0.06			0.19		0.05			0.16		0.014			0.04

Table 7: Phosphorus content in leaf, stem and flower as influenced by nitrogen, phosphorus in gladiolus cv. White prosperity

Treatment	Leaf (%)					Stem (%)					Flower (%)				
	P_1	P_2	P_3	P_4	Mean	P_1	P_2	P_3	P_4	Mean	P_1	P_2	P_3	P_4	Mean
N_1	0.12	0.14	0.14	0.18	0.14	0.08	0.10	0.11	0.13	0.10	0.07	0.08	0.09	0.10	0.08
N_2	0.22	0.25	0.30	0.28	0.26	0.15	0.18	0.22	0.21	0.19	0.11	0.12	0.16	0.14	0.13
N_3	0.26	0.32	0.45	0.40	0.35	0.19	0.24	0.31	0.27	0.25	0.12	0.18	0.28	0.21	0.19
N_4	0.35	0.34	0.41	0.37	0.36	0.25	0.26	0.28	0.23	0.25	0.20	0.21	0.24	0.19	0.21
Mean	0.23	0.26	0.32	0.30	0.28	0.16	0.19	0.23	0.21	0.20	0.12	0.14	0.19	0.16	0.15
		SEm±			**CD at 5%**		**SEm±**			**CD at 5%**		**SEm±**			**CD at 5%**
N		0.006			0.01		0.005			0.01		0.004			0.01
P		0.006			0.01		0.005			0.01		0.004			0.01
N × P		0.012			0.02		0.01			0.02		0.008			0.02

Table 8 : Nitrogen, phosphorus uptake (kg ha^{-1}) in whole plant as influenced by nitrogen, phosphorus in gladiolus cv. White prosperity.

Treatment	Nitrogen uptake in whole plant (kg ha^{-1})					Phosphorus uptake in whole plant (kg ha^{-1})				
	P_1	P_2	P_3	P_4	mean	P_1	P_2	P_3	P_4	mean
N_1	48.14	53.60	62.40	72.66	59.20	3.66	4.52	5.52	7.37	5.26
N_2	76.73	98.16	138.70	148.91	115.62	8.94	12.52	19.21	19.87	15.13
N_3	108.29	153.57	247.71	201.61	177.79	12.75	21.32	37.60	30.17	25.46
N_4	156.47	156.78	220.33	186.68	180.06	22.76	21.06	32.42	26.14	25.59
Mean	97.40	115.52	167.28	152.46	133.16	12.02	14.85	23.68	20.88	17.86
	SEm±		CD at 5%			SEm±			CD at 5%	
N	1.88		5.43			0.17			0.50	
P	1.88		5.43			0.17			0.50	
N × P	3.76		10.88			0.34			1.00	

Table 9 : Nitrogen, phosphorus content (kg ha^{-1}) in soil after harvest as influenced by nitrogen, phosphorus and their interactions in gladiolus cv. White prosperity.

Treatment	Nitrogen content (kg ha^{-1})					Phosphorus content (kg ha^{-1})				
	P_1	P_2	P_3	P_4	Mean	P_1	P_2	P_3	P_4	Mean
N_1	121.86	127.40	131.60	139.34	130.05	33.84	44.9	31.98	49.44	40.04
N_2	143.27	150.84	157.30	162.09	153.37	30.13	48.33	37.63	50.08	41.54
N_3	164.71	171.4	169.29	184.38	172.45	46.74	32.98	46.36	45.08	42.79
N_4	208.53	217.22	224.67	242.32	223.18	48.56	38.29	53.75	44.98	46.39
Mean	159.59	166.72	170.71	182.03	169.76	39.81	41.12	42.43	47.39	42.69
	SEm±		CD at 5%			SEm±			CD at 5%	
N	5.28		15.26			3.00			N.S.	
P	5.28		15.26			3.00			N.S.	
N × P	10.70		30.52			6.00			N.S.	

which was on par with P_4 (41.40). With respect to interactions, the treatment combination of N_3P_3 recorded the highest number of corms per plot (55.08), which was on par with N_4P_3 (48.24) and N_3P_4 (46.8). The least number of corms per plot (36.90) was recorded in N_1, P_1 (37.80) and N_1P_1 (36.00).

