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Effect of planting dates and integrated nitrogen management on growth, yield and quality of tuberose (*Polianthes tuberosa* L.)

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Abstract
The investigation was tried for figure out the effect of planting dates and integrated nitrogen management on growth, yield and quality of tuberose (*Polianthes tuberosa* L.)The experiment was laid out in split plot design with three date of planting *viz.* 15th March (P_1), 1st April (P_2) and 15th April (P_3) as main treatments and five integrated nitrogen management combinations *i.e.*, 100 percent recommended dose of nitrogen (N_1), 40 percent recommended dose of nitrogen through FYM + 40 percent recommended dose of nitrogen through urea + NPK consortium (N_2), 40 percent recommended dose of nitrogen through vermicompost + 40 percent recommended dose of nitrogen through urea + NPK consortium (N_3), 30 percent recommended dose of nitrogen through FYM + 30 percent recommended dose of nitrogen through urea + NPK consortium (N_4) and 30 percent recommended dose of nitrogen through vermicompost + 30 percent recommended dose of nitrogen through urea + NPK consortium (N_5) as sub-treatments which were replicated thrice. The results revealed that planting of tuberose bulbs on 15th April had taken minimum days to sprouting of bulb (11.49 days) and brought significant increase in plant height (39.20 cm), number of leaves (39.38 plant^{-1}) at 90 days after planting, number of spike (5.29 plant^{-1}, 55.40 plot^{-1} and 683.95 thousands ha^{-1}), weight of floret per plant (287.58 g) and floret yield (1.81 kg plot^{-1} and 225.51 q ha^{-1}), length of spike (80.20 cm) and rachis (36.61 cm), floret weight (3.37 g), number of florets (46.93 spike^{-1}) and vase life (10.98 days). The minimum taken for emergence of first spike (119.75 days) and opening of first floret (133.45 days) was also recorded with 15th April planting. Among integrated nitrogen management treatments, N_3(40% RDN through vermicompost + 40% RDN through urea + NPK consortium) recorded maximum plant height and number of leaves per plant (40.93 cm and 41.67 at 90 days after planting, respectively), number of spike (5.29 plant^{-1}, 55.40 plot^{-1} and 683.95 thousands ha^{-1}), weight of floret (287.58 g plant^{-1}), floret yield (1.81 kg plot^{-1} and 225.51 q ha^{-1}), length of spike (80.37 cm) and rachis (38.52 cm), weight of floret (3.49 g), number of floret (44.05 spike^{-1}) and vase life (11.99 days). Same treatment also taken minimum taken number of days to emergence of first spike (119.75 days) and opening of first floret (133.45 days). Among the P x N interactions, maximum plant height (46.65 cm) and number of leaves (47.34 plant^{-1}) at 90 days after planting, number of spike (6.46 plant^{-1}, 66.67 plot^{-1} and 823.05 thousand ha^{-1}), weight of florets (300.14 g plant^{-1}), floret yield (2.32 kg plot^{-1} and 286.83 q ha^{-1}) were recorded with P_3N_3 treatment combination.

Keywords: Planting dates, nitrogen, vermicompost, Spikes

Introduction
Tuberose (*Polianthes tuberosa* L.) is one of the most important ornamental key bulbous crop, valued for beauty, elegance, pleasant fragrance flowers and long lasting spikes. It is also known as *Rajanigandha* (Hindi and Bengali), *Gul-e-Shabab* (Urdu), *Nishigandha* (Marathi and *Sempengi* (Tamil). It belongs to family Amaryllidaceae and originated from Mexico where its spread all over the globe. In our country According to an estimate (ICAR-DFR, 2018-19) tuberose is grown in an area of about 3,39,386 hectares each year in our country with production of around 19,91,381 tonnes. The generic name *Polianthes* was derived from two Greek Words *Polios*, which means white or shining and *anthos*, a semi perennial bulbous plant. It produces waxy, white and fragrant flowers on longer vase life spikes which are mostly used as cut flowers for making garlands, flower arrangement and bouquets preparation. The growth and yield of tuberose influenced by planting dates and integrated nitrogen management. Proper planting dates play a key role in regulating growth and quality of tuberose and it depends on the hybrids and prevailing environment. The date of planting is also adjusted so as to synchronise the time of harvest with market demand. The choicest with most favourable finest supply of plant nutrient especially nitrogenis an important factor in growth and flowering in tuberose cultivation.

