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Response of integrated nutrient management on floral, bulb and economic parameters in tuberose cv. Phule Rajani under sub-humid southern plains of Rajasthan

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ABSTRACT

An investigation was carried out at AICRP on Floriculture, Horticulture Farm, RCA Campus, MPUAT, Udaipur to find out response of integrated nutrient management on floral, bulb and economic parameters in tuberose cv. Phule Rajani. Application of neem cake 12 q ha^{-1} + vermi-compost 20 q ha^{-1} + *Azotobacter* @ 2 g plant^{-1} + PSB @ 2 g plant^{-1} + 60% recommended dose of NPK through inorganic fertilizers showed significant influence on plant height (82.90 cm), spike length (58.43 cm), floret / spike (30.96), floret diameter (4.10 cm), flower duration (31.63 days), spike durability in field (7.83 days), spike / plant (2.98), ten floret weight (16.25), spike weight (53.26 g), bulbs/ plant (3.98), spike ha^{-1} (3,31,111), bulb ha^{-1} (4,42,222), gross return (Rs. 8,61,777 ha^{-1}), net return rupees (Rs. 6,20,000 ha^{-1}) and benefit / cost ratio (2.56) with highest trends in this treatment, which was found better over the recommended dose of NPK (120:60:60 kg / ha) through inorganic fertilizers and sole organic - neem cake (12 q / ha) + vermi-compost (30 q / ha) + *Azotobacter* @ 2 g plant^{-1} + PSB @ 2 g plant^{-1}.

Key words: *Azotobacter*, bulb, phosphate solublizing bacteria, spike, tuberose.

INTRODUCTION

Tuberose (*Polianthes tuberosa* L.) contains diploid chromosome 2n = 60 for single type, belongs to family Amaryllidaceae, which is native from Mexico and commonly known as 'Gulcheri' in Hindi and 'Rajanigandha' in Bengali. The 'single' type cultivars with one row of corolla are more strongly scented than double-flowered type and exploited for perfumery extraction. The estimated area under floricultural crops in India, *i.e.* 2,24,000 ha with total production is 14,59,200 metric tonnes of loose flowers and 87,499.6 lakhs cut spikes during 2012-13 during 2013 (Anon, 1). Major tuberose growing states are Karnataka, West Bengal, Maharashtra and Tamil Nadu. The nutritional imbalance in soil causes instability and hidden hunger of nutrients in plants besides resulting in less flowering duration along with poor quality of cut flower. To maintain sustainability in production through combined use of different sources may also help to maintain the soil fertility, avoids depletion of soil organic matter and plant nutrients besides suppression of some insect-pests and diseases (Gaur, 3; Palaniappan and Annadurai, 11). Major components of integrated nutrient management are organic manures, bio-fertilizers and chemical fertilizers. Organic manures not only balance the nutrient supply but also improve the physical, biological and chemical properties of soil (Nair and Peter, 9). Similarly, bio-fertilizers are supplements of fertilizers, relatively cheaper source and economically viable option, which helps to reduce chemical fertilizer consumption and soil pollution. In Indian agriculture, inadequate availability of organic sources of nutrients and expected yield decline at least in initial years, complete substitute of chemical fertilizers is not necessarily warranted. Rather organic sources should be used only as partial replacement of the chemical fertilizers. Thus, a strategy for judicious combination of both organic and inorganic sources of nutrients is the most viable option for nutrient management (Swarup *et al.*, 15). To find out suitable combination on response of integrated nutrient management on floral, bulb and economic parameters in tuberose, hence present study was undertaken.