The number of corms produced per plot increased as the dose of nitrogen and phosphorus increased up to 300 kg ha^{-1} (N_3) and 200 kg ha^{-1} (P_3), respectively. After this level there was still some marginal increment in the corm yield, but was not significant. This might be due to the fact that there was increase in the supply of photosynthates into corms as the external supply of nutrients was increased up to a threshold level N_3P_3. An increase beyond N_3 and P_3 could not produce significant improvement which might be due to their toxic effect at higher dosages or negative interactions with other nutrients suppressing their availability and consequently reducing the partitioning of assimilates into the corms and cormels. These results are in conformity with the findings of Khan *et al*. (2012), Shaukat *et al*. (2012), Patel *et al*. (2010), Zubair *et al*. (2006) and Ramesh and Raman (2006) in gladiolus.

Nitrogen content (kg ha^{-1})

The differences existed among the treatments with regard to nitrogen content in leaf, stem and flower at harvest were found to be significant (table 6).

The highest nitrogen content in leaf (3.02%) was recorded by N_4 among nitrogen levels, which was on par with N_3 (2.93%) and among phosphorus levels, P_3 recorded the maximum nitrogen content (2.90%), which is followed by P_4 (2.62%). Among interactions, N_3P_3 recorded the maximum nitrogen content in leaves (3.56%) which was on par with N_4P_3 (3.32%). The minimum nitrogen contents were recorded in N_1 (2.06%), P_1 (2.37%) and N_1P_1 (1.98%).

The maximum nitrogen content in stem (1.82%) among nitrogen levels was registered in N_4, which was on par with N_3 (1.79%). Among phosphorus levels P_3 (1.66%) recorded highest nitrogen content which was on par with P_4 (1.58%). Among interactions N_3P_3 (2.10%) registered the highest nitrogen content followed by N_3P_4 (1.92%). The minimum nitrogen content was recorded by N_1 (1.19%), P_1 (1.40%) and N_1P_1 (1.14%).

The highest nitrogen content of 1.02% was observed in flower at N_4 level, which was on par with N_3 (0.99%). Phosphorus application at P_3 level was found to contain maximum content of phosphorus in flower (0.91%). With regard to interaction effects, combination of N_3P_3 (1.19%) was found to have maximum phosphorus content in flowers followed by N_4P_3 (1.09%). The minimum phosphorus contents were recorded in N_1 (0.52%), P_1 (0.72%) and N_1P_1 (0.43%).

Phosphorus content (kg ha^{-1})

Significant differences existed among the treatments with regard to phosphorus content in leaf, stem and flower at harvest (table 7).

The highest phosphorus content in leaf (0.36%) was recorded in N_4 which was on par with N_3 (0.35%) and among phosphorus levels, P_3 recorded the maximum phosphorus content (0.32%) which was on par with P_4 (0.30%). Among interactions, N_3P_3 recorded the maximum phosphorus content in leaves (0.45%) which was on par with N_4P_3 (0.41%) followed by N_3P_4 (0.40%). The minimum phosphorus content was recorded in N_1 (0.14%), P_1 (0.23%) and N_1P_1 (0.12%).

The maximum phosphorus content in stem (0.25%) was registered with the application of nitrogen level of N_4 which was on par with N_3 (0.25%). Among phosphorus levels P_3 recorded highest phosphorus content (0.23%), which was on par with P_4 (0.21%). Among interactions N_3P_3 registered the highest phosphorus content (0.31%) which was on par with N_4P_3 (0.28%). The minimum phosphorus content was recorded by N_1 (0.10%), P_1 (0.16%) and N_1P_1 (0.08%).

The highest phosphorus content of 0.21% was observed in flower at N_4 level which was on par with N_3 (0.19%). Phosphorus application at P_3 level was found to contain maximum content of phosphorus in flower (0.19%) followed by P_4 (0.16%). With regard to interaction effects, combination of N_3P_3 (0.28%) was found to have maximum phosphorus content in flowers. The minimum phosphorus contents were recorded in N_1 (0.08%), P_1 (0.12%) and N_1P_1 (0.07%).

