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RESEARCH PAPER

Growth, yield and quality of tuberose (*Polianthes tuberosa* L.) as influenced by raised bed system, mulching and planting geometry

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Abstract: A field experiment was conducted to study the influence of raised bed system, mulching and planting geometry on growth, yield and quality of tuberose variety Prajwal. The experiment was laid out in a randomized block design with seventeen treatments replicated twice. The treatments include four raised bed system of 100 and 70 cm width with 50 and 30 cm isolation with and without plastic mulch having two plant spacing of 30 x 30 cm and 30 x 15 cm. Crop was also raised by conventional system of cultivation as check with ridge and furrow system spaced at 30 × 30 cm, applied with RDF @ 100: 50: 50 kg N:P_2O_5: K_2O ha^{-1} without mulch. The effects of these treatments on growth, yield, and quality of tuberose were studied. The treatments having closer spacing of 30 x 15 cm with mulch recorded significantly higher plant height. However, significantly higher plant spread, number of side shoots per plant and early flowering were recorded in the treatments having wider spacing of 30 x 30 cm with mulch irrespective of bed system. The treatments having 100 /30 cm bed system with mulch of 3 rows planting at 30 × 15 cm recorded significantly higher flower yield (46.04 t/ha), bulb yield (27.29 t/ha), B:C ratio (4.38) whereas the least flower yield (11.46 t/ha) and bulb yield 7.43 t/ha) was recorded in farmers practice with least B:C ratio (1.04). However, superior flowers with higher flower diameter (3.18 cm), 100 floret weight (107.86 g) and shelf life (8.50 days) were noticed in the treatments having 70 /50 cm bed system with mulch of 2 rows spaced at 30×30 cm.

Key words: Bed system, Mulching, Planting geometry, Tuberose

Introduction

Flowers are one of the most beautiful creation in nature and have become an integral part of civilization due to their fragrance, beauty and aesthetic value. Tuberose occupies pride place both as loose flower, cut flower and as a source of essential oil (Alan *et al*., 2007). Tuberose flowers are mainly used for garland, vase decoration, bouquets, *veni* making and frequently used during marriage or religious ceremonies. Tuberose (*Polianthes tuberosa* L.) is a half-hardy bulbous crop multiplying itself through the bulblets. It belongs to family Amaryllidaceae. Karnataka is one of the major tuberose growing states in the country and cultivated in most parts of the state. It is one of the lively hood crops for small and marginal farmers. Of the several factors that affect the growth, yield and quality of flowers, method of cultivation, mulching and planting geometry are of utmost importance.

Raised bed method of cultivation in horticultural crops is becoming very popular under intensive cultivation system with drip irrigation and mulching. It has come up as scientific method for proper growth and development of plants as it offers a pulverized loose aerated zone for root growth and protects the crop from water logging during heavy rains. The role of mulching is well known on the growth and production of many horticultural crops. It helps in retaining moisture in the soil and sometimes even substitutes. It protects the plants from loss of soil moisture by wind and soil evaporation and reduces the irrigation requirements besides controlling weed growth (Singh *et al*., 2015)

Planting geometry refers to the distance between and within the rows and markedly influences growth, yield, and quality of produce as it varies with the soil and climatic conditions. In tuberose low planting density results in wastage of inputs and very high planting density leads to severe competition, thus reducing individual bulb enlargement. For economic returns, bulbs should be planted at an optimum density. This practice helps not only for increased production of quality flowers but also for efficient utilization of resources. In view of it the trial was planned with set of objectives to assess the effect of raised bed system and mulching on crop growth, yield and quality of the flowers and to find out the suitable planting geometry for tuberose cultivation under raised bed system and mulching and also to with its economics.

Material and methods

A field experiment was conducted at Hi-Tech Horticulture Unit, Saidpur Farm, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad. during the *kharif* 2018-19 with an objective to assess the effect of raised bed system, mulching and planting geometry on growth, yield and quality of tuberose. The experimental site was located in Northern Transitional Zone (Zone No. 8) of Karnataka with latitude of 15° 28' 45.0" North, longitude of 74° 58' 52.2" East and altitude of 678 m above mean sea level (MSL).