Nitrogen is an essential constituent of protoplasm and proteins and integral part of chlorophyll, it imparts vigorous vegetative growth, dark green colour to plants. Utilisation of potassium, phosphorus and other elements is governed by nitrogen. Reported that nitrogen application significantly increased number of spikes per plant, spike length, rachis length and number of florets per spike. Tuberose crop is a eight month long duration crop and requires slow supply of nitrogen which is possible only through integrated nitrogen management i.e., use of organic and inorganic sources and biofertilizers. Organic sources are helpful in improving physical, chemical and biological health of soil, reduced and nutrient losses. FYM and vermicompost are the leading sources used by farmer traditionally. FYM is principle source of organic matter in our country and its application helps in improving the soil structure and water holding. While vermicompost is excellent base for the establishment of beneficial living and symbiotic microbes. It modifies soil physical, chemical and biochemical properties. Biofertilizers or NPK consortium are the ready to use live formulates containing live or latent cell of efficient strains of nitrogen fixing, phosphorus solubilizing, potassium mobilizing or cellulolytic micro-organisms used for application to seed, bulb, soil or composting areas with the objective of increasing number of such micro-organisms and accelerate those microbial processes which augment the availability of nutrients that can be easily assimilated by plants. The influence of planting time and nitrogen sources such as organic, inorganic and biofertilizers (NPK consortium) on the growth yield and quality of tuberose has not been studied in detail under North Gujarat conditions. Therefore, to ensure proper crop management and get the higher yield, retain the soil productivity, such studies under North Gujarat condition are needed. Considering the above facts, the present research entitled "Effect of planting dates and integrated nitrogen management on growth, yield and quality of tuberose (*Polianthes tuberosa* L.)''.

Materials and Methods

A field experiment on tuberose var. Suvasini was conducted at College Farm, College of Horticulture, S. D. Agricultural University, Jagudan, Gujarat, Mehsana district during March to December of the year 2021.The climate of this zone is typically sub-tropical, characterized by semi-arid condition having warm and humid monsoon, cool and dry winter and quite hot and dry summer. The experiment was laid out in split plot design with three date of planting *viz.* 15th March (P_1), 1st April (P_2) and 15th April (P_3) as main treatments and five integrated nitrogen management combinations *i.e.*, 100 percent recommended dose of nitrogen (N_1), 40 percent recommended dose of nitrogen through FYM + 40 percent recommended dose of nitrogen through urea + NPK consortium (N_2), 40 percent recommended dose of nitrogen through vermicompost + 40 percent recommended dose of nitrogen through urea + NPK consortium (N_3), 30 percent recommended dose of nitrogen through FYM + 30 percent recommended dose of nitrogen through urea + NPK consortium (N_4) and 30 percent recommended dose of nitrogen through vermicompost + 30 percent recommended dose of nitrogen through urea + NPK consortium (N_5) as sub-treatments which were replicated thrice. The entire experimental area was divided into plots each measuring 1.5 m ×1.5 m. There were total 45 plots. The manures and fertilizers were applied uniformly to the experimental plots during land preparation. The full dose of phosphorus and potassium were applied in the form of Single Super Phosphate and Muriate of Potash at the time of land preparation by mixing with soil. The NPK consortium enriched FYM and vermicompost and half dose of nitrogenous fertilizer (Urea) were applied uniformly as per the treatment. And then bulbs planted at 4 to 5 cm depth at 30 cm × 30 cm spacing. Observations on different growth, flowering, yield and quality parameters were recorded and analysed statistically.

