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Studies on the effect of nitrogen and phosphorus on flowering and spike yield of tuberose (*Polianthes tuberose* L.) cv. Prajwal

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Abstract
The present entitled "effect of nitrogen and phosphorus on flowering and spike yield of tuberose (*Polianthes tuberose* L.)" cv. Prajwal was carried out at Experimental Farm of the Department of Horticulture, CCS Haryana Agricultural University, Hisar during 2016-17 and 2017-18 to found out the optimum dose of nitrogen and phosphorus for flowering and spike yield of tuberose. The nitrogen (0, 10, 15, & 20 g/m^2) and phosphorus levels (0, 5 and 10 g/m^2) were used in randomized block design with three replications. Results found that the maximum days taken to spike initiation, days taken to flowering and duration of flowering, number of spike per clump and spike weight during both the years were observed in treatments where nitrogen at 20 g/m^2 and phosphorus at 10 g/m^2 was applied. Therefore, based on the study for better flowering and spike yield of tuberose plants nitrogen at 20 g/m^2 and phosphorus at 10 g/m^2 should be applied.

Keywords: Tuberose, nitrogen, phosphorus, flowering and spike yield parameters

Introduction

Tuberose (*Polianthes tuberose* L., 2n = 30), is a cross pollinated crop and belongs to Asparagaceae family. It is one of the important bulbous crops and is originated in Mexico. It is believed that tuberose was brought to India in 16th century *via* Europe. Tuberose is an important flower crop in India and abroad both in terms of loose and cut flower. There are about fifteen species under the genus *Polianthes*, of which, twelve species have been reported from Mexico and Central America, of these, nine species have white flowers, one white tinged with red flowers and two with completely red flowers. In Victorian times, it was considered a funeral flower but it is now used traditionally in Hawaii to prepare leis.

Tuberose is commercially grown for various uses such as making artistic garlands, floral ornaments, bouquets, buttonholes, *gajras* and extraction of essential oil, which is used in high value perfumes, cosmetic products and aromatherapy due to its ability to calm the nerves. The long flower spikes as cut flowers emitting a delightful fragrance are excellent for table decoration.

Nitrogen, which is one of the most important constituent of plant proteins, is required in the whole crop growth period, *i.e.*, from vegetative stage to subsequent harvesting (Madan and Munjal, 2009) [5]. The split application of nitrogen is advocated due to the fact that plant requires nitrogen at different stages of its growth and split application of nitrogen tends to meet the physiological and metabolic need of the plants synchronizing the requirements peak periods and able to correct its deficiency.

Phosphorus is a structural component of membrane system of the cell, chloroplast and the mitochondria. It is the constituent of nucleic acids like RNA and DNA, nucleoproteins, amino acids, proteins, phosphorus, phytin, several co-enzymes (NADP), *viz.* thiamine pyrophosphate and pyridoxylphosphite, adenosine diphosphate and adensine triphosphate which are energy compounds. It is also involved in energy transfer, metabolic processes and basic reactions of photosynthesis, transformation of sugars and starch and nutrient movement in plants.

The main functions are cell division, meristimatic growth, root, seed and fruit development as well as in stimulating flowering, ear emergence and maturation of crops (Rai, 2009) [7].

Materials and Methods

The study was conducted at Horticultural Experimental Field of College of Agriculture during 2016-17 and at Botanical Garden, department of plant physiology, CCSHAU, Hisar, Haryana during 2017-18. The experiment was laid out in Randomized Block Design with three replications. Four levels of nitrogen, *i.e*., 0, 10, 15 and 20 g/m^2 and three levels of phosphorus *viz*., 0, 5 and 10 g/m^2 were applied in well ploughed beds of 1.5×1.5 m^2 size with a planting distance 30cm × 30cm. The soil of the experimental field was sandy loam and clayey with slightly high pH of 8.10 and 7.05 and EC of 1.13 and 1.4 dS/m in 2016-2017 and 2017-2018, respectively. The soil was low in nitrogen, high in phosphorus and medium in available potassium (118.15, 23 and 270 kg/ha, respectively) in 2016-2017 while the soil was low in nitrogen, high in phosphorus and medium in available potassium (140.23, 19 and 280 kg/ha, respectively) in 2017-2018. Bulbs were planted at the spacing of 30x30 cm. Observations were recorded on five plants selected at random in each treatment in each replication. The data were recorded on days taken to spike initiation, days to flowering, duration of flowering, number of spikes per clump and spike weight.

