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Standardization of NPK dose for growth, floral, bulb and economic parameters on Phule Rajani tuberose

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ABSTRACT

An investigation was carried out during 2013 to 2015 to standardized NPK dose on growth, floral, bulb and economic parameters in tuberose cv. Phule Rajani an application of treatment T_8- 250: 200: 200 kg ha^{-1} NPK through inorganic fertilizers were showed significant influence on plant height (72.10 cm), spike length (66.07 cm), floret spike^{-1} (39.43), floret diameter (3.49 cm), flower duration (32.63 days), durability of spike in field (11.00 days), spike plant^{-1} (4.73), spike weight (75.12 g), bulbs plant^{-1} (16.93), gross return (Rs. 914450 ha^{-1}), net return (Rs. 678646 ha^{-1}) and benefit cost ratio (3.72) with highest trends in this treatment which was found better over the recommended dose of NPK treatment T_2- 300: 150: 150 kg ha^{-1} respectively. Highest nitrogen content (2.56%), phosphorus content (0.78 %) and potassium content (3.62 %) were recorded in bulb stage followed by spike and minimum were in leaf stage in treatment T_{16}- 350: 250:250 kg ha^{-1} NPK respectively.

Key words: *Polianthes tuberosa*, macronutrient, quantitative traits.

INTRODUCTION

Tuberose (*Polianthes tuberosa* L.) contains diploid chromosome 2n=60 for single type, belongs to family Amaryllidaceae and which is native from Mexico. In various states of India it's known as Gulcheri in Hindi, Rajnigandha in Bengali, Gul-Shabbo in Urdu, Nishigandha in Marathi, Nishigandhi in Malayalam and Nelasampengi in Tamil languages. In India four type *viz.* single, semi-double, double and variegated are cultivated. The 'single' type cultivars with one row of corolla are more strongly scented than double flowered type and exploited for perfumery extraction. The long cut spike is excellent as cut flower for table decoration and finds prominent place in flower vases. Tuberose blooms are mainly used to prepare garlands, bouquets, floral ornaments for bridal makeup, floral arrangements and also as cut flowers. The long cut spike of flowers is excellent for table decoration in vase. The flowers remain fresh for days together impart sweet and lingering pleasant fragrance to atmosphere. High value essential oil extracted from flower and which is used in perfume industry. The bulb of tuberose contains significant amount of '*hecogenin*' and '*tegogenine*' as alkaloid and also in small quantities medicinally active compounds. Moreover, tuberose has a very good export potentiality due to its popularity, elegance, fragrance and usefulness especially during scarcity in European market, which can fetch better market price. Today, estimated area under floricultural crops in India *i.e.* 317.2 '000' ha with total production is 1804.52 '000' metric tons of loose flowers and 501000 lakh spikes during 2014-15 as par horticulture statistics 2015 (Saxena *et al.*, 19). Tuberose is cultivated on large scale in France, South Africa, North Carolina, USA and India. In India, major tuberose growing states are Karnataka, West Bengal, Maharashtra, Andhra Pradesh and Tamilnadu.

There are several reports available on plants for essential minerals required by them to complete "life cycle". It is always beneficial to review the reports of every mineral, especially those which can be utilized for growth, floral and quality parameter. The three "major" nutrients are nitrogen, phosphorous and potassium. These macro elements are represented in the form of liquid as nitrogen, pepper as phosphate and salt as potassium, which are essential for all plant metabolic process. Plant analysis has been found to be a useful diagnostic tool to work out amount of fertilizer to be applied. However such information in tuberose is scanty under Rajasthan conditions. Therefore, the present investigation was carried out to standardization of NPK dose for growth, floral, bulb, economic parameters and NPK uptake in tuberose.