Results and Discussion

Growth parameters

The growth parameters *viz.* The vegetative growth was significantly affected by planting dates. P_3(15th April) planting had recorded earliest sprouting of bulb (11.49 days).The sprouting of bulb was significantly increased in later planting which indicated that environmental conditions were more suitable for sprouting of bulbs over remaining treatments of bulb planting. Yang *et al.* (2014) [22] maximum plant height (24.26 cm and 39.20 cm at 45 and 90 days after planting, respectively) and number of leaves (15.11 and 39.38 at 45 and 90 days after planting, respectively) as against a minimum 11.71 cm and 33.72 cm plant height at 45 and 90 days after planting, respectively and 12.89 and 34.14 leaves per plant at 45 and 90 days after planting, respectively with treatment P_1 (15th March) planting. Increasing in plant height it might be due 15thApril planting provides optimum environmental conditions especially temperature which stimulate vegetative growth of tuberose than other planting dates. Meena *et al.* (2018) [11]. More leaves per plant under later planting might be due to the fact that the crop received congenial condition in terms of temperature and sunny days during growth which might be resulted in higher rate of photosynthesis, which ultimately has reflected for increased number of leaves. Meena *et al.* (2018) [11].

The growth parameters *viz*. The vegetative growth was significantly influenced by integrated nitrogen management. Maximum plant height (21.17 cm and 40.93 cm at 45 and 90 days after planting, respectively) and number of leaves (16.18 and 41.67 at 45 and 90 days after planting, respectively) found with treatment N_3 (40% RDN through Vermicompost + 40% RDN through Urea + NPK consortium).This may be attributed to better nutritional environment in the root zone as well as in the plant system. This may be due to the significant effect on plant height as a consequence of chemical fertilizer, vermicompost and biofertilizers are attributed to the increased nutritional environment in the root zone as well as in the plant system resulting into increased growth of the crop (Devlin and Witham, 1986) [6].

Flowering and yield attributes

Flowering and yield attributes was statistically influenced by planting dates. The minimum days taken for emergence of first spike (119.75 days) and opening of first floret (133.45 days) was recorded withtreatment P_3. Maximum number of spike (5.29 plant^{-1}, 55.40 plot^{-1} and 683.95 thousand ha^{-1}).Increasing in number of spike per plant. This might be due to fact that 15th April planting provides more favourable weather condition for vegetative growth in term of more number of leaves per plant, resulting higher accumulation of photosynthates resulting higher count of spikes. These results are in accordance with the findings of Srivastava *et al.* (2014) [19], Rao *et al*. (2015) [15] and Mohanty *et al*. (2020) [12] in

tuberose. Maximum weight of floret (288.23 g plant^{-1}) and floret yield (1.83 kg plot^{-1} and 225.51 q ha^{-1}) was recorded with P_3 (15th April planting.). This might be due to 15thApril planting was exposed to avoided any setback and provides more favourable weather condition for vegetative growth in term of more number of leaves per plant and plant height, resulting higher accumulation of photosynthates resulting better spikes and florets growth, which ultimately increases florets yield. The variation in floret yield per plot among the planting dates was also reported previously in Mohanty *et al.* (2020) [12] and Sahana *et al.* (2020) [17] in tuberose.

The effect of integrated nitrogen management was measurable by F-test for flowering and yield parameters. Treatment N_3*i.e.*, 40 percent recommended dose of nitrogen through vermicompost plus 40 percent recommended dose of nitrogen urea along with NPK consortium had taken minimum number of days for emergence of first spike (119.04 days) and opening of first floret (134.46 days).It was possible due congenial temperature, more sunlight, nutrient uptakes in presence of water and CO_2 increases rate of photosynthesis which improve C: N ratio and florigen synthesis which ultimately resulted in early initiation of spike emergence. Similar result observed by Tripathi *et al.* (2012) [21] and Mazed *et al.* (2015) [10] in tuberose and Sharma *et al.* (2017) [16] in amaryllis. Treatment N_3also recoded maximum number of spike (5.64 plant^{-1}, 57.27 plot^{-1} and 756.38 thousand ha^{-1}). The higher number of spikes per plant might be due to presence of vermicompost, in addition to macronutrients it also contains micro nutrients and releases some plant hormones and humic acid, gradual and steady nutrient release during the growth period and proper nutrition to the crop. Moreover, NPK consortium enhances nutrient availability. Mohanty *et al.* (2020) [12] Significantly maximum weight of floret (275.88 g plant^{-1}) and floret yield (1.96 kg plot^{-1} and 242.51 q ha^{-1}).All these might have made quick mobilizations and sufficient availability of nutrients which could have resulted in increased yield attributes like florets weight ultimately resulting in higher yield. These results are in harmony with those obtained by Prakash and Shukla (2006) [14], Choudhury and Sarangi (2020) [4] and Sahana *et al*. (2020) [17] in tuberose.