Result and Discussion

1. Days taken to spike initiation

The perusal of data on days taken to spike initiation presented in Table 1 reveals that both nitrogen and phosphorus at increased levels resulted in significant increase in days taken to spike initiation in 2016-17 and 2017-18. The nitrogen level@ 20 g/m^2 significantly resulted in delayed spike emergence (103.77 and 114.58 days), while the early spike emergence was recorded where no nitrogen was applied (99.00 and 97.89 days), respectively during both the years of study.

Likewise, the increased level of phosphorus delayed the spike initiation in tuberose. The maximum days (103.73 and 108.67) was taken by the tuberose where the phosphorus was applied @10 g/m^2, whereas, the minimum number of days (100.99 and 102.12) was taken by the tuberose where no phosphorus was applied, respectively during both the years.

The interactions belongings of nitrogen and phosphorus also affect the emergence of spike. The maximum number of days (105.53 and 119.27 days) was taken for the emergence of spike where nitrogen was applied@ 20g/m^2 in combination with phosphorus @ 10 g/m^2, while the minimum number of days (97.53 and 92.80 days) was taken for the emergence of spike where the plants were not fertilized with nitrogen and phosphorus during both the years of study, respectively. The results of present experiment confirms the findings of Dahal *et al.* (2014) [1] and Gangwar *et al.* (2013) [3] who reported that the maximum number of days taken to spike initiation in tuberose might be due to the highest level of nitrogen which increased the vegetative growth thereby delaying the reproductive phase in tuberose.

2. Days taken to flowering

The data presented in Table 2 depicts that the different levels of nitrogen and phosphorus significantly influenced the days taken to flowering during the year 2016-17 and 2017-18.The data reveal that the minimum number of days (113.73 and 110.29) was taken to flowering where no nitrogen was applied, while the significantly maximum number of days was taken to flowering where nitrogen was applied @ 20 g/m^2 (119.80 and 125.04) during both the years, respectively.

The significantly maximum number of days was taken to flowering where the phosphorus was applied @ 10 g/m^2 (118.90 and 120.08), while the minimum number of days was taken to flowering in tuberose where no phosphorus was applied (115.83 and 114.73) during both the years, respectively.

The interaction of nitrogen and phosphorus increased the number of days taken to flowering in tuberose. The maximum number of days (121.33 and 129.40) was taken to flowering under the nitrogen and phosphorus levels applied @ 20 and 10 g/m^2 during both the years. The minimum number of days (113.53 and 104.13) was taken to flowering where no nitrogen and phosphorus was applied during both the years, respectively. This results were close conformity with Rathore *et al.* (2013) who found that duration required for emergence of flower scape significantly influence by nitrogen application. Nitrogen fertilized plants exhibited hastened flowering due to the simulative effect of nitrogen in protein synthesis and carbohydrates assimilation that eventually promoted the development of floral primor dial on the mother bulbs.

Table 1: Effect of nitrogen and phosphorus on days taken to spike initiation in tuberose

Nitroge levels (g/m^2)	Phosphorus levels (g/m^2)							
	2016-17				2017-18			
	P_0: 0	P_1: 5	P_2: 10	Mean	P_0: 0	P_1: 5	P_2: 10	Mean
N_0: 0	97.53	98.93	100.53	99.00	92.80	98.87	102.00	97.89
N_1: 10	101.40	101.47	104.33	102.40	103.33	103.80	104.80	103.98
N_2: 15	102.47	103.47	104.50	103.48	104.87	105.67	108.60	106.38
N_3: 20	102.57	103.20	105.53	103.77	107.47	117.00	119.27	114.58
Mean	100.99	101.77	103.73		102.12	106.33	108.67	

CD at 5%	:	**2016-17**	**2017-18**
Nitrogen	:	0.25	0.66
Phosphorus	:	0.22	0.57
Nitrogen x Phosphorus	:	0.44	1.15

Table 2: Effect of nitrogen and phosphorus on days taken to flowering in tuberose