MATERIALS AND METHODS

The present study was carried out during 2013-14 and 2014-15, from the month of April to March at AICRP on Floriculture, Horticulture Farm, Department of Horticulture, Maharana Pratap University of Agriculture and Technology, Udaipur. This is situated at 24°35' N latitude and 73° 42' E longitudes at an elevation of 579.5 meters above mean sea level. The region falls under Agro Climatic Zone IV A (Sub-humid Southern Plain and Aravali Hills) of Rajasthan. The field had fairly leveled

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topography and clay loam texture. Soil sample were also taken for analysis of initial available NPK status in soil. The experiment was laid out in randomized block design replicated thrice with 16 treatments and applied in plot size 1.80 x 1.80 m^2, bulb planted at row x plant spacing 30 x 30 cm at planting depth 5 cm. All the 16 treatment combination comprised of treatment T_1- N_0 P_0 K_0, T_2- N_{300} P_{150} K_{150}, T_3- N_0 P_{150} K_{150}, T_4- N_0 P_{200} K_{200}, T_5- N_0 P_{250} K_{250}, T_6- N_{250} P_0 K_0, T_7- N_{250} P_{150} K_{150}, T_8- N_{250} P_{200} K_{200}, T_9- N_{250} P_{250} K_{250}, T_{10}- N_{300} P_0 K_0, T_{11}- N_{300} P_{200} K_{200}, T_{12}- N_{300} P_{250} K_{250}, T_{13}- N_{350} P_0 K_0, T_{14}- N_{350} P_{150} K_{150}, T_{15}- N_{350} P_{200} K_{200} and T_{16}- N_{350} P_{250} K_{250} kg ha^{-1} NPK through inorganic fertilizer. The dose of phosphorus in the form of single super phosphate (SSP) and potash in the form of muriate of potash (MOP) and one-third dose of nitrogen in the form of urea were applied as basal dose at the time of last ploughing before final field preparation and planting of tuberose bulbs. Remaining two- third nitrogen was applied in two equal split doses as top dressing at 30 and 60 days after planting as per treatment. The data were recorded on ten plants per treatment per replication on floral, bulb and economic parameters for two consecutive years. The pool data were statistically analyzed as per the method suggested (Panse and Sukhatme, 16).

Plant samples were also collected from each treatment plot at three stages *i.e.* leaf, spike and at bulb analyzed for nitrogen, phosphorus and potassium content in plant parts at all three the stages. Nitrogen content in plant was estimated by a colorimetric method (Snell and Snell, 22) using spectronic 20 after development of colour with Nesseler's reagent, phosphorus content by vando-molybdate colour reaction method and potassium content by microprocessor based flame photometer method (Jackson, 9).

RESULTS AND DISCUSSION

The two year pooled data in Table 1 and 2 shows that highest significant trends for leaf length (28.98cm), leaves $plant^{-1}$ (32.30), plant height (72.10 cm), spike length (66.07 cm), rachis length (30.40 cm), days to open 1st floret on spike (116.19 days), days to open last floret on spike (125.60 days), floret opening at a time (5.38), floret remain open at a time (10.32), florets $spike^{-1}$ (39.43), florets diameter (3.49 cm), flowering duration (32.63 days), durability of spike in field (11.00 days), spikes $plant^{-1}$ (4.73), floral weight on spike $plant^{-1}$ (215.33 g) and spike weight (75.12 g) were recorded with an application of T_8- 250: 200: 200 kg ha^{-1} NPK, whereas, percent magnitude of increase in plant height (2.22), spike length (3.99), rachis length (5.80), floret opening at a time (3.19), floret remain open at a time (2.65), florets $spike^{-1}$

Table 1. Response of NPK on vegetative growth and floral parameters in Tuberose.

