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Response of Sancerre gladiolus to different levels of nitrogen and phosphorus application under south Gujarat condition

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ABSTRACT

An experiment was conducted in the field to study the response of *gladiolus* 'Sancerre' to different levels of nitrogen and phosphorus application with respect to growth and yield parameters at Floriculture Research Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari for three years (2014-15, 2015-16 and 2016-17). The experiment was laid out in Factorial Randomized Block Design (RBD) which included nine treatment combinations consisting of two factors, *viz.*, three levels of nitrogen (200, 250 and 300 kg/ha) and three levels of phosphorus (50, 100 and 150 kg/ha). All treatments were replicated thrice and data were analyzed for each year as well pooled. Gladiolus plants fertilized with 250 kg N/ha recorded significant improvement in number of tillers/ corm, plant height, number of leaves/ plant, number of florets/spike, spike length, floret diameter, vase-life, number of spikes per pant and per hector, size of corm, number of corms per plant and per hector. Among all the different levels of phosphorus, treatment receiving 150 kg P_2O_5/ha was found superior for almost all the growth, quality and yield parameters. The results revealed that all the growth parameters, quality characters and yield parameters were remained unaffected due to interaction of nitrogen and phosphorus levels.

Keywords: *Gladiolus grandiflorus*, fertilizers, flowering, yield parameters, corms.

INTRODUCTION

The demand for cut flowers is increasing due to a change in lifestyle and consumer preference besides increasing demand. Gladiolus, an ornamental bulbous plant is popular for its spike having row of florets in beautiful colours with long lasting quality. Also known as "Queen of the bulbous flowers", its name originated from Latin word '*Gladius*' meaning 'sword' due to its foliage resembling sword and so called as 'Sword lily'. It belongs to family Iridiaceae, order Liliaceae and class Monocotyledoneae. Gladiolus is very popular cut flower and commercially grown worldwide. It gained popularity among gardeners and growers on account of its easy cultivation during winter season. Wide adaptability to diverse soil and climatic conditions, habit of profuse flowering to produce marketable flowers, wide spectrum of attractive colours, shape and good keeping quality are the reasons for its popularity. In India, it is one of the most commonly grown cut flowers in open field for commercial purpose. There is great scope for increasing cultivation of gladiolus in Gujarat, as the soil and climatic conditions of these regions are favorable.

Nutrients play a vital role in metabolic activities of plants. Nitrogen is responsible for synthesis of protein, amino acids, nucleic acids, chlorophyll and protoplasm of cell which help in harvesting solar energy through chlorophyll compounds. Phosphorus has a great role in energy storage and transfer. It serves as a structural component of cell constitutes like chloroplast and mitochondria, also a part of sugar phosphates (ATP & ADP), which plays an inevitable role in photosynthesis and respiration, consequently leading to increase vegetative growth and flower production of plants. In this crop, little research has been done on the standardization of nitrogen and phosphorus in gladiolus particular south Gujarat agro-climatic conditions. Commercial cultivation of this crop is popular in India and hence, it is important to standardize the nutrient requirement to fetch higher yields and marketable quality of cut flowers and therefore, the experiment was designed to achieve the objective.

MATERIALS AND METHODS

The experiment was designed to find out the effect of different levels of nitrogen and phosphorus on *gladiolus* 'Sancerre' with respect to growth and yield parameters at Floriculture Research Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari for three years during 2014-15, 2015-16 and 2016-17. The experimental plot was uniform and had good drainage capacity. The soil was deep, moderately drained clayey soils classified as deep black soils predominant

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montmorillonite clay minerals by its origin. The soil has good water holding capacity reasonably suitable for gladiolus cultivation.

The experiment was laid out in Factorial Randomized Block Design, which included nine treatment combinations consisting of two factors *viz.,* three levels of each nitrogen (150, 200 and 250 kg/ha) and phosphorus (50, 100 and 150 kg/ha). All treatments were replicated thrice. Well decomposed farm yard manure @ 8 t/ha was applied at the time of field preparation while treatmentwise half dose of nitrogen along with full dose of phosphorus as per treatments and common dose of potassium @ 200 kg/ha was applied as basal dose. Remaining half dose of nitrogen was applied at 45 days after planting according to the treatments. Observations on vegetative, flowering and yield parameters were recorded at proper stage and statistically analyzed as per the method given by Panse and Sukhatme (10).

