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EFFECT OF GRADED LEVELS OF NITROGEN ON PRODUCTION OF FLOWER, OIL AND BULB OF TUBEROSE (*Polianthes tuberosa* L.)

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ABSTRACT: A field experiment was conducted to determine the effect of different levels of nitrogen on flowering, essential oil and bulb production in tuberose (*Polianthes tuberosa* L. cv Rajat Rekha). Four treatments of graded level of nitrogen as (N_0=0, N_1=120, N_2= 220 and N_3= 320 kg/ha^{-1}) were evaluated under hot subtropical climatic conditions on loamy soils. Application of graded level of nitrogen significantly increased the number of leaves / clump (20.47%), plant height (37.35%), leaf area (32.86%), spike length (35.25%), number of florets / spike (43.23%) and flower yield / clump (93.03%) in N_3 as compared to control, N_1 and N_2, respectively. Nitrogen application @ 220 kg ha^{-1} reduced days to flowering (by 13.36%), increased vase life (by 17.57 %), enhanced essential oil (by 0.128 %) and increased total bulb yield (by 66.94%, 34.01%) and 3.97% over control, N_2 and N_3, respectively.

Keywords: *Bulb yield, essential oil, nitrogen, tuberose.*

Tuberose (*Polianthes tuberosa* Linn.) known as *Rajnigandha* is an important commercial flower crop. Tuberose occupies a very selective and special position in Indian ornamental bulbous plants due to its lovely pretty flowers, elegance and pleasantly sweet fragrance. The flowers are widely used for table decoration, floral ornaments, cut flower, fragrance and essential oil. Spikes are used in preparation of very artistic garlands in different parts of the country and are in great demand during festivals, marriages and other functions. There is 912 ha area under cultivation of tuberose. The bulbs of tuberose have medicinal importance that has been reported since in *Vedic* era. The bulbs are used for making a paste by adding with turmeric and butter and applied over red rashes of infants. Dried bulbs in a powdered form are used as a remedy for gonorrhea. Nitrogen plays an important role in improving the plant growth because it is a major constituent of chlorophyll, protein and amino acids that accelerates synthesis of amino acids and chlorophyll. That increases production of green leaves, which synthesized carbohydrates, protein (Arnon., 2). It also improves bulbs production by promotion of cell proliferation and storage of starch in resulting cells. The main function of nitrogen is the initiation of meristematic activity which accelerates cell division and cell-enlargement. Nitrogen influences emergence, production and quality of spikes (Singh, 9). Hence this study was undertaken to investigate the effect of graded levels of nitrogen application on flowering, essential oil and bulb production in tuberose cv. *Rajat Rekha.*

MATERIALS AND METHODS

An experiment was conducted at Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, on medium loamy soil having pH 7.4, E.C. 0.4 mmhos/cm, organic carbon 0.50% and low available nitrogen (209 kg ha^{-1}) for two consecutive years (2000-2002). Healthy bulbs of single type of tuberose cv Rajat Rekha were planted at 5 cm depth in the last week of March and the study was repeated again in the subsequent year. During planting, half dose of nitrogen (60, 110 and 160 kg ha^{-1}) in the form of urea, full dose of phosphorus (250 kg ha^{-1}) as single super phosphate and full dose of potash (250 kg ha^{-1}) muriate of potash were applied as basal dose before bulbs planting. The remaining half dose of nitrogen was applied at the two month of planting. Treatments of graded

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nitrogen (N_0=0, N_1=120, N_2=220 and N_3=320 kg ha^{-1}) were evaluated and each treatment was replicated thrice in a randomized block design (RBD). The observations were recorded from 3 plants/clump of each treatment at weekly intervals on plant height, leaf numbers/clump, leaf area, days taken for flowering, spike length, number of florets per spike, flower yield, vase life, essential oil and bulb yield. Estimation of essential oil content was done by the solvent extraction method as outlined by Guenther (5).

RESULTS AND DISCUSSION

The results depicted in Table 1 to 3 reveal that application of nitrogen significantly influenced almost all growth parameters, flower quality, essential oil (%) and bulb production.

The number of leaves/clump, plant height and leaf area significantly increased due to application of various graded levels of nitrogen. The number of leaves/clump, plant height and leaf area increased by 20.47%, 37.35% and 32.86%, respectively (Table 1) in N_3 over control. Favourable effect of nitrogen in promoting vegetative growth of plant can be attributed to N application which increased metabolite transport for growth (Marschner, 6). Total leaf area, plant height and number of leaves per plant increased significantly with N application. The increase in leaf area due to photosynthetic ability resulting in positive influence on growth parameters (Anamika and Lavania, 1) in rose confirms present findings. Duration required for emergence of flower scape exhibited significant influence of nitrogen application. It appears that the 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 primordial on the mother bulbs. Treatment with 220 kg ha^{-1} nitrogen reduced days for flowering by 13.36% as compared to control (Table 1). Singh (9) also revealed similar reports in tuberose under Agra condition.

Nitrogen application significantly influenced length of spike and number of florets per spike (Table 2). The length of spike increased by 35.25% and number of florets per spike by 43.23% was observed in N_3 as compared to control. A proportionate increase in length of spike and number of florets as a consequence of nitrogen fertilization may be due to the substantial increase in the spike length. It is possible that the production of higher number of florets at higher N doses increased the longevity of spike, as pointed out by Arvind and Kale (3) in rose cultivars where they reported an increase in stick length with a corresponding increase in N dose.