Nitrogen uptake (kg ha^{-1})

The results pertaining to the uptake of nitrogen and phosphorus are presented in table 8. The highest nitrogen uptake in whole plant (180.06 kg ha^{-1}) was recorded in N_4 which was on par with N_3 (177.79 kg ha^{-1}) and among phosphorus levels, P_3 recorded the maximum nitrogen uptake (167.28 kg ha^{-1}) which was on par with P_4 (152.46 kg ha^{-1}). Among interactions, N_3P_3 recorded the maximum nitrogen uptake in whole plant (247.71 kg ha^{-1}), which was on par with N_4P_3 (220.33 kg ha^{-1}) followed by N_3P_4 (201.61 kg ha^{-1}). The minimum nitrogen uptake was recorded in N_1 (59.20 kg ha^{-1}), P_1 (97.40 kg ha^{-1}) and N_1P_1 (48.14 kg ha^{-1}).

Phosphorus uptake (kg ha^{-1})

The maximum phosphorus uptake in whole plant (25.59 kg ha^{-1}) was registered with the application of nitrogen level of N_4 which was on par with N_3 (25.46 kg ha^{-1}). Among phosphorus levels P_3 recorded highest phosphorus content (23.68 kg ha^{-1}), which was on par with P_4 (20.88 kg ha^{-1}). Among interactions N_3P_3 registered the highest phosphorus content (37.60 kg ha^{-1}), which was on par with N_4P_3 (32.42 kg ha^{-1}). The minimum phosphorus content was recorded by N_1 (5.26 kg ha^{-1}), P_1 (12.02 kg ha^{-1}) and N_1P_1 (3.66 kg ha^{-1}).

The data on total content of nitrogen and phosphorus revealed that there was a higher nitrogen and phosphorus contents at the highest and next to highest levels of application. The difference between these two was found non-significant. It is also evident from the data on nitrogen and phosphorus content in individual parts that partitioning to flower was more at last two levels on higher side of these nutrients indicating that the ultimate development of the plants vegetative and reproductive parameters would be better at these levels since their efficiency is more in terms of pushing more assimilates into flower. These results are in line with the findings of Kumar and Misra (2011), Mahgoub *et al*. (2006) and Singh *et al*. (2010).

Nitrogen content in soil after harvest (kg ha^{-1})

Nitrogen content increased significantly with increase in nitrogen dose, maximum content was recorded by N_4 (223.18 kg ha^{-1}) followed by N_3 (172.45 kg ha^{-1}) (table 9). It also varied due to phosphorus doses, but not significantly, maximum being recorded by P_4 (182.03 kg ha^{-1}) followed by P_3 (170.71 kg ha^{-1}). Among the interactions, the combination of N_4P_4 recorded the maximum nitrogen content (242.32 kg ha^{-1}) significantly superior to all combinations.

Phosphorus content in soil after harvest (kg ha^{-1})

The phosphorus content in the soil after the experimentation did not show significant variations among the different treatments (table 9). Phosphorus content increased numerically with increase in nitrogen dose, maximum content (46.39 kg ha^{-1}) being recorded by N_4 followed by N_3 (42.79 kg ha^{-1}). The variations due to phosphorus doses were also non-significant, maximum numerical value being recorded by P_4 (47.39 kg ha^{-1}) followed by P_3 (42.43 kg ha^{-1}) during both seasons. Among the interactions, the combination of N_4P_3 recorded the maximum phosphorus content (53.75 kg ha^{-1}).

References

Apte, S. S. (1959). Kieming van gladiolekran l (Sprouting of gladiolus corms1). *Meded Dir. Tuimb*, **21** : 749-753.

Dalvi, N. V., A. D. Rangwala and G. D. Joshi (2008). Effect of spacing and graded levels of fertilizers on yield attributes of gladiolus. *Journal of Maharashtra Agricultural University*, **33(2)** : 167-170.

Devi, K. L. and U. C. Singh (2010). Effect of nitrogen on growth, flowering and yield of tuberose (*Polianthes tuberose* L.) cv. Single. *Journal of Ornamental Horticulture*, **13(3)** : 228-232.