Nitrogen levels (g/m^2)	Phosphorus levels (g/m^2)							
	2016-17				2017-18			
	P_0: 0	P_1: 5	P_2: 10	Mean	P_0: 0	P_1: 5	P_2: 10	Mean
N_0: 0	113.53	113.60	114.07	113.73	104.13	112.67	114.07	110.29
N_1: 10	114.13	116.40	120.00	116.84	115.87	117.00	117.13	116.67
N_2: 15	117.13	118.60	120.20	118.64	117.33	119.20	119.73	118.76
N_3: 20	118.53	119.53	121.33	119.80	121.60	124.13	129.40	125.04
Mean	115.83	117.03	118.90		114.73	118.25	120.08	

CD at 5%	:	**2016-17**	**2017-18**
Nitrogen	:	1.06	1.14
Phosphorus	:	0.92	0.98
Nitrogen x Phosphorus	:	1.83	1.97

3. Duration of flowering

The data concerning to duration of flowering have been presented in Table 3, which show that different levels of nitrogen and phosphorus significantly affected the duration of flowering in tuberose and their increasing levels significantly increased the flowering duration in tuberose during the year 2016-17 and 2017-18. The notably minimum flowering duration (11.56 and 12.16 days) was observed where no nitrogen was applied, while the maximum duration of flowering (15.70 and 15.69) was recorded where nitrogen was applied @ 20 g/m^{2}during both the years, respectively.

Nitrogen @ 15 and 20g/m^2 were statically similar in respect of flowering duration in tuberose.

The maximum duration of flowering (15.38 and 14.33) was noticed where the phosphorus was applied @ 10 g/m^2, while the minimum flowering duration(13.23 and 13.38)in tuberose was noticed where no phosphorus was applied during both the years, respectively.

The interaction between nitrogen and phosphorus significantly increased the duration of flowering. The maximum flowering duration (16.67 and 16.33 days) was observed under the nitrogen and phosphorus @ 20 and 10 g/m^2 during both the years. The treatment combination where nitrogen and phosphorus applied @ 15 with 10g/m^2 was found at par with nitrogen and phosphorus applied @ 20 and 10 g/m^2, respectively during 2016-17. The minimum duration of flowering (10.54 and 11.47 days) was noticed where no nitrogen and phosphorus was applied during both the years.

The increased duration of flowering due to the application of nitrogen might have resulted because of the increased availability of nitrogen in the root zone, which led to the optimum uptake of water and nutrients from the soil. Further, the increase in duration of flowering was probably due to the development of number of leaves and flowering continued for a longer period, resulting in the extended duration of flowering. The results of present experiment confirm the findings of Dahal *et al.* (2014) [1] and Gangwar *et al.* (2014) [2].

Table 3: Effect of nitrogen and phosphorus on duration of flowering in tuberose

Nitrogen levels (g/m^2)	Phosphorus levels (g/m^2)							
	2016-17				2017-18			
	P_0: 0	P_1: 5	P_2: 10	Mean	P_0: 0	P_1: 5	P_2: 10	Mean
N_0: 0	10.54	11.53	12.60	11.56	11.47	11.60	13.40	12.16
N_1: 10	13.07	13.33	15.67	14.02	13.40	13.40	13.54	13.45
N_2: 15	14.60	15.63	16.60	15.61	13.53	14.53	14.07	14.04
N_3: 20	14.70	15.73	16.67	15.70	15.13	15.60	16.33	15.69
Mean	13.23	14.06	15.38		13.38	13.78	14.33	

CD at 5%	:	**2016-17**	**2017-18**
Nitrogen	:	0.23	0.35
Phosphorus	:	0.20	0.30
Nitrogen x Phosphorus	:	0.39	0.61

4. Number of spikes per clump

The data in Table 4 indicate significant influence of different levels of nitrogen and phosphorus on number of spikes per clump and their increasing levels significantly increased the number of spikes per clump in tuberose during the year 2016-17 and 2017-18. The markedly minimum number of spikes per clump (1.47 and 1.09) was observed where no nitrogen was applied, while the maximum number of spikes per clump (2.02 and 1.88) was found where nitrogen was applied @ 20 g/m^{2}during both the years, respectively.