MATERIALS AND METHODS

The present study was carried out during 2009-10 and 2010-11, from the month of March to February at AICRP on Floriculture, Horticulture Farm, Department of Horticulture, MPUA&T, Udaipur. Which is situated at 24°35 N latitude and 73°42 E longitudes at an elevation of 561.9 m above mean sea level, crop was planted in 2009 and observed for two consecutive years. The region falls under agro-climatic Zone IV A -Sub-humid Southern Plain and Aravali hills of Rajasthan. The soil type was clay loam with pH 8.4 and EC 0.54 dS/m under irrigated condition. The experiment was laid out in randomized block design replicated thrice with 16 treatments and applied in plot size 1.2 m × 1.5 m,

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bulb planted at row × plant spacing 30 cm × 30 cm with planting depth 5 cm. All the 16 treatment combinations comprised of different combinations (Table 1). The dose of NPK through vermi-compost and neem cake was supplemented as basal dose before 20 days of bulb planting and bio-fertilizers like *Azotobacter* and phosphorus solubilizing bacteria were applied at the time of bulb planting as per treatment detail. The data were recorded on ten plants per treatment per replication on floral, bulb and economic parameters. The data were statistically analyzed as per the method suggested by Gomez and Gomez (4).

RESULTS AND DISCUSSION

The pooled data in Table 1 shows that significant influence with highest trends for plant height (82.90 cm), spike length (58.43 cm), floret per spike (30.96), floret diameter (4.10 cm), flower duration (31.63 days), spike durability in field (7.83 days), however earliest days to spike emergence (90.07) and days to open basal floret (110.03) were recorded with an application of neem cake (12 q / ha) + vermi-compost (20 q / ha) + *Azotobacter* @ 2 g plant^{-1} + PSB2 g plant^{-1} + 60% recommended dose of NPK through inorganic fertilizer (T_{15}), whereas, percent magnitude of increase in plant height (16.33), spike length (15.70), floret per spike (18.48), floret diameter (12.32), flower duration (72.28), spike durability in field (51.74) respectively than recommended dose of NPK (120:60:60 kg ha^{-1}) through inorganic fertilizers (T_1), followed by 40% recommended dose of NPK through inorganic fertilizer supplemented with neem cake

Table 1. Effect of INM on plant growth and floral characters in tuberose cv. Phule Rajani.

Treatment	Plant height (cm)	Days to spike emergence	Days to open basal floret	Spike length (cm)	Floret/ spike	Floret dia. (cm)	Flower duration (days)	Spike durability (days)
RDF of NPK (120:60:60 kg/ha (control)	71.26	100.87	120.20	50.50	26.13	3.65	18.36	5.16
NC (12 q/ha) + VC (30 q/ha) + *AZ* + PSB (pure organic)	64.36	100.91	120.243	49.86	24.53	3.64	18.30	5.30
NC (12 q/ha) + 60% RDF of NPK	66.03	101.24	121.730	52.03	26.46	3.70	20.50	5.76
NC (18 q/ha) + 40% RDF of NPK	68.93	104.63	124.150	51.56	25.63	3.74	21.03	5.70
VC (20 q/ha) + 60% RDF of NPK	70.06	100.15	120.150	52.83	25.83	3.74	22.20	6.30
VC (30 q/ha) + 40 RDF of NPK	71.26	101.00	121.000	53.46	26.33	3.69	24.76	6.23
AZ + 60% RDF of N + full dose of P and K	71.46	95.52	115.183	52.60	25.20	3.62	24.46	6.50
AZ + 40% RDF of N + full dose of P and K	72.43	94.74	114.073	53.70	22.93	3.54	24.03	6.36
PSB + 60% RDF of P + full dose of N and K	72.73	97.22	117.220	53.73	23.60	3.68	24.10	7.36
PSB + 40% RDF of P + full dose of N and K	72.30	94.11	114.330	52.63	23.73	3.57	25.40	7.06
NC (12 q/ha) + VC (20 q/ha) + 60% RDF of NPK	77.10	94.11	114.110	54.36	27.26	3.73	28.10	7.43
NC (18 q/ha) +VC (30 q/ha) + 40% RDF of NPK	76.23	93.26	113.183	54.40	25.03	3.73	27.43	7.36
AZ + PSB + 60% RDF of N and P + full dose of K	74.93	95.88	115.183	53.26	26.66	3.64	26.16	6.86
AZ + PSB + 40% RDF of N and P + full dose of K	77.10	93.11	113.037	52.73	25.76	3.65	26.80	6.73
NC (12 q/ha) + VC (20 q/ha) + *AZ* + PSB + 60% RDF of NPK	82.90	90.07	110.037	58.43	30.96	4.10	31.63	7.83
NC (18 q/ha) + VC (30 q/ha) + *AZ* + PSB + 40% RDF of NPK	82.33	91.41	111.183	57.20	29.23	3.96	29.90	7.56
CD (P = 0.05)	5.016	5.512	6.263	1.856	3.756	0.271	1.806	0.597