RESULTS AND DISCUSSION

The data pertaining to vegetative growth parameters, *viz.,* number of tillers/ corm, plant height and number of leaves per plant were significantly influenced by different treatments of nitrogen and phosphorus are presented in Table 1 during all individual years and in pooled analysis. Significantly maximum tillers/ corm (1.49, 1.67, 1.64 and 1.60), plant height (83.80, 77.88, 80.61 and 80.76 cm) and number of leaves per plant (6.62, 7.60, 7.56 and 7.26) were recorded with the application of nitrogen @ 250 kg/ ha (N_3) during individual year and in pooled analysis, respectively which was followed by treatment N_2, *i.e.* application of nitrogen @ 200 kg /ha, whereas, minimum values were recorded in N_1 (150 kg N/ha). The increase in vegetative parameters with increasing levels of nitrogen might be due to important role of adequate dose of nitrogen in photosynthesis as well as cell multiplication and cell elongation. Many organic compounds contain nitrogen and sufficient nitrogen is required in each cell for the good growth and development (Gajbhiye *et al.*, 6). These findings are in close agreement with the findings of Sharma and Singh (15), Rajhansa *et al.* (13) and Khan *et al*. (9) in Gladiolus.

Application of phosphorus @ 150 kg/ha (P_3) recorded significantly highest number of tillers/ corm (1.47, 1.62, 1.53 and 1.54), plant height (81.41, 74.34, 78.73 and 78.16 cm) and number of leaves per plant (6.44, 7.16, 7.27 and 6.96) in individual year as well as in pooled analysis, respectively. Number of tillers/ corm and number of leaves per plant were found at par with P_2 *i.e.* 100 kg/ha P_2O_5, whereas all parameters recorded minimum values in application of phosphorus @ 50 kg/ha (P_1). Potassium plays a complex role in photosynthesis, the process by which plant synthesize energy from sunlight, carbon dioxide and water that leads to cell division and tissue formation (Arnon, 1). Thus, sufficient supply of potassium helps to enhance healthy plant growth in terms of vegetative characters. This might have been the reason to increase in plant growth of gladiolus with increased dose of phosphorus. These results are congruent with the findings of Talukdar *et al.* (16) in tuberose, Hossian *et al.* (7) and Khan *et al.* (9) in gladiolus. Moreover, interaction effect of nitrogen and phosphorus was found non-significant for all vegetative parameters during individual years as well as in pooled analysis.

Table 1. Growth parameters of gladiolus as influenced by different levels of nitrogen and phosphorus.

Treatment	No. of tillers/ corm				Plant height (cm)				No. of leaves/plant			
	2014-15	2015-16	2016-17	Pooled	2014-15	2015-16	2016-17	Pooled	2014-15	2015-16	2016-17	Pooled
Factor 1: Nitrogen												
N_1 (150 kg/ha)	1.20	1.16	1.22	1.19	71.95	60.88	69.83	67.55	5.69	5.78	6.29	5.92
N_2 (200 kg/ha)	1.44	1.49	1.47	1.47	78.98	71.52	75.67	75.39	5.96	6.60	7.07	6.54
N_3 (250 kg/ha)	1.49	1.67	1.64	1.60	83.80	77.88	80.61	80.76	6.62	7.60	7.56	7.26
CD @ 5%	0.15	0.27	0.14	0.11	5.40	6.55	6.91	3.41	0.44	0.59	0.26	0.26
Factor 2: Phosphorus												
P_1 (50 kg/ha)	1.22	1.27	1.31	1.27	74.45	65.85	72.73	71.01	5.78	6.18	6.69	6.21
P_2 (100 kg/ha)	1.44	1.42	1.49	1.45	78.88	70.09	74.66	74.54	6.04	6.64	6.96	6.55
P_3 (150 kg/ha)	1.47	1.62	1.53	1.54	81.41	74.34	78.73	78.16	6.44	7.16	7.27	6.96
CD @ 5%	0.15	0.27	0.14	0.11	5.40	6.55	4.05	3.34	0.44	0.59	0.26	0.24
N × P CD @ 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.43
CV %	10.55	18.75	9.79	13.71	6.91	9.35	9.17	8.48	7.18	8.87	3.70	6.84

Data pertaining to flowering and quality parameters of gladiolus were influenced by different treatments of nitrogen and phosphorus (Tables 2 & 3). On the basis of results obtained, different levels of nitrogen and phosphorus showed significant effect on all flowering parameters. In individual years and pooled analysis, significantly maximum number of florets per spike (15.67, 15.29, 15.11 and 15.36, respectively), spike length (89.47, 85.28, 86.80 and 87.19 cm, respectively), floret diameter (11.56, 11.17, 11.17 and 11.30 cm, respectively) and vase life (11.47, 11.40, 11.44 and 11.44 days, respectively) were recorded in N_3 (250 kg N/ha), while minimum results were obtained in plants treated with lowest dose of nitrogen, *i.e.* 150 kg/ha (N_1). It is well established that the nitrogen is one of the major essential elements, which regulates the cell and tissue functions of the plant being essential part of the nucleic acid, mitochondria and cytoplasmic contents of the cells. These results indicate that wherever nitrogen, whether or not in combination with phosphorus and potassium or both, was added into the soil it showed increase in the spike length (Butt, 2). The increase in diameter of floret was noted with

Table 2. Flower quality parameters of gladiolus as influenced by different levels of nitrogen and phosphorus.