Treatments	Leaf length (cm)	Leaves $plant^{-1}$	Plant height (cm)	Spike length (cm)	Rachis length (cm)	Days to open 1st floret	Days to open last floret	Floret opening at a time	Floret remains open at a time
T_1-N_0 P_0 K_0	25.03	25.58	64.83	57.83	26.61	134.17	140.75	4.10	8.18
T_2-N_{300} P_{150} K_{150}	28.04	29.50	70.53	63.53	28.73	120.23	129.48	5.22	10.05
T_3-N_0 P_{150} K_{150}	27.50	26.83	68.25	61.25	28.46	126.98	134.56	4.43	8.45
T_4-N_0 P_{200} K_{200}	27.68	27.15	69.03	62.03	28.63	129.63	136.22	4.45	9.42
T_5-N_0 P_{250} K_{250}	27.45	27.82	67.57	60.57	28.06	129.00	136.92	4.85	9.65
T_6-N_{250} P_0 K_0	25.52	28.68	66.25	59.25	27.08	130.86	138.44	4.32	9.47
T_7-N_{250} P_{150} K_{150}	28.02	31.27	71.08	64.08	28.94	122.01	129.14	5.18	9.22
T_8-N_{250} P_{200} K_{200}	28.98	32.30	72.10	66.07	30.40	116.19	125.60	5.38	10.32
T_9-N_{250} P_{250} K_{250}	28.59	31.53	71.33	65.33	29.91	117.94	126.86	5.20	10.15
T_{10}-N_{300} P_0 K_0	25.63	29.13	67.13	60.13	27.54	126.83	134.75	4.38	9.52
T_{11}-N_{300} P_{200} K_{200}	28.24	30.25	70.48	63.48	28.13	122.49	131.07	5.03	9.60
T_{12}-N_{300} P_{250} K_{250}	28.62	30.05	70.67	63.67	28.79	124.77	131.68	5.02	9.97
T_{13}-N_{350} P_0 K_0	26.03	29.40	65.75	58.75	27.31	128.09	136.01	4.02	9.12
T_{14}-N_{350} P_{150} K_{150}	28.66	30.77	70.50	63.50	28.58	121.83	128.75	5.25	9.92
T_{15}-N_{350} P_{200} K_{200}	28.36	30.58	72.08	65.10	29.81	123.07	131.65	5.15	10.10
T_{16}-N_{350} P_{250} K_{250}	28.09	31.32	71.38	64.38	29.06	121.38	129.96	5.33	10.08
CD_P=0.05	1.46	2.08	3.33	3.07	1.31	3.93	4.12	0.43	0.37

Table 2. Response of NPK on floral and bulb parameters in Tuberose.

Treatments	Floret spike^{-1}	Floret diameter (cm)	Flowering duration	Durability of spike in field	Spikes plant^{-1}	Spike weight (g)	Floral weight spike plant^{-1} (g)	Bulb diameter (cm)	Bulb weight plant^{-1} (g)	Bulb plant^{-1}
T_1-N_0 P_0 K_0	34.83	2.84	22.87	9.28	3.16	53.40	91.66	2.20	208.07	11.64
T_2-N_{300} P_{150} K_{150}	37.20	3.20	29.53	10.35	4.50	68.26	181.65	3.48	316.90	15.64
T_3-N_0 P_{150} K_{150}	36.67	2.88	25.27	9.50	3.47	61.43	121.23	2.36	267.17	13.44
T_4-N_0 P_{200} K_{200}	35.83	3.05	25.57	9.88	3.53	59.46	119.04	2.28	262.99	13.56
T_5-N_0 P_{250} K_{250}	36.03	2.98	24.47	9.92	3.66	60.78	127.06	2.39	273.76	13.48
T_6-N_{250} P_0 K_0	35.07	2.99	24.30	9.62	3.61	61.79	128.35	2.37	253.76	12.90
T_7-N_{250} P_{150} K_{150}	37.73	3.20	29.70	10.33	4.46	70.79	192.56	3.56	314.05	16.27
T_8-N_{250} P_{200} K_{200}	39.43	3.49	32.63	11.00	4.73	75.12	215.33	3.63	331.26	16.93
T_9-N_{250} P_{250} K_{250}	38.40	3.45	29.27	10.78	4.54	73.00	194.33	3.59	329.29	16.00
T_{10}-N_{300} P_0 K_0	35.27	2.91	26.67	9.88	3.57	63.85	131.50	2.54	248.82	14.69
T_{11}-N_{300} P_{200} K_{200}	37.47	3.03	28.24	10.58	4.40	73.33	188.33	3.57	328.66	15.92
T_{12}-N_{300} P_{250} K_{250}	37.03	3.18	28.30	10.45	4.59	69.80	190.06	3.60	329.54	16.52
T_{13}-N_{350} P_0 K_0	35.07	2.93	25.63	9.55	3.88	60.71	134.68	2.49	262.53	14.40
T_{14}-N_{350} P_{150} K_{150}	37.20	3.19	29.80	10.55	4.61	69.54	190.21	3.57	320.30	16.22
T_{15}-N_{350} P_{200} K_{200}	38.07	3.27	30.93	10.68	4.65	74.31	194.05	3.62	326.03	16.20
T_{16}-N_{350} P_{250} K_{250}	38.20	3.38	31.63	10.73	4.62	69.32	192.01	3.61	327.27	16.05
CD_P=0.05	1.73	0.26	2.41	0.66	0.48	3.19	21.80	0.28	15.03	1.17

(6.00), florets diameter (8.96), duration of flowering (10.50), durability of spike in field (6.28), spikes plant^{-1} (5.11), floral weight on spike plant^{-1} (18.54) and spike weight (10.04) respectively than recommended dose of fertilizer treatment T_2- 300: 150: 150 kg ha^{-1} NPK.

