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Effect of Nitrogen and Phosphorus on Flowering, Bulb Yield and Nutrient Contents in Leaves of Tuberose (*Polianthes Tuberose* L.) cv. Prajwal

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Abstract: The present investigation was conducted to find out the optimum dose of nitrogen and phosphorus for flowering and yield of tuberose. Fertilizer requirement of tuberose was studied with 12 treatments comprising four levels of nitrogen (0, 10, 15 and 20 g/m^2) and three levels of phosphorus (0, 5 and 10 g/m^2). This field experiment was carried out as randomized block design in all possible combinations. All flowering, spike and bulb yield and NPK analysis parameters were significantly influenced with every increase in nitrogen and phosphorus dose. Flowering and spike yield in terms of spike length, rachis length, stem diameter, number of florets per spike, number of spike per plot, number of spike per hectare significantly increased with increasing nitrogen level up to 20 g/m^2 with phosphorus up to 10 g/m^2 during both the years of study, respectively. Similar trend was observed in various bulb yield parameters viz. number of bulbs per clump, diameter of bulb, weight of bulb, bulb yield and nutrient content in plant.

Keywords: Tuberose, Nitrogen, Phosphorus, Flowering, Yield and nutrients

Tuberose, which is a half-hardy bulbous summer flowering perennial ornamental plant, is best suited for cultivation in tropical to subtropical and temperate climates. It prefers to grow in an open sunny location since shady or semi-shady conditions drastically reduce the flower yield. A temperature range from 20 to 30°C is considered ideal for the cultivation of this crop (Safeena et al 2015). Flowering takes place profusely throughout the year under mild climatic conditions. The length of the spike and quality of the flowers are severely affected at temperature 40°C or above. Tuberose although not strictly photosensitive but long-day exposure promotes vegetative growth as well as early emergence of the first flower spike and increases the flower spike length. Tuberose can be grown on varieties of soil ranging from sandy loam to a clay loam but it cannot tolerate waterlogging conditions even for a short period (Safeena et al 2015). It can also be successfully grown in saline and alkaline soils. However, the soils having a pH range of 6.5 to 7.5 with good aeration and drainage are ideal for its cultivation. The area under tuberose is about 7.77 thousand hectares with a production of 40.22 thousand tonnes of loose flowers and 13.90 thousand tonnes of cut flowers (NHB 2014). The total area under tuberose in Haryana is 103 hectares with a production of 13850000 cut spikes (Saxena et al 2014). Being constituent of proteins, nucleic acids, chlorophyll, nitrogen is essential nutrient required by the plants for their growth and development. Patel et al (2017) studied that increase in flowers numbers and yield with application of nitrogen might be due significantly increased the growth parameters, which might have synthesized more plant metabolites and ultimately lead to increase in flower production. Similarly, an adequate supply of phosphorus is associated with rapid and vigorous start to plant, helping to initiate bulbs quickly, stimulates flowering of plant. Phosphorus enhances the symbiotic nitrogen fixation in flower crops and ultimately improved the uptake of nutrients. These findings were coincided with the results of Dishaben et al (2017) in bird of paradise. Amin et al (2012) observed that spike length, spike diameter, rachis length and number of flowers per spike were found maximum with the application of phosphorus 155 kg/ha in tuberose. Some aspects of the production technology of tuberose in agro-climatic conditions of Haryana have not been standardized so far. So present investigation was conducted to find out the optimum dose of nitrogen and phosphorus for flowering and yield of tuberose.

