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Bulb production of tuberose (*Polianthes tuberosa* Linn.) cv. Prajwal as influenced by NPK, FYM, and vermicompost

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ABSTRACT

Commercial bulb production is an important aspect in the floriculture industry for ornamental Plants propagated through bulbs, asexually. Production of optimum bulb size is crucial in tuberose, as it influences the plant characteristics, flowering and yield parameters. The present study investigated the response of tuberose (*Polianthes tuberosa* Lin.) to organic amendments (FYM, vermicompost) and recommended dose of NPK in terms of bulb production. The experiment consisted of 11 treatments and was replicated 3 times. The treatment combinations were T_1 (Control), T_2 (Recommended dose of NPK/60:30:45 kg/ha), T_3 (FYM @25 tons/ha), T_4 (FYM @50 tons/ha), T_5 (FYM @75 tons/ha), T_6 (Vermicompost @10 tons/ha), T_7 (Vermicompost @20 tons/ha), T_8 (Vermicompost @30 tons/ha), T_9 (FYM + Vermicompost @25 tons/ha + 10 tons/ha), T_{10} (FYM + Vermicompost @50 tons/ha + 20 tons/ha) and T_{11} (FYM + Vermicompost @75 tons/ ha + 30 tons/ha). Treatment T_{11} had the highest bulblet the world diameter, mother bulb diameter (4.69 cm), bulblet weight (7.34 g), mother bulb weight (69.02 g), maximum number of bulbs/clump (29.10), clump weight (214.44 g) and 1.50 kg bulb yield/unit area. Thus, treatment T_{11} was found to be the best treatment combination among all the treatments in terms of bulb production.

***Key words :** Farm Yard Manure, Fertilizers, Floriculture, Manure, Tuberose, Vermicompost*

Introduction

Tuberose (*Polianthes tuberosa* Linn.) commonly known as Gulcheri or Nishigandha (Marathi), Rajnigandha (Bengali and Hindi), Nelasampengi (Telugu), Gul-e-shabu (Urdu), Sugandharaja (Kannada and Tamil) and Gulchadi (Gujrati) (Randhawa *et al.*, 2001), is one of the most important tropical bulbous, perennial flowering plants cultivated for the production of long-lasting flower spikes (Singh and Shankar, 2011). It belongs to the family Amaryllidaceae and is native to Mexico (Trueblood, 1973). Tuberose has a prominent position among ornamental bulbous crops due to its magnificent flowers and fragrance. They are grown commercially in different countries, including India, Kenya, Mexico, Morocco, France, Italy, South Africa, Taiwan, USA, Egypt, China and many other tropical and subtropical areas in the world. Tuberose is grown on a large scale in India; however, its commercial cultivation is mainly confined to Karnataka, Uttar Pradesh, West Bengal, Tamil Nadu, Maharashtra, Andhra Pradesh, Gujarat, Haryana, Punjab, Rajasthan, Delhi, Assam and Chhattisgarh.

Tuberose can be grown on almost all types of soils, but their production in terms of flower and bulb yield is highly influenced by soil physical and chemical properties (Noghani *et al.,* 2012). They are heavy feeders and require a high amount of organic and inorganic fertilizers to maintain sustainable growth and flowering over a long period (Amarjeet *et al.,* 1996). The bulb size used for planting material is one of the determining factors that affects the growth, development and yield of the tuberose. The performance of tuberose is significantly affected by nitrogen, phosphorus, and potassium (Singh *et al.,* 2004). There are reports that suggest that the application of fair amounts of both organic and inorganic fertilizers significantly enhances the vegetative growth of the tuberose, which directly influences the bulb development of the plant (Jat *et al*., 2007).

Chemical fertilizers alone are not sustainable for crop production in the long run. The excessive and indiscriminate use of chemical fertilizers and negligence in soil conservation have not only resulted in exhaustion of soil and its nutrients but also in alterations in soil fertility and in the pollution of soil and water bodies. Therefore, it is necessary to reduce the dose of chemical fertilizers and supplement it with low-cost input organic fertilizer. The use of cost-effective and eco-friendly organic fertilizers has currently attained special significance in crop production to address sustainability problems, and tremendous success has been achieved in several economic crops. The present study aimed to investigate the effect of the combination of various organic soil amendments on bulb production and to determine the best treatment combination for tuberose bulb production.