The favourable effect of nitrogen in promoting number and length of leaves might be due to the fact that nitrogen is a constituent part of protein and component of protoplasm which increases the chlorophyll contents in leaves. These factors led to cell multiplication, cell enlargement and cell differentiation which have resulted in increasing of number and length of leaves reported by (Mahmoodinezhadedezfully *et al.,* 15 and Rajwal and Singh, 18) in tuberose. The reason of growth increase was the role of nitrogen in forming important molecules of phospholipids, nucleotides, nucleic acid and certain co-enzymes which play an important role in plant metabolism and shortage of N results in the reduction of auxin and thus growth. Promoting height of plant and shoots plant^{-1} might be due to the fact that the increase in nitrogen level enhanced the chlorophyll formation and thereby increased photosynthesis and synthesis of reserve food material, which ultimately promotes vegetative growth. Similar increase in vegetative growth with increased level of nitrogen was also found by Mahadik and Chopde (14) in gladiolus. Phosphorus stimulates generation of rootlets and nurtures the roots. It is also an important constituent in energy rich compounds and thus an indispensable element in energy metabolism. This is involved in the synthesis of growth stimulating compounds, absorption of nutrients, cell division and cell growth which might result in vigorous growth. On the other hand, plants with low levels of nitrogen and phosphorus were under developed and shorter in stature.

The increase in growth characters and yield components from increased nitrogen level might be due to the role of nitrogen in stimulating vegetative growth. The reasoning is that nitrogen is a constituent of protein, nucleic acids and nucleotides that are essential to the metabolic function of plants in tuberose which results in highest spike length, floret spike^{-1} at 200 kg N ha^{-1}, while highest rachis length and spike plot^{-1} at 350 kg ha^{-1} (Singh *et al.*, 21). This increase in flower yield with increase in nitrogen level might be due to the fact that increase in nitrogen level enhanced the chlorophyll formation thereby increased photosynthesis and synthesis of reserve food material, which promoted vegetative growth and increased flower yield. Present results are in conformity with the findings of Devi and Singh (6) in tuberose 220 kg N ha^{-1} improve spike plant^{-1}, rachis length, florets spike^{-1} and duration of flowering. However, in combination with nitrogen, phosphorus and potassium appreciably improved the flower and bulb yield with quality. The two year pooled data showed significantly influence by combination of 300 kg N, 150 kg P and 100 kg K ha^{-1} produces improve florets $spike^{-1}$, spike $plant^{-1}$, spike ha^{-1}, floral $weight^{-1}$ and floral yield ha^{-1} as compared to control as reported by (Kadu *et al.,* 8) in tuberose.

Recent researches have also shown that addition of nitrogen fertilizers has improved absorption ability of phosphorus, potassium and calcium as well as increases the cation exchange capacity of plant roots. These results are in confirmation with the findings of Patil and Reddy (17), Bawedja (3), Talukdar *et al.* (24), Sultana *et al.* (23), Yadav (25), Sharma *et al.* (20), Kour and Sharma (11), Amin *et al.* (1) in *P. tuberosa,* Kumar *et al.* (13), Gupta *et al.* (7), Kumar and Misra (12) and Chandana and Dorajeerao (4) in gladiolus.