Quality characterises

The quality parameters were significantly affected by planting dates. 15th April (P_3) planting had recorded maximum length of spike and rachis (80.20 cmand 36.61 cm, respectively).This might also be due to the fact that initial long and sunny days and later hot and humid weather of monsoon enhances better plant vegetative growth and stimulated the auxiliary buds resulting in more spike and rachis length. Similar finding was earlier reported by Rao *et al.* (2015) [15] and Meena *et al.* (2018) [11] in tuberose. maximum weight of floret (3.37 g). Increase in weight of floret might be due to more favourable environment for florets development in later planting. Maximum number of florets (46.93 spike^{-1}). This might be favoured by optimum temperature and longer days with ample sunshine hours during the crop growth period. These results are in agreement with Das *et al.* (2011) [5], Singh *et al.* (2014^a) [18], Rao *et al.* (2015) [15], Attia *et al.* (2018) [2], Pattnaik *et al.* (2018) [13], Sureshkumar *et al.*(2019) [20],Choudhury and Sarangi (2020) [4] and Fatmi and Singh (2020) [8] in tuberose. significantly maximum days of vase life (10.98 days) was obtained in 15thApril (P_3) planting.

Integrated nitrogen management treatments had resulted in significant variation in quality parameters. Maximum length of spike (80.37 cm) and rachis (38.52 cm). This might have enhanced vegetative growth by N_3 treatment accumulated more carbohydrates, resulting into increased length of spike which is the storage organ. This clearly indicated that combine use of fertilizer, organic source and biofertilizer at optimum level are beneficial for the longer tuberose spike development which is preferred by the consumer. These results were in agreement with those reported by Rao *et al.* (2015) [15] in tuberose. Maximum weight of floret (3.49 g). The reason for the weight of floret results may be that high level of available nitrogen increases synthesis of amino acid and chlorophyll formation and better carbohydrates translocation to flowering stalk which resulted to heavier tuberose florets. These findings are in consonance with the results of Rao *et al. (*2015) [15] in tuberose. maximum number of floret (47.27 spike^{-1}). Increase in number of florets per spike might be due to sufficient availability of nutrients, especially nitrogen as well as the presence of growth promotive substances like essential plant nutrients, vitamins, enzymes and antibiotics in vermicompost. Similar findings was earlier reported in tuberose (Choudhury and Sarangi, 2020) [4] and in gladiolus (Singh *et al.*, 2014^b) [18]. and maximum vase life (11.99 days) was recorded with N_3 (40% RDN through Vermicompost + 40% RDN through Urea + NPK consortium) treatment. Kabir *et al.* (2011) [9] observed that vermicompost can serve as soil amendments to improve soil nutrient status, resulting more accumulation of carbohydrates and higher WHC resulting prolonged vase life of tuberose spike. Similar results was earlier reported by Singh *et al.* (2014^b) [18] in gladiolus.

Table 1: Effect of planting dates and integrated nitrogen management on growth parameters

Treatment Details	Days taken to sprouting of bulbs	Plant height at 45 DAP(cm)	Plant height at 90 DAP(cm)	Number of leaves per plant at 45 DAP(cm)	Number of leaves per plant at 90 DAP(cm)
Planting date (P)					
P_1: 15th March	23.97	11.71	33.72	12.89	34.14
P_2: 1st April	13.95	21.89	34.68	12.96	37.43
P_3: 15th April	11.49	24.26	39.20	15.11	39.38
S.Em±	0.27	0.43	0.93	0.24	0.95
C.D. at 5%	1.07	1.72	3.66	0.97	3.76
C.V.%	6.43	8.82	10.07	7.06	10.04
Integrated nitrogen management (N)					
N_1:100% RDF	16.71	19.16	36.65	14.77	37.71
N_2:40% RDN through FYM + 40% RDN through Urea + NPK consortium	16.45	18.07	36.70	13.21	37.50

N_3:40% RDN through Vermicompost + 40% RDN through Urea + NPK consortium	15.61	21.17	40.93	16.18	41.67
N_4:30% RDN through FYM + 30% RDN through Urea + NPK consortium	16.57	17.82	31.63	11.74	32.81
N_5:30% RDN through Vermicompost + 30% RDN through Urea + NPK consortium	17.02	20.21	33.43	12.37	35.23
S.Em±	0.45	0.51	0.71	0.22	0.83
C.D. at 5%	NS	1.50	2.09	0.66	2.44
C.V.%	8.26	8.00	6.01	5.01	6.80