Materials and Method

Experimental location

The experiment was carried out on an experimental farm in the Department of Horticulture, North Eastern Hill University, Tura Campus, Meghalaya (India) during 2020-2021. The climatic conditions of the region are subtropical, with high humid temperatures during summer and cool temperatures in winter months. The maximum and minimum temperatures during the study period were 37.85°C and 13.30 °C, respectively, while the relative humidity was 89.76% and 55.86%, respectively. The annual rainfall during the study period was 148.47 mm.

Experimental details

The study consisted of 11 treatments and 3 replications in a randomized block design (RBD). The experimental plot was prepared with the recommended dose of fertilizers and the combination of FYM and vermicompost as follows: T_1: Control, T_2: Recommended dose of NPK, T_3: FYM (25 tons/ha), T_4: FYM (50 tons/ha), T_5: FYM (75 tons/ha), T_6: Vermicompost (10 tons/ha), T_7: Vermicompost (20 tons/ha), T_8: Vermicompost (30 tons/ha), T_9: FYM + Vermicompost (25 tons/ha + 10 tons/ha), T_{10}: FYM + Vermicompost (50 tons/ha + 20 tons/ha), and T_{11}: FYM + Vermicompost (75 tons/ha+ 30 tons/ha). The fertilizers and organic amendments were mixed thoroughly with the soil in each plot according to the treatments prior to bulb planting.

Planting materials and planting

Healthy bulbs of the tuberose cultivar Prajwal were purchased from Horticultural Research Station, Kahikuchi, Guwahati, Assam (India). The bulbs were treated with 4% thiourea to break dormancy. Bulbs were later dipped in 0.2% Bavistin to prevent fungal infection and dried in an open shade area. Well-dried bulbs were planted in a bed mixed with different soil amendments according to the treatments. A uniform optimum bulb size with a 2.5-3 cm diameter was used for planting. A hole/pit was planted at 30 x20 cm (Fig. 1).

Bulb production and harvesting

The bulbs were harvested after the end of flowering, the plants started ceasing growth, and the leaves became yellow and dry. Irrigation was withheld before collection of the bulbs, and soil was allowed to dry properly. Dried leaves and clumps were cut

Fig. 1. Field layout, tuberose at young stage

to ground level, and bulbs were lifted out by digging and collected for treatment. Adhering soil and unwanted particles were shaken off and cleaned up properly. Bulbs were then brought to the laboratory for further examination and kept under shade for one week.

Data collection and analysis

The bulblet diameter, mother bulb diameter, mother bulb weight, bulblet weight, No. of bulbs/clump, bulb yield/clump, and bulbs/unit area were examined by digital weighing machine. A total five bulbs/replication were measured and average value were subjected to ANOVA in online statistical analysis tool, OPSTAT.

Results and Discussion

Bulblet diameter

From the data shown in **Table 1** and **Fig. 2,** the maximum average bulblet diameter was recorded in treatment T_{11} (1.49 cm), which was on par with T_5 (1.48 cm), T_2 (1.45), T_{10} (1.42 cm) T_8 (1.41 cm), T_3 (1.40 cm), T_9 (1.39 cm) T_7 (1.37 cm) and T_4 (1.31 cm), whereas the lowest bulblet diameter was recorded in T_1 (1.11 cm), which was on par with treatment T_6 (1.12 cm). The largest bulblet size was obtained in T_{11}, which was significantly different from all the treatments. The lowest bulblet size was recorded in T_1 (2.85 cm), which was significantly lower than that in all other treatments.

Mother bulb diameter (cm)

The data pertaining to mother bulb diameter revealed that the maximum mother bulb diameter was found in T_{11} (4.69 cm), which was on par with T_5 (4.52 cm), T_{10} (4.52 cm), T_8 (4.49 cm), T_2 (4.45 cm), T_4 (4.36 cm), and T_9 (4.38 cm). The minimum mother bulb diameter was recorded in T_1 (3.19 cm), which was on par with treatment T_6 (3.39 cm) (Table 1 and Fig. 2).