Further, two year pooled data in Table 2 reveals that significant influence on bulb diameter (3.63 cm), bulb weight $plant^{-1}$ (331.26 g) and bulb $plant^{-1}$ (16.93) respectively were obtained in application of treatment T_8- 250: 200: 200 kg ha^{-1} NPK. The percent magnitude increase in bulb diameter (4.21), bulb weight $plant^{-1}$ (4.53) and bulb $plant^{-1}$ (8.23) over recommended fertilizer treatment T_2- 300: 150: 150 kg ha^{-1} NPK. The favorable effect of higher levels of nitrogen in promoting bulbs yield might be due to the fact that the higher level of nitrogen provides better growth and development of plant and helps in translocation of photosynthates from source (leaves) to sink (bulbs) which might be resulted in to higher bulbs yield in tuberose. Devi and Singh (6) also reported that increasing nitrogen levels resulted in superior yield of bulbs in tuberose. The increase in quality parameters with higher rates of nitrogen may be due to positive effect of nitrogen in stimulation of vegetative growth and increase in translocation and accumulation of reserve food material in the new bulbs and finally improve on bulbs size, diameter and weight. Similar trend are also found by Khalaj and Edrisi (10) in tuberose and Kumar *et al*. (13) in gladiolus. The increase in bulb diameter, bulb weight and bulblet $plant^{-1}$ with increase in level of potassium might be due to the fact that potassium promotes larger size of bulb and bulblet by increasing water accumulation in the underground plant parts resulting in higher weight of bulbs and bulblet. These results are in conformity with Mahadik and Chopde (14) in gladiolus. However, in combination with nitrogen, phosphorus and potassium appreciably improved the flower and bulb yield with quality Kadu *et al.,* (8) in tuberose. The present findings are in agreement with the findings of Rajwal and Singh (18), Amin *et al.,* (2), Dahal (5), Chandana and Dorajeerao (4) in *Polianthes tuberosa*, Gupta *et al.,* (7), Kumar and Misra (12), in *G. grandiflorus* and Singh *et al.,* (21) in Asiatic hybrid lily.

Table 3. Response of NPK on nitrogen and phosphorus content in plant part of Tuberose.

Treatments	N content in leaf (%)	N content in spike (%)	N content in bulb (%)	P content in leaf (%)	P content in spike (%)	P content in bulb (%)	K content in leaf (%)	K content in spike (%)	K content in bulb (%)
T_1-N_0 P_0 K_0	1.82	1.86	1.93	0.38	0.44	0.53	2.40	2.46	2.60
T_2-N_{300} P_{150} K_{150}	2.32	2.36	2.47	0.48	0.53	0.62	3.31	3.37	3.51
T_3-N_0 P_{150} K_{150}	1.84	1.88	1.99	0.44	0.50	0.58	3.06	3.12	3.26
T_4-N_0 P_{200} K_{200}	1.87	1.90	2.01	0.48	0.54	0.62	3.08	3.14	3.28
T_5-N_0 P_{250} K_{250}	1.88	1.92	2.02	0.50	0.56	0.64	3.10	3.16	3.30
T_6-N_{250} P_0 K_0	2.23	2.28	2.39	0.41	0.47	0.55	2.43	2.49	2.63
T_7-N_{250} P_{150} K_{150}	2.27	2.31	2.42	0.46	0.52	0.60	3.23	3.29	3.43
T_8-N_{250} P_{200} K_{200}	2.30	2.33	2.45	0.50	0.54	0.63	2.94	3.32	3.46
T_9-N_{250} P_{250} K_{250}	2.31	2.34	2.46	0.52	0.57	0.66	3.27	3.33	3.47
T_{10}-N_{300} P_0 K_0	2.33	2.35	2.47	0.42	0.47	0.56	2.46	2.52	2.66
T_{11}-N_{300} P_{200} K_{200}	2.34	2.36	2.48	0.50	0.55	0.65	3.38	3.43	3.55
T_{12}-N_{300} P_{250} K_{250}	2.33	2.36	2.48	0.49	0.55	0.64	3.38	3.45	3.57
T_{13}-N_{350} P_0 K_0	2.36	2.39	2.51	0.43	0.48	0.58	2.50	2.57	2.69
T_{14}-N_{350} P_{150} K_{150}	2.37	2.40	2.52	0.53	0.58	0.68	3.38	3.45	3.57
T_{15}-N_{350} P_{200} K_{200}	2.40	2.44	2.55	0.56	0.61	0.71	3.40	3.48	3.59
T_{16}-N_{350} P_{250} K_{250}	2.42	2.44	2.56	0.63	0.63	0.78	3.43	3.50	3.62
CD_P=0.05	0.03	0.09	0.08	0.02	0.02	0.02	0.16	0.11	0.06

Table 4. Economic feasibility of different treatment in two year.