The significantly maximum number of spikes per clump (1.93 and 1.57) was observed where the phosphorus was applied @ 10 g/m^2, while the minimum number of spikes per clump (1.58 and 1.39) was noted where no phosphorus was applied during both the years, respectively. No significant interaction was observed between nitrogen and phosphorus to affect the number of spikes per clump in tuberose during both the years of study. These results were closely related to Kumar and Singh (1998) [4] who observed that number of spike per clump and weight of inflorescence were increased at higher dose of nitrogen. Sharma *et al.* (2007) [8] who found that number of spikes per plant and per hectare increases at higher dose of nitrogen *i.e.*, 300 kg/ha.

Table 4: Effect of nitrogen and phosphorus on number of spikes per clump in tuberose

Nitrogen levels (g/m^2)	Phosphorus levels (g/m^2)							
	2016-17				2017-18			
	P_0: 0	P_1: 5	P_2: 10	Mean	P_0: 0	P_1: 5	P_2: 10	Mean
N_0: 0	1.33	1.47	1.60	1.47	1.00	1.13	1.13	1.09
N_1: 10	1.47	1.67	1.80	1.64	1.20	1.27	1.53	1.33
N_2: 15	1.67	1.93	2.13	1.91	1.57	1.63	1.67	1.62
N_3: 20	1.87	2.00	2.20	2.02	1.80	1.90	1.93	1.88
Mean	1.58	1.77	1.93		1.39	1.48	1.57	

CD at 5%	:	**2016-17**	**2017-18**
Nitrogen	:	0.15	0.10
Phosphorus	:	0.13	0.08
Nitrogen x Phosphorus	:	NS	NS

5. Spike weight (g)

The data pertaining to spike weight at different levels of nitrogen and phosphorus are presented in Table 5, which clearly indicate that spike weight of tuberose significantly increased with increasing levels of nitrogen (84.86 and 126.15 g), being maximum at nitrogen level 20 g/m^2 and it was noticed minimum where plants were not fertilized with nitrogen (72.88 and 74.03g) during 2016-17 and 2017-18, respectively.

Similarly, increasing dose of phosphorus significantly increased the spike weight. The maximum spike weight (80.01 and 107.07g) was recorded in treatment where phosphorus was applied @10 g/m^2, while the minimum spike weight (77.13 and 94.39g) was observed where the plants were not fertilized with phosphorus during both the years.

Table 5: Effect of nitrogen and phosphorus on spike weight (g) in tuberose

Nitrogen levels (g/m^2)	Phosphorus levels (g/m^2)							
	2016-17				2017-18			
	P_0: 0	P_1: 5	P_2: 10	Mean	P_0: 0	P_1: 5	P_2: 10	Mean
N_0: 0	68.64	74.80	75.18	72.88	69.47	74.18	78.44	74.03
N_1: 10	75.36	75.57	76.20	75.71	87.02	95.44	98.52	93.66
N_2: 15	84.27	79.13	79.31	80.90	99.44	99.64	120.35	106.48
N_3: 20	80.26	84.97	89.34	84.86	121.62	125.87	130.95	126.15
Mean	77.13	78.62	80.01		94.39	98.78	107.07	

CD at 5%	:	**2016-17**	**2017-18**
Nitrogen	:	0.52	1.11
Phosphorus	:	0.45	0.96
Nitrogen x Phosphorus	:	0.89	1.92

The interaction effect between nitrogen and phosphorus significantly increased the spike weight in tuberose. The maximum spike weight (89.34 and 130.95 g) was noted when application of nitrogen @ 20 g/m^2 was applied in combination with phosphorus @ 10 g/m^2, while the minimum spike weight (68.64 and 69.47g) was observed when no nitrogen and phosphorus was applied during both the years, respectively.

The increase in spike weight might be due to the higher length and girth of spike with the application of nitrogen at higher doses in splits at different growth stages in tuberose (Dahal *et al.*, 2014) [1]. Kumar and Singh (1998) [4] who observed that weight of inflorescence were increased at higher dose of nitrogen.

Conclusion

The present investigation indicates that nitrogen and phosphorus affects the growth parameters of tuberose. The study revealed that all the parameters were found best when nitrogen at 20 g/m^2 and phosphorus at 10 g/m^2 were applied.

Therefore, for better growth of tuberose plants nutrients must be applied as nitrogen at 20 g/m^2 and phosphorus at 10 g/m^2.

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