Treatment	No. of florets/ spike				Spike length (cm)				Diameter of florets (cm)			
	2014-15	2015-16	2016-17	Pooled	2014-15	2015-16	2016-17	Pooled	2014-15	2015-16	2016-17	Pooled
Factor 1: Nitrogen												
N_1 (150 kg/ha)	12.62	12.16	12.69	12.49	78.89	75.56	77.58	77.35	9.97	9.58	9.81	9.79
N_2 (200 kg/ha)	14.89	14.20	13.96	14.35	84.66	81.59	82.85	83.04	10.64	10.25	10.81	10.57
N_3 (250 kg/ha)	15.67	15.29	15.11	15.36	89.47	85.28	86.80	87.19	11.56	11.17	11.17	11.30
CD @ 5%	1.23	1.11	0.78	0.57	4.43	4.03	5.74	2.53	0.63	0.60	0.60	0.33
Factor 2: Phosphorus												
P_1 (50 kg/ha)	13.53	12.82	13.38	13.24	81.26	78.15	77.34	78.92	10.31	9.86	10.08	10.08
P_2 (100 kg/ha)	14.51	14.11	13.82	14.15	84.87	81.00	83.96	83.27	10.61	10.42	10.72	10.58
P_3 (150 kg/ha)	15.13	14.71	14.56	14.80	86.89	83.30	85.94	85.37	11.25	10.73	10.98	10.99
CD @ 5%	1.23	1.11	0.78	0.57	4.43	4.03	5.74	2.57	0.63	0.60	0.60	0.33
N × P CD at 5 %	NS	NS	1.35	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV %	8.56	8.00	5.59	7.52	5.26	4.99	6.97	5.81	5.92	5.82	5.64	5.79

Table 3. Flowering and yield parameters of gladiolus as influenced by different levels of nitrogen and phosphorus.

Treatment	Vase-life (days)				No. of spikes/plant				Spike yield/ ha (in '000)			
	2014-15	2015-16	2016-17	Pooled	2014-15	2015-16	2016-17	Pooled	2014-15	2015-16	2016-17	Pooled
Factor 1: Nitrogen												
N_1 (150 kg/ha)	10.53	10.33	10.33	10.40	1.09	1.07	1.11	1.09	128.24	126.85	130.56	128.55
N_2 (200 kg/ha)	11.20	11.13	11.16	11.16	1.24	1.56	1.42	1.41	145.37	178.70	167.13	163.73
N_3 (250 kg/ha)	11.47	11.40	11.44	11.44	1.40	1.69	1.60	1.56	165.28	191.20	184.72	180.40
CD @ 5%	0.31	0.43	0.27	0.19	0.16	0.16	0.19	0.21	17.84	14.13	20.09	10.03
Factor 2: Phosphorus												
P_1 (50 kg/ha)	10.84	10.76	10.87	10.82	1.13	1.31	1.24	1.23	131.94	152.31	147.69	143.98
P_2 (100 kg/ha)	11.13	10.96	10.93	11.01	1.24	1.44	1.36	1.35	147.69	167.13	161.11	158.64
P_3 (150 kg/ha)	11.22	11.16	11.13	11.17	1.36	1.56	1.53	1.48	159.26	177.31	173.61	170.06
CD at 5%	0.31	NS	NS	0.19	0.16	0.16	0.19	0.10	17.84	14.13	20.09	10.03
N × P CD @ 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV %	2.80	3.88	2.49	3.11	13.12	10.96	14.11	12.75	12.20	8.54	12.50	11.63

increase in the level of nitrogen, which might be due to the fact that, nitrogen is a constituent of protein, nucleic acid and nucleotides that are essential to the metabolic functions of plants. Similar findings have been cited by Patel *et al*. (11) in gladiolus. Maximum vase-life might be due to the accumulation and delay in degeneration of carbohydrates and proteins in the plants. Increase in vegetative parameters may result into good quality flowers too (Pradhan *et al.*, 12). Similarly, Dalvi *et al.* (4) stated that the higher nitrogen level enhanced vegetative growth and due to that accumulation of food reserves is more, which are diverted for flower bud differentiation and result in more number of florets per spike.