MATERIAL AND METHODS

The study effect of nitrogen and phosphorus on flowering and spike yield of tuberose (*Polianthes tuberose* L.) cv. Prajwal was carried out at CCS Haryana Agricultural University, Hisar during 2016-17 and 2017-18 to find out the optimum dose of nitrogen and phosphorus for flowering and yield of tuberose. Twelve treatment combinations comprising four levels of nitrogen (0, 10, 15 and 20 g/m^2) and three levels of phosphorus (0, 5 and 10g/m^2) were tried in randomized block design with three replications. Thus 36 plots were used for 12 treatment combinations. The soil of the experimental field was sandy loam and clayey in texture, pH 8.10, 7.05, E.C. 1.13, 1.40 dSm^{-1}, organic carbon 0.35, 0.37 % and 118.23, 140.23 kg/ha available N, 23.00, 19.00 kg/ha available P_2O_5, 270.00, 280.00 kg/ha available K_2O_5 during both the years of experiment. Experimental field was prepared by repeated ploughing and harrowing well in advance. First year planting was done on 16th March at 2016-17 and in second year the planting was done on 25 February during 2017-18. For the first experiment, the bulbs of 3.5 cm in diameter were planted and for second experiment, the different bulbs size viz. 0.5-1.5, 1.5-2.5 and 2.5-3.5 cm in diameter were planted. Before planting the bulbs, one third dose of nitrogen as per the treatment along with full dose of FYM @ 5 kg/m^2 and phosphorus and potassium each @ 10 g/m^2 was applied and mixed thoroughly into the soil. The remaining two-third dose of nitrogen was applied in two splits first one third at 30 days after planting and second one third at 60 days after planting. Observations were recorded for various flowering, yield, bulb yield and nutrient analysis parameters in Tuberose cv. Prajwal.

RESULTS AND DISCUSSION

Floral and yield parameters: Significant increase in stem diameter, spike length, rachis length, number of florets per spike, number of spikes per plot and number of spikes per hectare with successive increase in nitrogen levels from 0 to 20 g/m^2 was observed (Table 1). Maximum spike length, rachis length, stem diameter, number of florets per spike, number of spike per plot and number of spikes per hectare was recorded when nitrogen was applied @ 20g N/m^2 and minimum spike length, rachis length, stem diameter, number of florets per spike, number of spike per plot and number of spikes per hectare was observed in control during both the years . The increase in flower yield with increasing nitrogen level might be due to the fact that increasing nitrogen level enhanced the chlorophyll formation thereby increased photosynthesis and synthesis of reserve food material, which promoted vegetative growth and increased flower yield (Maske et al 2015). Nitrogen plays an important role for improvement in yield parameters and in efficient metabolic activity which increased the rate of photosynthesis as it generates an important role in synthesis of proteins, amino acid and chlorophyll enhances the flower and bulb yield (Sendhilnathan et al 2019). Dahal et al (2014) also observed maximum spike length, rachis length, spike weight and number of florets were obtained when nitrogen was applied in splits. Similarly, Pal et al (2020) studied that nitrogen applied at 200 kg/ha recorded significantly the higher value of spike yield/ha in tuberose. The response of phosphorus was non-significant on vegetative characters while floral characters viz., rachis length and number of florets per spike were significant. Stem diameter, spike length, rachis length, number of florets per spike, number of spikes per plot and number of spikes per hectare increased significantly with gradual increase in phosphorus level from 0 to 10 g/m^2 as (Table 1). Maximum spike length, rachis length, stem diameter, number of florets per spike, number of spike per plot and number of spikes per hectare was recorded with 10 g $P_2O_5m^{-2}$ while minimum spike length, rachis length, stem diameter, number of florets per spike, number of spike per plot and number of spikes per hectare was in control during both the years, respectively. Similar results were reported in gladiolus by Sabastian et al (2017) and Sendhilnathan et al (2019) in tuberose. The interaction effect between nitrogen and phosphorus levels on Stem diameter, spike length, number of florets per spike was found significant while it was found non-significant for rachis length, number of spikes per plot and number of spikes per hectare. Maximum spike length, rachis length, stem diameter , number of florets per spike, number of spike per plot and number of spikes per hectare was recorded when nitrogen was applied @ 20 g/m^2 in combination with phosphorus @ 10 g/m^2over control.