Table 2: Effect of planting dates and integrated nitrogen management on flowering and yield parameters

Treatment Details	Days taken to emergence of first spike	Days taken to opening of first floret	Number of spike plant^{-1}	Number of spikes plot^{-1}	Number of spikes (ha^{-1}) ('000)	Weight of florets g plant^{-1}	Floret Yield kg plot^{-1}	Floret Yield q ha^{-1}
Planting date (P)								
P_1: 15th March	135.81	153.61	4.05	44.99	555.47	200.55	1.59	196.54
P_2: 1st April	127.59	142.79	4.19	47.77	589.71	214.91	1.64	202.05
P_3: 15th April	119.75	133.45	5.29	55.40	683.95	288.23	1.83	225.51
S.Em±	2.93	3.12	0.13	1.26	15.67	4.29	0.03	3.81
C.D. at 5%	11.52	12.27	0.53	4.98	61.53	16.84	0.12	14.95
C.V.%	8.90	8.45	11.61	9.96	9.96	7.08	7.09	7.09
Integrated nitrogen management (N)								
N_1:100% RDF	128.24	142.04	5.03	49.63	612.76	236.88	1.78	220.16
N_2:40% RDN through FYM + 40% RDN through Urea + NPK consortium	126.91	143.44	4.46	50.04	617.97	275.88	1.67	205.62
N_3:40% RDN through Vermicompost + 40% RDN through Urea + NPK consortium	119.04	134.46	5.64	57.27	756.38	193.58	1.96	242.51
N_4:30% RDN through FYM + 30% RDN through Urea + NPK consortium	133.84	150.06	3.47	42.04	519.07	210.67	1.46	179.97
N_5:30% RDN through Vermicompost + 30% RDN through Urea + NPK consortium	130.56	146.42	3.92	43.93	542.39	4.88	1.55	191.91
S.Em±	2.35	3.08	0.09	1.17	14.54	14.26	0.032	3.96
C.D. at 5%	6.86	9.01	0.27	3.43	42.43	6.25	0.094	11.56
C.V.%	5.53	6.47	6.21	7.15	7.15		5.71	5.71

Table 3: Effect of planting dates and integrated nitrogen management on quality parameters

Treatment Details	Length of spike (cm)	Length of rachis (cm)	Number of floret per spike	Weight of floret (g)	Vase life (days)
Planting date (P)					
P_1: 15th March	68.14	33.32	38.12	3.08	9.91
P_2: 1st April	73.74	35.73	43.56	3.22	10.11
P_3: 15th April	80.20	36.61	46.93	3.37	10.98
S.Em±	1.05	0.48	0.41	0.03	0.13
C.D. at 5%	4.13	1.89	1.61	0.14	0.54
C.V.%	5.51	7.17	3.71	4.51	5.17
Integrated nitrogen management (N)					
N_1:100% RDF	77.14	37.58	43.57	3.28	10.92
N_2:40% RDN through FYM + 40% RDN through Urea + NPK consortium	73.77	36.73	43.28	3.20	10.41
N_3:40% RDN through Vermicompost + 40% RDN through Urea + NPK consortium	80.37	38.52	47.27	3.49	11.99
N_4:30% RDN through FYM + 30% RDN through Urea + NPK consortium	68.73	33.64	39.78	2.99	8.92
N_5:30% RDN through Vermicompost + 30% RDN through Urea + NPK consortium	70.13	34.63	41.14	3.15	9.43
S.Em±	1.23	0.61	0.51	0.04	0.16
C.D. at 5%	3.60	1.78	1.51	0.13	0.46
C.V.%	5.00	7.06	3.62	4.33	4.64

Conclusion

In view of the results obtained from the present investigation, it may be concluded that tuberose should be planted on 15th April with the application of 40 percent recommended dose of nitrogen through vermicompost plus 40percent recommended dose of nitrogen through urea along with NPK consortium for higher growth, yield and quality under North Gujarat Agro-climatic condition.

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