In case of application of phosphorus, P_3 (150 kg/ha) recorded highest number of florets per spike (15.13, 14.71, 14.56 and 14.80), spike length (86.89, 83.30, 85.94 and 85.37 cm), floret diameter (11.25, 10.73, 10.98 and 10.99 cm) and vase life (11.22, 11.16, 11.13 and 11.17 days) in all three years and in pooled analysis, respectively. P_2 (100 kg/ha) was found at par for florets per spike, spike length and vase-life, whereas application of 50 kg/ha phosphorus produced spikes of lower quality with respect to all parameters. This might be due to vital role of phosphorus in adequate amount to improve the crop quality. Parallel findings to this result have been cited in gladiolus by Patel *et al*. (11) and Chandana and Dorajeerao (3) in cv. 'White Prosperity'. Interaction effect of nitrogen and phosphorus was found non-significant in case of individual year and in pooled analysis, except number of florets per spike in year 2016-17. The effect of added nutrients on the length of spike could be attributed to the better mobilization of applied nutrients during the advanced growth stage of plants. Pradhan *et al.* (12) reported that the application of higher doses of nitrogen, phosphorus and potassium increased the spike length due to the higher levels resulting in production of more number of leaves in plants which produced more photosynthates.

Application of nitrogen @ 250 kg/ha recorded maximum production of spikes/ plant (1.40, 1.69, 1.60 and 1.56) and spikes/ha [165.28, 191.20, 184.72 and 180.40 (in '000)] for each year and in pooled analysis, respectively (Table 3). However, spikes per plant were found at par with N_2 (200 kg/ha). Significantly lower production was observed in treatment N_1 (150 kg/ha). Increase in number of spikes might be due to the adequate supply of nitrogen to the plants resulting in the proper development of required photosynthetic system, which helped to increase the production of spikes. These results were in agreement with Rajhansa *et al.* (13) in gladiolus and Yadav (17) in tuberose. Similarly, significantly maximum spikes/ plant (1.36, 1.56, 1.53 and 1.48) and spikes per hectare [159.26, 177.31, 173.61 and 170.06 (in '000)] was recorded during individual years as well as in pooled analysis, respectively in the phosphorus application @ 150 kg/ha (P_3) treatment, whereas minimum spike production was recorded with application of phosphorus @ 50 kg/ha. This might be due to higher protein synthesis and thus, improved the vegetative growth, dry matter accumulation and partitioning of nutrients towards the developing spikes. These findings are in close conformity with the findings of Deo-Shankar and Dubey (5), Sharma and Singh (15) and Rajhansa *et al.* (13) in gladiolus. Interaction effect of nitrogen and phosphorus was found non-significant in case of yield for individual year and in pooled analysis.

At the end of experiment, significantly maximum corms per plant (1.53, 1.51, 1.51 and 1.52), per hectare [179.17, 178.24, 178.70 and 178.70 (in '000)], size of corm (6.33, 6.61, 6.56 and 6.50 cm), weight of coms/ plant (74.26, 74.93, 75.10 and 74.76 g) and weight of cormels/ plant (7.44, 6.92, 7.36 and 7.24 g) were recorded in N_3 (250 kg N/ha) for individual year as well as in pooled analysis, respectively (Table 4 and Fig. 1). Minimum values were recorded in treatment N_1. Using nitrogen at a suitable level led to improve the vegetative growth of gladiolus plants and consequently the plants could produce a good quality of corms. Nitrogen at higher level enhanced the yield of gladiolus corms as higher rate of nitrogen provides better growth and development that helps in translocation of photosynthates from source to sink (corms and cormels). Similar results were also reported by Jha *et al*. (8) in gladiolus, and Rathore and Singh (14) in tuberose. Similar case was found with phosphorus application where significantly maximum production of corms per plant (1.49, 1.44, 1.47 and 1.47), per hectare (174.07, 172.69, 173.61 and 173.46 (in '000)), size of corms (6.29, 6.17, 6.38 and 6.28 cm), weight of corms/ plant (73.36, 72.03, 73.64 and 73.01 g) and weight of cormels per plant (7.21, 6.40, 6.77 and 6.79 g) was recorded in treatment P_3 (150 hg P_2O_5/ha) in individual years and pooled analysis, respectively. These results may be due to the positive effect of the used factors in the stimulation of the vegetative growth and increase the back translocation and accumulation of organic matter in the new corms and cormels and finally reflexes on the corms and cormels weight. These results are in close conformity with the results of Talukdar *et al.* (16) in tuberose and Chandana and Dorajeerao (3) in gladiolus. Interaction effect of nitrogen and phosphorus in case of corms per plant and per hectare was found significant in pooled analysis only, while it was found non-significant for individual years.