Bulb yield parameters: Maximum Number of bulbs per clump, diameter of bulb weight of bulb and bulb yield of tuberose was recorded with 20g Nm^{-2} while minimum number of bulbs per clump, diameter of bulb, weight of bulb and bulb yield was in control during both the years of experiment. Increase in number of bulbs per clump and weight and diameter of bulb might be due to more nitrogen supply to the plant to stimulate the production and export of cytokinins to the shoots (Kejkar et al 2015). Rathore et al (2013) also observed the increase in bulb yield might be due to better availability of nutrients to tuberose plants, which resulted in better vegetative growth of plant and more accumulation of food in bulbs. Maximum number of bulbs per clump, diameter of bulb, weight of bulb and bulb yield of tuberose was recorded with 10 g $P_2O_5m^{-2}$ while minimum number of bulbs per clump, diameter of bulb, weight of bulb and bulb yield was in control during both the years. Amin et al (2012) observed in number of side bulbs, bulb diameter and bulb yield increased at higher dose of phosphorus, which might be due to the production of maximum number of side bulbs with larger size in tuberose. The interactional effect between nitrogen and phosphorus levels on bulb yield parameters was found significant. Maximum number of bulbs per clump, diameter of bulb, weight of bulb and bulb yield of tuberose was recorded when nitrogen was applied @ 20g/m^2 in

Table 1. Effect of nitrogen and phosphorus on stem diameter, length of spike, length of Rachis and number of florets per spike in tuberose

Treatment	Stem diameter (cm)		Length of spike (cm)		Number of spikes per plot		Length of Rachis (cm)		No. of florets per spike		Number of spikes per ha	
Effect of Nitrogen Levels												
N (g/m^2)	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
0	0.857	0.649	65.96	78.24	24.67	22.78	26.09	20.50	35.80	32.56	109630	101235
10	0.873	0.692	71.87	81.60	26.11	24.89	27.91	23.29	36.58	35.47	116049	110632
15	0.881	0.765	75.76	85.04	28.44	27.00	28.96	25.53	39.31	37.93	126420	120000
20	0.978	0.800	80.31	91.64	30.33	31.11	30.07	27.71	43.60	39.22	134815	138272
CD (5%)	0.016	0.007	0.42	0.21	0.96	1.24	0.47	0.59	1.02	0.47	4266.92	5662.42
Effect of Phosphorus Levels												
P (g/m^2)												
0	0.884	0.703	72.27	81.45	26.58	24.64	27.82	23.79	37.98	34.98	118148	109511
5	0.892	0.733	73.38	83.97	27.42	26.81	28.23	24.34	38.45	36.40	121852	119137
10	0.916	0.744	74.77	86.98	28.17	27.89	28.72	24.65	40.03	37.50	125185	123956
CD (5%)	0.014	0.006	0.36	0.70	0.31	1.07	0.41	0.51	0.88	0.40	3695.26	4903.80
Interaction effect between different levels of nitrogen and phosphorus												
N× P (g/m^2)												
N_0P_0	0.840	0.632	65.33	76.00	24.33	21.00	25.73	20.47	35.20	31.13	108148	93333
N_0P_1	0.861	0.657	65.73	77.80	24.67	23.00	26.13	20.23	36.00	33.07	109630	102222
N_0P_2	0.869	0.660	66.80	80.93	25.00	24.33	26.40	20.79	36.20	33.47	111111	108148
N_1P_0	0.865	0.673	70.13	79.13	25.00	22.23	27.40	22.40	36.07	34.00	111111	98785
N_1P_1	0.875	0.698	72.20	81.07	26.00	25.56	27.87	23.53	36.73	36.07	115556	113585
N_1P_2	0.877	0.706	73.27	84.60	27.33	26.89	28.47	23.93	36.93	36.33	121481	119526
N_2P_0	0.878	0.727	74.67	80.47	27.67	25.67	28.80	25.20	37.60	37.07	122963	114074
N_2P_1	0.882	0.770	75.40	85.67	28.67	27.00	28.87	25.60	37.67	37.73	127407	120000
N_2P_2	0.884	0.798	77.20	89.00	29.00	28.33	29.20	25.80	42.67	39.00	128889	125926
N_3P_0	0.953	0.778	78.93	90.20	29.33	29.67	29.33	27.07	43.07	37.73	130370	131852
N_3P_1	0.950	0.808	80.20	91.33	30.33	31.67	30.07	28.00	43.40	38.73	134815	140741
N_3P_2	1.032	0.814	81.80	93.40	31.33	32.00	30.80	28.07	44.33	41.20	139259	142222
CD at 5%	0.027	0.012	0.72	1.40	NS	NS	NS	NS	1.76	0.81	NS	NS