18 q ha^{-1} + vermi-compost 30 q ha^{-1} + *Azotobacter* 2 g $plant^{-1}$ + PSB 2 g $plant^{-1}$ (T_{16}). An improvement in cut flower production and quality by chemical and biofertilizer application might be due to the fact that vermi-compost is nutritive fertilizer helps in availability of macro-and micro-nutrients levels in soil to plant system and also improve level of growth promoting substances. As a result, their combined application helped in stimulating the vegetative and reproductive phase of the plants. The results of the study are also in agreement with the findings of Shankar *et al.* (12). Tripathi *et al.* (16) reported earliest days to opening of first floret (22.18 days), highest trends for florets $spike^{-1}$ (29.44), spike yield (2,05,030.71 spike / ha) were recorded in 75% recommended dose of NPK + 500 q FYM ha^{-1} + 250 q vermi-compost ha^{-1}, Kabir *et al.* (5) reported highest plant height (95.6 cm), spike length (32.1 cm) and florets per spike (35.1) were recorded in treatment half dose of chemical fertilizers (400, 300 and 300 kg / ha urea, triple super phosphate and murate of potash respectively) + 20 t / ha poultry litter in tuberose, Bhalla *et al.* (2) in carnation, Singh (13) in rose, and Sunitha *et al.* (14) in African marigold.

Further, pooled data in Table 2 reveals that significant influence on spike per plant (2.98), weight of ten floret per spike (16.25 g), spike weight (53.26 g), bulb diameter (2.35 cm), clump weight per plant (201.66 g) and bulb per plant (3.98) respectively were obtained in application of neem cake (12 q / ha) + vermi-compost (20 q / ha) + *Azotobacter* 2 g $plant^{-1}$ + PSB 2 g $plant^{-1}$ + 60% recommended dose of NPK through inorganic fertilizer (T_{15}). The percent magnitude increase in spike per plant (56.84), weight of ten floret (40.57), spike weight (29.14), bulb diameter (59.86), clump weight per plant (22.72) and bulb per plant (37.24) over recommended dose of NPK (120:60:60 kg ha^{-1}) through inorganic fertilizers (T_1). The obtained results are in accordance with the earlier findings of Shankar *et al.* (12); Tripathi *et al.* (16); Yadav *et al.* (17) in tuberose, Singh (13) in rose, Mogal *et al.* (7) and Kumar (6) in China aster. The beneficial effect of nitrogen and phosphorous nutrients on length of cut spike and spike $plant^{-1}$ might be due to the fact that nitrogen increases the proteins synthesis, which maintained optimum C: N ratio in the plant system resulted in more gibberellins, florigen synthesis and thus promoting the development of floral bud primordial with the help of phosphorus resulted in earliest flowering and improvement in cut spike and bulb yield. The inclusion of neem cake and vermi-compost with chemical fertilizer greatly helped in improving the flower attributes because of fact that vermi-compost and neem cake application most

Table 2. Effect of INM on spike and bulb yield parameters in tuberose cv. Phule Rajani.