Table 4. Yield of gladiolus corms as influenced by different levels of nitrogen and phosphorus.

Treatment	No. of corms/plant				No. of corms/ha (in 000)				Size of corms (cm)			
	2014-15	2015-16	2016-17	Pooled	2014-15	2015-16	2016-17	Pooled	2014-15	2015-16	2016-17	Pooled
Factor 1: Nitrogen												
N_1 (150 kg/ha)	1.16	1.13	1.18	1.16	137.04	134.72	139.81	137.19	5.39	5.12	5.46	5.32
N_2 (200 kg/ha)	1.36	1.33	1.27	1.32	159.72	157.41	150.93	156.02	6.12	5.85	5.51	5.83
N_3 (250 kg/ha)	1.53	1.51	1.51	1.52	179.17	178.24	178.70	178.70	6.33	6.61	6.56	6.50
CD @ 5%	0.16	0.19	0.21	0.10	19.09	17.79	21.83	10.79	0.44	0.40	0.63	0.29
Factor 2: Phosphorus												
P_1 (50 kg/ha)	1.22	1.18	1.16	1.19	144.44	138.43	137.04	139.97	5.72	5.59	5.45	5.59
P_2 (100 kg/ha)	1.33	1.36	1.33	1.34	157.41	159.26	158.80	158.49	5.84	5.82	5.69	5.78
P_3 (150 kg/ha)	1.49	1.44	1.47	1.47	174.07	172.69	173.61	173.46	6.29	6.17	6.38	6.28
CD at 5%	0.16	0.19	0.21	0.10	19.09	17.79	21.83	10.79	0.44	0.40	0.63	0.28
N × P CD @ 5%	NS	NS	NS	0.17	NS	NS	NS	18.69	0.75	NS	NS	NS
CV %	11.55	14.30	15.86	13.98	12.04	11.36	13.96	12.53	7.32	6.76	10.87	8.50

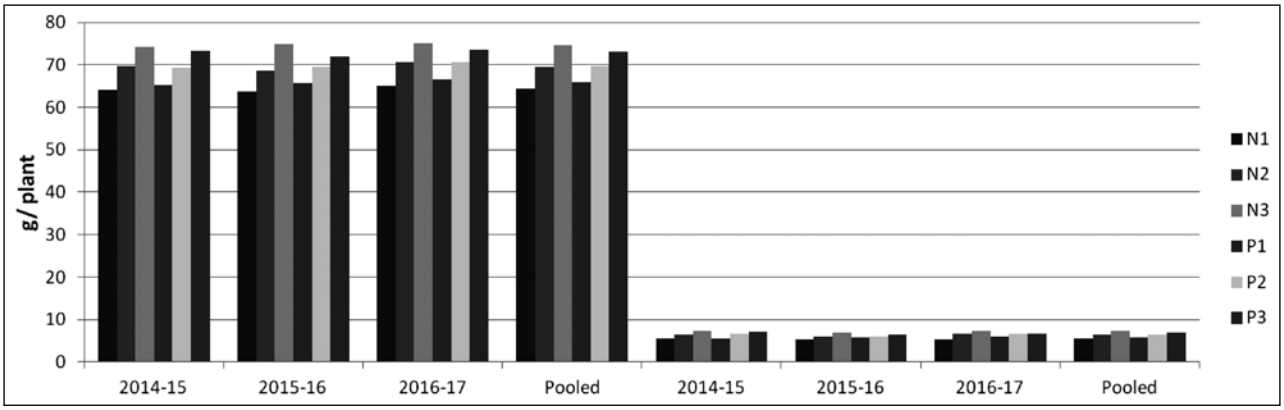

Fig. 1. Weight of corms and cormels of gladiolus as influenced by different levels of nitrogen and phosphorous.

From the study, it can be concluded that the application of nitrogen @ 250 kg/ha and phosphorus @ 150 kg/ha resulted in luxurious vegetative growth, flowering and yield of spikes as well as corms. Nitrogen and phosphorous fertilizers are the most essential plant nutrients for the optimum growth and development of the plant. Gladiolus is a heavy nutrient requiring cut-flower crop. Proper fertilization is needed for optimum growth and development of the plant, flower spike, florets on the spike and the underground corms and cormels, which are the food storage organs of the plant.

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