Dorajee Rao, A. V. D. (2010). Standardisation of production technology in garland chrysanthemum (*Chrysanthemum coronarium* L.). *Ph.D. Thesis*, University of Agricultural Sciences, Dharwad.

Haitbura, P. and R. L. Misra (1999). Effect of nitrogen sources on vegetative and floral characters of gladiolus cv. Dhanvantari. *Journal of Ornamental Horticulture*. New series **2** : 111-4.

Javid, Q. A., N. A. Abbasi, I. A. Hafiz and A. L. Mughal (2005). Performance of zinnia (*Zinnia elegans*) "Dahlia Flowered" Crimson Shade by Application of NPK fertilizer. *International Journal of Agricultural Biology*, **7(3)** : 474-476.

Khan, F. N., M. M. Rahman, A. J. M. S. Karim and K. M. Hossain (2012). Effects of nitrogen and potassium on growth and yield of gladiolus corms. *Bangladesh Journal of Agricultural Research*, **37(4)** : 607-616.

Kumar, R. and R. L. Misra (2011). Studies on nitrogen application in combination with phosphorus or potassium on gladiolus cv. Jester Gold. *Journal of Ornamental Horticulture*, **68(4)** : 535-539.

Mahgoub, H. M., A. E. Rawia and Bedour, H. Abou Leila (2006). Response of iris bulbs grown in sandy soil to nitrogen and potassium fertilization. *Journal of Applied Sciences Research*, **2(11)** : 899-903.

Parthiban, S. and M. A. Khader (1991). Effect of N, P and K on yield components and yield in tuberose. *South Indian Horticulture*, **39(6)** : 363-367.

Patel, N. M., J. R. Desai, S. N. Saravaiya, N. B. Patel, K. A. Patel and R. B. Patel (2010). Influence of chemical fertilizer on growth, quality, corm and cormel production of gladiolus (*Gladiolus grandiflorus* L.) cv. Sancerree under South Gujarat conditions. *The Asian Journal of Horticulture*, **5(1)** : 123-126.

Ramesh, B. and Raman Deep Singh (2006). Response of nitrogen, phosphorus and corm size on flowering and corm production in gladiolus. *Journal of Ornamental Horticulture*, **9(1)** : 66-68.

Shankar, D. and P. Dubey (2005). Effect of NPK, FYM and NPK+FYM on growth and flowering and corm yield of gladiolus when propagated through cormels. *Journal of Soils and Crops*, **15(1)** : 34-38.

Sharma, J. R., R. B. Gupta, R. D. Panwar and R. A. Kaushik (2003). Growth and flowering of gladiolus as affected by N and P levels. *Journal of Ornamental Horticulture*, **6(1)** : 76-77.

Shaukat, S. A., S. Z. A. Shah, Y. Ishaq, M. Ahmed, S. K. Shaukat and S. W. Shoukat (2012). Influence of phosphorus fertilization on gladiolus corm and flower production. *Scientific Journal of Agricultural*, **1(5)** : 105-111.

Singh, J., J. P. Singh and Asha Yadav (2010). Effect of nitrogen and potassium di-hydrogen phosphate on the nutritional and metabolital status of plant and production of corms in gladiolus. *Annals of Horticulture*, **3(1)** : 47-57.

Vijayakumar, K. T., A. A. Patil and N. C. Hulmani (1988). Effect of plant density of nitrogen on growth characters and flower yield of china aster (*Callistephus chinensis* Nees.) cv. Ostrich Plume Mixed. *South Indian Horticulture*, **36(6)** : 318-320.

Yousif, S. and S. Al-Safar Mahmoud (2006). Effect of GA_3 treatment and nitrogen on growth and development of gladiolus corms. *Pakistan Journal of Biological Sciences*, **9(13)** : 2516-2519.

Zubair, M. and F. K. Gohar AyubWazir (2007). Effect of phosphorus levels on yield and quality of corms and cormels of gladiolus cultivars. *Sarhad Journal of Agriculture*, **22(4)** : 623-632.