Table 2. Effect of nitrogen and phosphorus on number of bulbs per clump, diameter of bulb, weight of bulb, bulb yield, Nitrogen, Phosphorus and potassium content in tuberose

Treatment	Number of bulbs per clump		Diameter of bulb (cm)		Weight of bulb (g)		Bulb yield (t/ha)		Nitrogen content (%)		Phosphorus content (%)		Potassium content (%)	
N (g/m^2)	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
0	14.98	15.78	1.92	2.17	14.98	15.78	24.58	25.69	1.49	1.44	0.68	0.64	0.84	0.86
10	18.07	18.11	2.43	2.24	18.07	18.11	36.88	36.30	1.54	1.51	0.74	0.72	0.86	0.87
15	21.20	21.09	2.64	2.43	21.20	21.09	50.72	48.52	1.58	1.55	0.79	0.75	0.87	0.88
20	24.64	24.47	3.03	2.57	24.64	24.47	66.12	62.68	1.70	1.66	0.88	0.91	0.89	0.90
CD (5%)	0.27	0.57	0.07	0.03	0.39	0.42	1.04	2.39	0.01	0.01	0.01	0.01	0.001	0.005
P (g/m^2)														
0	18.67	18.68	2.28	2.26	18.67	18.68	39.53	38.72	1.55	1.50	0.76	0.72	0.87	0.87
5	19.83	19.77	2.56	2.36	19.83	19.77	43.53	41.72	1.57	1.53	0.77	0.76	0.86	0.88
10	20.67	21.13	2.68	2.42	20.67	21.13	50.67	49.46	1.60	1.59	0.79	0.79	0.87	0.88
CD (5%)	0.23	0.50	0.06	0.02	0.34	0.37	0.90	2.07	0.01	0.01	0.01	0.01	0.004	0.004
N× P (g/m^2)														
N_0P_0	13.13	14.20	1.41	2.07	12.94	13.93	18.88	20.94	1.48	1.41	0.65	0.58	0.85	0.86
N_0P_1	15.60	16.07	2.14	2.20	14.51	14.42	25.14	26.36	1.49	1.44	0.67	0.64	0.84	0.86
N_0P_2	16.20	17.07	2.22	2.24	16.50	15.70	29.71	29.78	1.50	1.46	0.72	0.70	0.84	0.86
N_1P_0	17.40	16.47	2.36	2.21	17.25	15.78	33.33	30.80	1.53	1.49	0.72	0.71	0.87	0.87
N_1P_1	18.33	18.47	2.45	2.22	17.31	17.61	35.27	35.44	1.54	1.51	0.73	0.72	0.86	0.87
N_1P_2	18.47	19.40	2.49	2.29	20.48	19.14	42.04	42.67	1.54	1.53	0.76	0.73	0.87	0.87
N_2P_0	20.53	20.07	2.59	2.31	20.83	20.26	47.51	44.46	1.55	1.53	0.79	0.74	0.87	0.88
N_2P_1	20.73	20.13	2.62	2.46	21.27	20.34	49.01	45.27	1.58	1.56	0.79	0.75	0.87	0.88
N_2P_2	22.33	23.07	2.71	2.52	22.43	20.91	55.65	55.82	1.60	1.57	0.80	0.77	0.88	0.89
N_3P_0	23.60	24.00	2.77	2.55	22.27	21.37	58.38	58.67	1.64	1.57	0.89	0.84	0.88	0.89
N_3P_1	24.67	24.40	3.01	2.56	23.60	22.06	64.70	59.80	1.68	1.61	0.87	0.94	0.88	0.90
N_3P_2	25.67	25.00	3.31	2.61	26.40	24.70	75.29	69.57	1.77	1.79	0.88	0.96	0.92	0.91
CD (5%)	0.47	0.99	0.13	0.05	0.68	0.73	1.80	NS	0.02	0.02	0.02	0.01	0.008	0.008