Treatment	Spike per plant	Wt. of ten floret/ spike (g)	Spike wt. (g)	Bulb dia. (cm)	Clump wt. (g)	Bulb per plant
RDF of NPK (120:60:60 kg/ha (control)	1.90	11.56	41.24	1.47	164.33	2.90
NC (12 q/ha) + VC (30 q/ha) + *AZ* + PSB (pure organic)	1.89	11.41	42.22	1.47	151.00	2.89
NC (12 q/ha) + 60% RDF of NPK	1.93	12.76	42.50	1.48	172.33	2.93
NC (18 q/ha) + 40% RDF of NPK	2.08	12.58	42.91	1.47	182.33	3.08
VC (20 q/ha) + 60% RDF of NPK	2.15	12.77	43.10	1.57	165.33	3.15
VC (30 q/ha) + 40 RDF of NPK	2.26	13.24	43.11	1.56	171.00	3.26
AZ + 60% RDF of N + full dose of P and K	2.33	14.18	46.10	1.56	183.33	3.33
AZ + 40% RDF of N + full dose of P and K	2.06	14.29	44.18	1.63	164.00	3.08
PSB + 60% RDF of P + full dose of N and K	2.36	14.06	44.38	1.79	181.33	3.36
PSB + 40% RDF of P + full dose of N and K	2.53	13.95	45.25	1.72	173.00	3.53
NC (12 q/ha) + VC (20q/ha) + 60% RDF of NPK	2.76	14.88	49.61	1.94	193.00	3.78
NC (18 q/ha) + VC (30 q/ha) + 40% RDF of NPK	2.65	14.86	48.14	1.84	191.00	3.65
AZ + PSB + 60% RDF of N and P + full dose of K	2.66	14.25	48.74	1.81	188.00	3.61
AZ + PSB + 40% RDF of N and P + full dose of K	2.62	13.69	47.61	1.77	184.66	3.62
NC (12 q/ha) + VC (20 q/ha) + *AZ* + PSB + 60% RDF of NPK	2.98	16.25	53.26	2.35	201.66	3.98
NC (18 q/ha) + VC (30 q/ha) + *AZ* + PSB + 40% RDF of NPK	2.85	15.32	52.50	2.00	196.66	3.94
CD (P = 0.05)	0.291	0.925	1.495	0.263	12.383	0.277

probably increased the level of growth promoting substances and nutrients availability forms in the soil to plant system and therefore helped in enhancing the uptake of nutrients and accumulation of more photosynthates in plant sink, *viz.* cut spike and bulbs.

It is evident from the study that application of organic manures increased the production of organic acids which play a leading role for availability of P (Mukharjee *et al*., 8), which might induce earliness in flowering than its counterpart. The significant interactive effect as a consequence of organic sources and fertilizers are attributed to the favorable nutritional status in the soil resulting into increased cut spike and bulb production in tuberose. This may be attributed to favourable effect of neem cake, vermi-compost and bio-fertilizers on microbial and root proliferation in soil, which caused solubilizing effect on native nitrogen, phosphorus, potassium and other nutrients. Nambiar (10), while reviewed the results of long-term fertilizer experiments, suggested that neither organic manures alone nor exclusive application of chemical fertilizers could achieve the yield sustainability at a high order under modern farming where the nutrient turn over in the soil plant system is quite high. Integrated use of organic, inorganic and bio-fertilizers were however, found to be quite promising not only in maintaining higher productivity but also to impart greater stability in crop production by synergistic effect of organic sources on improving fertilizer use efficiency of NPK.

A significant increase in yield parameters in tuberose with integrated nutrient management may be due to vigorous vegetative growth, increased in leaf per plant, chlorophyll content, which together accelerate the photosynthetic rate and increased the supply of carbohydrate from source (leaves) to sink (floral or bulb act as sink). The beneficial role of supplemented organic manures and bio-fertilizers in improving physical, chemical and biological properties of soil is well know, which helps in better nutrient absorption by plants in available forms of nitrogen (NO_3), phosphorus ($H_2PO_4^-$ and HPO_4^{2-}) and potassium (K^+) along with certain micro nutrient results in higher yield.

The beneficial effect of vermi-compost is well described in the case of above discussed treatment combination neem cake 12 q ha^{-1} + vermi-compost 20 q ha^{-1} + *Azotobacter* 2 g $plant^{-1}$ + PSB 2 g $plant^{-1}$ + 60 % recommended dose of NPK through inorganic fertilizers (T_{15}), it is well known that *Azotobacter* helps in available N_2 by fixing atmospheric nitrogen as non-symbiotic in rhizosphere of inoculated bulbs, since nutrients like N and Fe are important constituents of chlorophyll, ultimately which increased availability of these nutrients as a result of biofertilizers activity. Owing to direct involvement of chlorophyll and leaf area in photosynthesis, the corresponding increase in growth rate can be reasoned. It also synthesizes IAA and gibberellin-like substances in addition to the production of antifungal antibiotics.