Mother bulb weight (g)

An appraisal of data on mother bulb weight is presented in Table 1 and Fig. 2. The maximum weight of the mother bulb was recorded in treatment T_{11} (69.02 g), which was on par with treatment T_5 (63.03 g). The lowest mother bulb weight was recorded in treatment T_6 (29.25 g), which was on par with treatments T_1 (31.58 g), T_7 (34.38 g) and T_3 (36.10 g).

Bulblet weight (g)

The maximum weight of bulblets was recorded in treatment T_{11} (7.34 g), which was significantly higher than the rest of the treatments. The minimum weight of bulblets was recorded in treatment T_1

Table 1. Effect of NPK, FYM and vermicompost on bulblet diameter, mother bulb diameter, mother bulb weight, bulblet weight, number of bulbs per clump, bulb yield per clump, and bulb yield per unit area of tuberose (*Polianthes tuberosa* L.) cv. Prajwal

Treatments	BD (cm)	LBS (cm)	MBD (cm)	MBW(g)	BW(g)	BPC	BYPC (g)	BY/A (kg/m²)
T_1	1.51	2.85	3.19	31.58	2.28	20.47	57.33	0.55
T_2	1.65	3.97	4.45	57. 04	3.74	28.44	124.44	1.00
T_3	1.70	3.83	3.98	36.10	3.58	24.06	134.44	0.91
T_4	1.71	3.59	4.36	60.15	5.63	27.42	137.50	1.19
T_5	1.58	3.86	4.52	63.03	5.61	28.49	154.16	1.41
T_6	1.72	3.54	3.39	29.25	3.22	23.27	77.11	0.74
T_7	1.77	3.52	3.64	34.38	3.39	25.93	122.77	0.74
T_8	1.71	3.76	4.49	58.19	5.75	27.44	167.77	1.33
T_9	1.79	3.73	4.38	57.97	5.95	26.70	164.16	1.18
T_{10}	1.72	3.84	4.52	58.49	5.40	27.53	203.30	1.44
T_{11}	1.89	4.36	4.69	69.02	7.34	29.18	214.44	1.50
Mean	1.36	3.76	4.1	50.47	4.72	26.27	141.58	1.09
C.D (5%)	0.23	0.34	0.35	8.31	0.84	2.40	27.56	0.56
SE(d)	0.11	0.16	0.16	3.96	0.40	1.14	13.12	0.27
C.V (%)	8.99	5.26	9.49	9.60	10.45	5.33	11.34	31.17

BD: Bulblet diameter; LBS: Largest bulblet size; MBD: Mother bulb diameter; MBW: Mother bulb weight; BW: Bulb weight; BPC: Bulb per clump; BYPC: Bulb yield per clump; BY/A: Bulb yield per area

(2.28 g), which was significantly lower than the rest of the treatments (**Table 1**).

Number of bulbs/clump

From the data collected on the number of bulbs per clump presented in **Table 1,** the maximum number of bulbs per clump (29.18) was recorded in treatment $T_{11,}$ which was on par with treatments T_5 (28.49), T_2 (28.44), T_{10} (27.53), T_8 (27.44), and T_4 (27.42), while the minimum number of bulbs per clump (20.47) was recorded in treatment T_1.

Bulb yield per clump (g)

The observation recorded on bulb yield per clump is presented in Table 1, which shows that T_{11} had the highest weight of bulbs per clump (214.44 g) and was at par with treatment T_{10} (203.30 g). The lowest bulb yield per clump was recorded in treatment T_1 (57.33 g), which was on par with treatment T_6 (77.11 g).