combination with phosphorus @ 10 g/m^2 while minimum number of bulbs per clump, diameter of bulb, weight of bulb and bulb yield was in control. Similar results were reported by Kejkar et al (2015) in Ratoon Spider lily and Sendhilnathan et al (2019) in tuberose.

Nutrient Content in Leaves

Nitrogen content (%): Maximum nitrogen content in leaves was observed when nitrogen was applied @ 20 g/m^2 over the control where no nitrogen was applied during both the years of study, respectively. Similarly, maximum nitrogen content was observed in leaves of tuberose supplied with phosphorus @ 10 g/m^2 and the minimum nitrogen content was without the application of phosphorus. The interaction between nitrogen and phosphorus significantly affected the nitrogen content in leaves of tuberose. Maximum nitrogen content was observed in the leaves of tuberose when plants were fertilized with nitrogen at 20 g/m^2 along with phosphorus at 10 g/m^2 as compare to control , which was not fertilized with nitrogen and phosphorus.

Phosphorus content (%): Application of nitrogen at 20 g/m^2 significantly increased the phosphorus content in leaves of tuberose and minimum content was with no nitrogen application. The maximum phosphorus content was observed when phosphorus level was increased up to 10 g/m^2 and the minimum phosphorus content in leaves of tuberose was estimated in leaves of tuberose grown without phosphorus during both the years, respectively. The maximum phosphorus content was observed in leaves when nitrogen and phosphorus were applied @ 20 and 10 g/m^2 to the plants, whereas, the minimum phosphorus content was neither nitrogen nor phosphorus was given to the plants during both the years of study, respectively.

Potassium content (%): The maximum potassium content in leaves (0.89 and 0.90%) was observed when the nitrogen was applied @ 20 g/m^2, while the minimum (0.84 and 0.86%) was estimated where no nitrogen was applied during both the years.

The application of phosphorus @ 10 g/m^2 significantly increased the potassium content in leaves (0.87 and 0.88%) of tuberose, whereas, minimum (0.87 and 0.87%) was found in plots unfertilized with phosphorus. Phosphorus level 0 and 5 g/m^2 were statistically similar in respect of potassium content in leaves of tuberose during both the years, respectively. The maximum potassium content in leaves of tuberose (0.92 and 0.91%) was estimated when the plants were supplied with nitrogen @ 20 g and phosphorus @ 10 g/m^2, while the minimum potassium content (0.85 and 0.86%) was found in tuberose leaves taken from the plots not supplied with nitrogen and phosphorus during both the years. The results of present experiment corroborate the findings of Kejkar et al (2015) in spider lily. The soil of experimental field was medium in available phosphorus. Higher application of phosphorus led to show significant response and an increase in phosphorus content in leaves of tuberose.

CONCLUSION

From the experiment it is concluded that nitrogen 20 g/m^2 along with phosphorus 10 g/m^2 seemed to be optimum for better flowering, yield, bulb yield and NPK content in tuberose in terms of spike length, rachis length, stem diameter, number of florets per spike, number of spike per plot and number of spikes per hectare, number of bulbs per clump, diameter of bulb, weight of bulb, bulb yield, NPK content in leaves of tuberose cv. Prajwal.

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