The experiment was laid out in randomized complete block design (RCBD) design with seventeen treatments and two replications. The crop was grown on raised bed system with fertigation facility. Single type tuberose hybrid Prajwal was used for the study. Four raised bed system of 100 and 70 cm width with 50 and 30 cm isolation with and without plastic mulches spaced at two plant spacings of 30 x 30 cm and 30 x 15 cm were used for the experiment. Conventional ridge and furrow system with a spacing of 30 x 30 cm without mulch was taken as control. The crop was supplied with RDF @100: 50: 50 kg N:P_2O_5: K_2O

ha^{-1} in all the experimental plots. Treatments included were, T_1: 100 /50 cm bed with mulch of 3 rows planting at 30 × 30 cm, T_2: 100 /50 cm bed with mulch of 3 rows planting at 30 × 15 cm, T_3: 100 /50 cm bed without mulch of 3 rows planting at 30 × 30 cm, T_4: 100 /50 cm bed without mulch of 3 rows planting at 30 × 15 cm, T_5: 100 /30 cm bed with mulch of 3 rows planting at 30 × 30 cm, T_6: 100 /30 cm bed with mulch of 3 rows planting at 30 × 15 cm, T_7: 100 /30 cm bed without mulch of 3 rows planting at 30 × 30 cm, T_8: 100 /30 cm bed without mulch of 3 rows planting at 30 × 15 cm,T_9: 70 /50 cm bed with mulch of 2 rows planting at 30 × 30 cm, T_{10}: 70/50 cm bed with mulch of 2 rows planting at 30 × 15 cm, T_{11}: 70/50 cm bed without mulch of 2 rows planting at 30 × 30 cm,T_{12}: 70 /50 cm bed without mulch of 2 rows planting at 30 × 15 cm,T_{13}: 70 /30 cm bed with mulch of 2 rows planting at 30 × 30 cm, T_{14}: 70 /30 cm bed with mulch of 2 rows planting at 30 × 15 cm, T_{15}: 70 /30 cm bed without mulch of 2 rows planting at 30 × 30 cm, T_{16}: 70 /30 cm bed without mulch of 2 rows planting at 30 × 15 cm, T_{17}: Farmers practice of ridge and furrow planting at 30 × 30 cm, without mulch. Data were recorded on growth, yield and quality parameters and subjected to statistical analysis.

Results and discussion

Effect on growth parameters of tuberose

The treatments of closer spacing of 30 x 15 cm with mulch (T_2 T_6 T_{14} & T_{10}) recorded significantly higher plant height (75.81, 73.09, 72.39 & 71.93 cm respectively) irrespective of bed system and were on par with each other . The lower plant height was recorded in the treatment having wider spacing of 30 x 30 cm without mulch and least (58.87 cm) was in farmers practice (T_{17}) (Table 1). The higher values for plant height at closer spacing with mulch were due to vertical growth of plant because of dense population and soil covered with plastic mulch provided the favourable microclimate resulted in less horizontal growth. The results obtained by Sharma *et al.* (2015) in chrysanthemum indicates that the wider spacing of 30 × 20 cm recorded taller plants, less number of branches per plant, while, wider spacing of 30 × 30 cm recorded higher fresh flower weight and number of flowers per plant.Significantly higher plant spread (41.82, 39.86 & 37.41cm) and number of side shoots per plant (11.15,10.75 & 9.75) were recorded in the treatments having wider spacing of 30 x 30 cm with mulch (T_9 T_{13} & T_5 respectively) irrespective of bed system. The lower plant spread and number of side shoots per plant was recorded in the treatment having closer spacing of 30 x 15 cm without mulch(8.61cm) and the least (1.53 cm) was in farmers practice (T_{17}) and data are presented in Table 1. The increase in the plant spread and number of side shoots per plant might be due to the availability of more space in wider spacing which might be congenial for more horizontal growth leading to higher plant spread and higher number of side shoots per plant.

These results were in close conformity with the findings of Singh and Kishan (2003) in tuberose var. Sringar, wherein they obtained higher plant spread (46.25cm) and more number of side shoots (11.50) per plant in wider spacing of 45x30 cm.