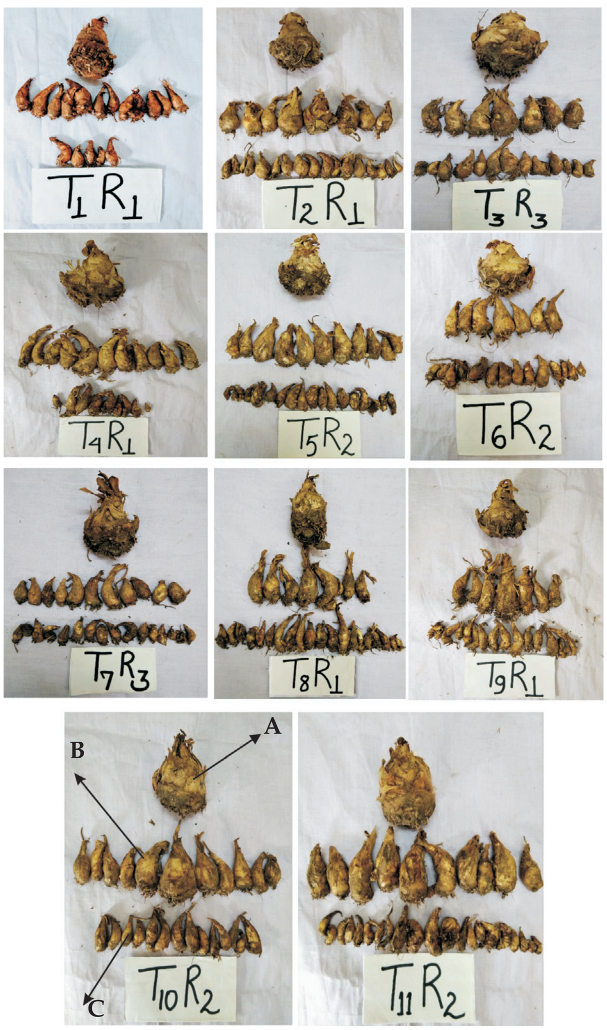

Fig. 2. Bulb size of different treatments A) Mother bulb; B) Optimum size bulblets; C) Bulblets smaller than optimum size (≤ 2.5 cm diameter)

Bulb yield per unit area (kg/m²)

The data on bulb yield per plot are presented in Table. The maximum bulb yield was found in treatment T_{11} (1.50 kg), which was on par with treatments T_{10} (1.44 kg), T_5 (1.41 kg), T_8 (1.33 kg), T_4 (1.19 kg) and T_9 (1.18 kg). The minimum yield was recorded in T_1 (0.55 kg), which was on par with treatments T_6 (0.74 kg), T_7 (0.74 kg), T_3 (0.91 kg) and T_2 (1.00 kg).

Discussion

The maximum bulblet size was recorded in T_{11} (1.49 cm) with the application of FYM @ 75 tons/ha + vermicompost @ 30 tons/ha. This was in line with Martolia and Srivastava (2012), who reported similar results of 1.18 cm bulblet diameter in tuberose. Bulblet size was directly correlated with the vegetative growth of the plant, as reported by Jat *et al*. (2007). Profuse vegetative growth helps to accumulate more carbohydrate storage in tuberose organs, resulting in increased bulb diameter. This was also in accordance with Kabir *et al.* (2011), who found that bulb diameter in tuberose cv. Single were greater in plants treated with organic fertilizers along with a half dose of chemical fertilizers than in those treated with the absolute use of chemical fertilizers.

This might be due to the production of more assimilates by a greater number of leaves (Shankar *et al*., 2010 and Kabir *et al.*, 2011) in tuberose. The significant effect of FYM along with vermicompost may be because vermicompost provided better nutrition, as it contains all the major nutrients in addition to micronutrients. It also improved the chemical, physical and biological properties of soil, in addition to providing organic carbon and improving the nutrient and water use efficiency, water holding capacity and porosity of soil. The obtained results were in accordance with the earlier findings of Preetham (2009), who reported maximum bulb diameter with the application of poultry manure + *Trichoderma*. Similar findings were also reported by Prakash *et al.* (2016) and Chaturvedi *et al.* (2014), who observed maximum bulb diameter in tuberose cv. Prajwal.