Treatments	Cost of Production 2013	Cost of Production 2014	Spike returns (Rs./ha)	Bulb returns (Rs./ha)	Gross returns (Rs./ha)	Net return (Rs/ha)	B:C ratio
T_1-N_0 P_0 K_0	277200	143867	298602	323414	622016	411483	2.71
T_2-N_{300} P_{150} K_{150}	298081	164748	425157	434525	859683	628268	3.55
T_3-N_0 P_{150} K_{150}	292939	159606	327801	373206	701007	474735	2.80
T_4-N_0 P_{200} K_{200}	298185	164852	333074	376782	709856	478338	2.75
T_5-N_0 P_{250} K_{250}	303431	170098	345667	374352	720019	483254	2.70
T_6-N_{250} P_0 K_0	281485	148152	341102	358241	699343	484524	3.09
T_7-N_{250} P_{150} K_{150}	297224	163891	421380	452025	873405	642848	3.64
T_8-N_{250} P_{200} K_{200}	302470	169137	444195	470255	914450	678646	3.72
T_9-N_{250} P_{250} K_{250}	307717	174384	428620	444525	873146	632096	3.38
T_{10}-N_{300} P_0 K_0	282342	149009	336931	408032	744963	529287	3.30
T_{11}-N_{300} P_{200} K_{200}	303327	169994	419412	442234	861646	624985	3.40
T_{12}-N_{300} P_{250} K_{250}	308574	175241	433815	459005	892819	650912	3.45
T_{13}-N_{350} P_0 K_0	283199	149866	366051	400046	766097	549564	3.42
T_{14}-N_{350} P_{150} K_{150}	298938	165605	435468	450637	886104	653833	3.66
T_{15}-N_{350} P_{200} K_{200}	304184	170851	438555	449838	888392	650875	3.54
T_{16}-N_{350} P_{250} K_{250}	309431	176098	436569	445706	882275	639511	3.38

**Rs. 1,33,333 was the initial planting material not required in 2014; **Estimated market selling price Rs. 1.00/- for each cut spike and Rs. 1.20/- planting marketable bulbs at Udaipur condition

A perusal two year pooled data in Table 3 indicated that highest percent N content in leaf (2.42 %), spike (2.44 %), bulb (2.56 %), phosphorus content in leaf (0.63 %), spike (0.63 %) bulb (0.78 %), potassium content in leaf (3.43 %), spike (3.50 %) and bulb (3.62 %) were recorded in treatment T_{16}- 350: 250:250 kg ha^{-1} NPK application as compared to T_2- recommended dose of fertilizer 300:150:150 kg ha^{-1} NPK in tuberose cv. Phule Rajani. While, among three stage of plant analysis showed highest NPK content were accumulated in bulb followed by spike and lower content were recorded at leaf stage nitrogen content in leaf due to highest NPK availability and better uptake by the plant system these results are in harmony with the finding of Singh (21) and Khalaj and Edrisi (10) in tuberose and Kumar and Misra (12) in gladiolus. Moreover, highest accumulation of NPK in tuberose bulb improve fresh weight of bulb, bulb diameter and number of bulb plant^{-1} in tuberose and this was conform by NPK analysis in plant part at leaf, spike and bulb stage.

The two year pooled data presented in Table 4 indicated that among various treatments the higher gross return (914450), net return (678646) and benefit cost ratio (3.72) were recorded in tuberose with an application of T_8- 250: 200:200 kg ha^{-1} NPK as compared to recommended dose of treatment T_2- 300: 150: 150 kg ha^{-1}. In the light of two year experimental results it may be concluded that the application of T_8- 250: 200:200 kg ha^{-1} NPK in tuberose cv. Phule Rajani under sub humid southern plains and Aravalli hills of Udaipur, Rajasthan were found better than recommended dose of treatment T_2- 300: 150: 150 kg ha^{-1} NPK. Hence, it's recommended that tuberose growing farmers of Rajasthan state in India can get highest net return and benefit cost ratio by adopting modified package of recommendation *viz.* 250: 200: 200 kg ha^{-1} NPK fertilizers.

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