Vase life of spikes significantly increased by 17.57%, 12.26% and 10.61% in N_2, N_1 and N_3 treatments, respectively over control (Table 2). According to Woltz (11), high doses of nitrogen produce soft and tender stalk, which causes deleterious effects on vase life of cut flowers. Ageing petals show break down of protein and nucleic acids at the onset of wilting and the activities of various hydrolase's enzymes are increased dramatically. Endogenous ethylene production shoots up in flowers and petals causes deterioration of vase life. In ageing petals at the cellular level, lysosomal section acts by the auto-phagic activity of the vacuole. During the last phase of senescence, the tonoplast ruptures and complete digestion of the cytoplasm constituents occurs in the autolysins cells. The factors, which play a key role in governing the vase life of cut flowers, include carbohydrates supply and water balance. Addition of a sugar and an anti-microbial agent to the holding solution prolongs vase life substantially. Low pH, however, helps in improving the colour of flowers (Mohan Ram and Chandra, 8).

Application of nitrogen significantly increased spike yield/clump by 15.71%, 45.69% and 93.03% in N_3 as compared to N_2, N_1 and control, respectively. Increase in flower yield by nitrogen application may be attributed to increased metabolite transport required for growth (Marschner, 6). The percentage of essential oil increased significantly with the corresponding

Table 1: Effect of graded levels of nitrogen on plant growth and flower characters.

Treatments (Nitrogen)	Number of leaves/clump	Plant height (cm)	Leaf area (cm^2)	Days taken to flowering
0 kg/ha	82.18	35.7	27.34	137.26
120 kg/ha	90.13 (9.67)	39.6 (10.87)	30.27 (10.71)	126.53 (7.82)
220 kg/ha	89.07 (8.38)	45.73 (28.13)	34.16 (24.95)	118.92 (13.36)
320 kg/ha	99.00 (20.47)	49.02 (37.35)	36.59 (32.86)	130.05 (5.25)
C.D(P=0.05)	1.73	1.37	1.02	2.61

Figures in parentheses are percentage increase over control.

Table 2: Effect of graded levels of nitrogen on flower yield and the essential oil.

Treatments (Nitrogen)	Spike length (cm)	Florets number / Spike	Vase life (days)	Flower yield/ clump (g)	Essential oil (%)
0 kg/ha	75.88	27.62	8.48	24.68	0.099
120 kg/ha	85.98 (13.31)	31.32 (13.40)	9.52 (12.26)	32.70	0.114
220 kg/ha	95.26 (25.54)	35.67 (29.15)	9.97 (17.57)	41.17	0.128
320 kg/ha	102.63 (35.25)	39.56 (43.23)	9.38 (10.61)	47.64	0.116
CD P=0.05)	1.38	1.45	0.30	1.48	0.004

Table 3: Effect of graded levels of nitrogen on bulb yield and yield contributive characters.

Treatments (Nitrogen)	Bulbs yield (t/ha)	Fresh weight of bulbs / clump (g)	Number of bulbs / clump	Fresh weight of bulblets /clump (g)	Number of bulblets/ clump
0 kg/ha	12.25	124.41	9.23	8.78	4.45
120 kg/ha	15.26 (24.57)	167.63 (21.41)	12.42 (34.56)	11.72 (33.49)	5.05 (13.48)
220 kg/ha	20.45 (66.94)	257.24 (93.94)	17.15 (85.81)	13.62 (55.13)	7.60 (70.79)
320kg/ha	19.67 (60.57)	250.92 (77.97)	15.48 (67.71)	12.59 (43.39)	6.07 (36.40)
C.D (P=0.05)	3.75	3.980	1.162	0.687	0.211

Figures in parentheses are percentage increase over control.

increase in the level of nitrogen application from N0 (control) to 220 kg/ha^{-1} but declined at 320 kg/ha^{-1}. The highest essential oil yield (0.128%) was recorded in N_2 treatment as compared to control (0.099%), N_1 (0.114%) and N_3 (0.116%) (Table 2) because of highest N uptake in N_2 treatment, which has also been reported by Mohandas and Sampath (7) in geranium where herbage and oil yield increased by the application of nitrogen.

Bulb production was differed significantly with all doses of graded nitrogen application except N_3, indicating that minimum bulb yield (12.25 tha^{-1}), fresh weight of bulb / clump (124.41 g), number of bulb / clump (9.23), fresh weight of bulblet / clump (8.78 g), number of bulblet / clump (4.45) in the control plot. Further, the bulb yield increased significantly with different graded levels of nitrogen upto 220 kg ha^{-1}and failed to increase further at a dose of 320 kg/ha^{-1}. Nitrogen application @ 220 kg ha^{-1} produced the highest bulb yields (20.45 t ha), number of bulbs per clump 17.15, maximum bulb weight per clump 257.24 g, highest number of bulblets per clump 7.60 and maximum fresh weight of bulblets per clump was found 13.62 g as compared to control, N_1 and N_3, and proved its superiority over all nitrogen applications. Nitrogen application @ 220 kg ha^{-1} produced maximum under ground biomass per ha and was proved most effective in improving bulb yield. Formation and development of bulbs/bulblets are directly related with nitrogen fertilization and depends upon promotion of cell proliferation and storage of starch in the resulting cells. Cell division and cell enlargement are accelerated by ample supply of nitrogen which initiates meristematic activity as reported by Crowther (4) in crops. The accumulation of starch or carbohydrates depends upon the surplus production of photosynthates, which depends upon rate and area available for photosynthesis. Formation and development of bulbs and bulb-lets increased due to more photosynthate accumulation on account of increased leaf area and number of leaves per clump under influence of nitrogen application. Talukdar *et al* (10) recorded profound increase in the size of bulbs and bulb yield per plant in tuberose.

It could be concluded from this study that graded nitrogen (N_{320} kg ha^{-1}) influenced vegetative growth and flower yield while nitrogen @ (220 kg ha^{-1} tended to influence the bulb yield and essential oil production in a hot subtropical climatic conditions of loamy soils.

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