The results showed that the maximum weight (69.02 g) of the mother bulb was recorded in treatment T_{11} (FYM @ 75 tons/ha + vermicompost @30 tons/ha). This treatment increased the number of microbes in the soil. The use of organic manure helped increase the yield, weight and size of bulbs, which may be due to better root proliferation, more uptake of nutrients and water, luxuriant vegetative growth, more photosynthesis and enhanced food accumulation. The above results were also in conformity with the findings of Chaturvedi *et al.* (2014), who noticed the highest weight of bulbs (56.17 g) in cv. Prajwal, followed by Vaibhav (48.25 g).

The results revealed that the maximum weight of bulblets (7.34 g) was observed under treatment T_{11} (FYM @ 75 tons/ha + vermicompost @ 30 tons/ha). The obtained results were in accordance with the earlier findings of Wange *et al.* (1995) in tuberose, who revealed that inoculation with *Azotobacter* resulted in the maximum weight of bulblets. The higher weight of bulblets might be due to the higher vegetative growth as reported by Patil *et al.* (2009) in tuberose cv. Prajwal. The increase in bulblet weight might be attributed to the balanced distribution of dry matter between the storage organs and reproductive parts (Krishnamoorthy, 2014). Swaminathan *et al.* (1999) also reported similar results with the effect of biofertilizers on tuberose.

The results showed that the highest number of bulbs per clump (29.18) was observed in treatment T_{11} (FYM @ 75 tons/ha + vermicompost @ 30 tons/ha). It was evident from the data that the combined use of FYM and vermicompost produced more bulbs than the control. The results were in conformity with the findings of Rao *et al.* (2015), who reported a maximum number of bulbs/plant (32.60) when treated with 75% RDF in combination with FYM, vermicompost, *Azospirillum* and phosphate solubilizing bacteria in tuberose cv. Hyderabad Double. Similar results were reported by Meena *et al.* (2015) and Tripathi *et al.* (2012), who found that tuberose cv. A single treatment with 75% RDF + 500 quintal FYM + 250 quintal vermicompost/ha resulted in the maximum number of bulbs per clump (7.70 and 7.76). Kannan *et al.* (2013) also found the highest number of bulblets (34.16) in tuberose cv. Phule Rajani, followed by 30.28 in cv. Hyderabad Single and the lowest in Mexican Single (13.54).

The results revealed that the highest bulb weight per clump (214.44 g) was recorded in treatment T_{11} (FYM @ 75 tons/ha + vermicompost @ 30 tons/ha). Similar findings were also reported by Shankar *et al.* (2010) in tuberose, whose results indicated that the combined application of FYM and vermicompost was highly beneficial due to healthy vegetative growth, which might be responsible for higher photosynthesis resulting in increased bulb weight. The beneficial role of added organic manures in improving soil physical, chemical and biological properties is well known, which in turn helps in better nutrient absorption by plants and results in higher weight. The application of organic manures significantly enhanced the availability of macro- and micronutrients in soil, which increased the net weight of the bulb.

The results showed that the maximum bulb yield (1.50 kg) per plot was found in treatment T_{11} (FYM @ 75 tons/ha + vermicompost @ 30 tons/ha). Similar improvements in bulb yield obtained by the application of vermicompost with other organic manures were also reported by Meena *et al.* (2015), Tripathi *et al.* (2012) and Rao *et al.* (2015) in tuberose. Jhon *et al.* (2007) also found an increase in bulb yield in tulip by the application of 100 tons/ha FYM and vermicompost.

Conclusion

From the present study, it can be concluded that treatment T11 (FYM @ 75 tons/ha + vermicompost @ 30 tons/ha) outperformed all other treatments in all the parameters recorded, viz., bulblet diameter, largest bulb size, mother bulb diameter, mother bulb weight, bulblet weight, number of bulbs per clump, bulb yield per clump, and bulb yield per unit area. Therefore, the combination of FYM and vermicompost at rates of 75 tons/ha and 30 tons/ha, respectively, can be successfully used for bulb production in tuberose.

Conflict of interest

The authors declare no conflict of interest.

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