A perusal pooled data in Table 3 indicated that estimated economic parameter study. However, economic parameters were recorded the highest trend for marketable cut spikes yield ha^{-1} (3,31,111), marketable bulbs ha^{-1} (4, 42, 222), gross return ha^{-1} (Rs. 8,61,777), net return ha^{-1} (Rs. 6,20,000) and B/C ratio (2.56) in tuberose with an application of neem cake (12 q/ha) + vermi-compost (20 q/ha) + *Azotobacter* 2 g $plant^{-1}$ + PSB 2 g $plant^{-1}$ + 60% recommended dose of NPK through inorganic fertilizer (T_{15}) over the recommended dose of NPK (120:60:60 kg ha^{-1}) through chemical fertilizers in tuberose cv. Phule Rajani under sub humid southern plains and Aravalli hills of Udaipur Rajasthan were found best than other treatment under study.

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Table 3. Effect of integrated nutrient management on economic parameters in tuberose cv. Phule Rajani.

Treatment	Cost of production (Rs.)	Marketable spike / ha	Marketable bulbs / ha	Gross returns (Rs/ ha)	Net return (Rs/ ha)	B:C ratio
RDF of NPK (120:60:60 kg/ha (control)	2,24,933	2,11,111	3,22,222	5,97,777	3,72,844	1.66
NC (12 q/ha) + VC (30 q/ha) + *AZ* + PSB (pure organic)	2,42,506	2,01,000	3,21,111	5,86,333	3,43,827	1.41
NC (12 q/ha) + 60% RDF of NPK	2,29,953	2,14,444	3,25,555	6,05,110	3,75,157	1.63
NC (18 q/ha) + 40% RDF of NPK	2,32,461	2,31,111	3,42,222	6,41,777	4,09,316	1.77
VC (20 q/ha) + 60% RDF of NPK	2,29,953	2,38,889	3,49,910	6,58,781	4,28,828	1.86
VC (30 q/ha) + 40 RDF of NPK	2,32,461	2,51,111	3,62,222	6,85,777	4,53,316	1.95
AZ + 60% RDF of N + full dose of P and K	2,26,629	2,58,889	3,69,910	7,02,781	4,76,152	2.10
AZ + 40% RDF of N + full dose of P and K	2,26,215	2,28,889	3,42,222	6,39,555	4,13,340	1.83
PSB + 60% RDF of P + full dose of N and K	2,26,770	2,62,222	3,73,333	7,10,222	4,83,452	2.13
PSB + 40% RDF of P + full dose of N and K	2,26,430	2,81,111	3,92,223	7,51,779	5,25,349	2.32
NC (12 q/ha) + VC (20 q/ha) + 60% RDF of NPK	2,36,746	3,06,666	4,19,910	8,10,558	5,73,812	2.42
NC (18 q/ha) + VC (30 q/ha) + 40% RDF of NPK	2,42,649	2,94,444	4,05,555	7,81,110	5,38,461	2.21
AZ + PSB + 60% RDF of N and P + full dose of K	2,28,465	2,95,555	4,01,111	7,76,888	5,48,423	2.40
AZ + PSB + 40% RDF of N and P + full dose of K	2,27,712	2,91,111	4,02,222	7,73,777	5,46,065	2.39
NC (12 q/ha) + VC (20 q/ha) + *AZ* + PSB + 60% RDF of NPK	2,41,777	3,31,111	4,42,222	8,61,777	6,20,000	2.56
NC (18 q/ha) + VC (30 q/ha) + *AZ* + PSB + 40% RDF of NPK	2,47,680	3,16,666	4,37,777	8,41,998	5,94,318	2.40

Estimated market selling price Rs. 1.00/- for each cut spike and Rs. 1.20/- planting marketable bulbs at Udaipur conditions.

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