Early flowering (66.03 days) was recorded in treatment having 100 /30 cm bed system with mulch of 3 rows planting at 30 × 30 cm (T_5) and was superior over all the treatments. The delayed flowering (93.97 days) was observed in farmers practice (T_{17}) and data are presented in Table 1. This could be due the wide space between the plants and lower isolation space between the raised beds besides the favourable microclimate under much. The findings of Desai *et al*. (2017) confirm that wider plant spacing of 45 x 30 cm flowered early (73.50 days) than closer spacing of 30 x 30 cm (81.25 days).

Table 1. Growth characters of tuberose as influenced by raised bed system, mulching and planting geometry

Treatments	Plant height (cm)	Plant spread (cm)	No. of side shoots per plant	Days to first flowering
T_1: 100 /50 cm bed with mulch of 3 rows planting at 30 × 30 cm	68.24	38.34	10.05	72.25
T_2: 100 /50 cm bed with mulch of 3 rows planting at 30 × 15 cm	75.81	34.36	8.75	77.46
T_3: 100 /50 cm bed without mulch of 3 rows planting at 30 × 30 cm	64.25	37.25	8.95	82.28
T_4: 100 /50 cm bed without mulch of 3 rows planting at 30 × 15 cm	69.81	32.84	7.90	83.47
T_5: 100 /30 cm bed with mulch of 3 rows planting at 30 × 30 cm	68.69	37.41	9.75	66.03
T_6: 100 /30 cm bed with mulch of 3 rows planting at 30 × 15 cm	73.09	33.74	8.05	77.07
T_7: 100 /30 cm bed without mulch of 3 rows planting at 30 × 30 cm	66.80	35.83	9.10	83.35
T_8: 100 /30 cm bed without mulch of 3 rows planting at 30 × 15 cm	69.89	32.26	7.55	84.40
T_9: 70 /50 cm bed with mulch of 2 rows planting at 30 × 30 cm	63.42	41.82	11.15	74.80
T_{10}: 70/50 cm bed with mulch of 2 rows planting at 30 × 15 cm	71.93	36.17	8.55	76.23
T_{11}: 70/50 cm bed without mulch of 2 rows planting at 30 × 30 cm	63.26	38.42	9.55	80.85
T_{12}: 70 /50 cm bed without mulch of 2 rows planting at 30 × 15 cm	68.75	32.48	8.30	83.87
T_{13}: 70 /30 cm bed with mulch of 2 rows planting at 30 × 30 cm	71.10	39.86	10.75	82.05
T_{14}: 70 /30 cm bed with mulch of 2 rows planting at 30 × 15 cm	72.39	35.40	8.55	83.50
T_{15}: 70 /30 cm bed without mulch of 2 rows planting at 30 × 30 cm	64.66	37.24	9.30	84.80
T_{16}: 70 /30 cm bed without mulch of 2 rows planting at 30 × 15 cm	68.21	32.32	7.70	86.60
S. Em.±	2.23	1.97	0.34	0.99
C.D. @ 0.05	6.69	5.89	1.02	2.98
T_{17}: Farmers practice of ridge and furrow planting at 30 × 30 cm with RDF @100: 50: 50 kg $N:P_2O_5:K_2O$ ha^{-1} without mulch	58.87	30.17	7.05	93.97
Dunnett's CD @0.05	10.05	8.61	1.53	4.47

Table 2. Yield and flower quality parameters of tuberose as influenced by raised bed system, mulching and planting geometry

Treatments	Flower yield (t/ha)	Bulb yield (t/ha)	Flower diameter (cm)	100 floret weight (g)	Shelf life (days)
T_1: 100 /50 cm bed with mulch of 3 rows planting at 30 × 30 cm	18.92	13.03	2.91	109.91	6.00
T_2: 100 /50 cm bed with mulch of 3 rows planting at 30 × 15 cm	33.92	20.52	2.60	102.30	8.00
T_3: 100 /50 cm bed without mulch of 3 rows planting at 30 × 30 cm	17.22	11.70	2.78	100.82	6.50
T_4: 100 /50 cm bed without mulch of 3 rows planting at 30 × 15 cm	31.87	19.72	2.59	97.00	6.50
T_5: 100 /30 cm bed with mulch of 3 rows planting at 30 × 30 cm	18.68	11.33	2.88	105.35	6.00
T_6: 100 /30 cm bed with mulch of 3 rows planting at 30 × 15 cm	46.04	27.29	3.14	100.85	6.50
T_7: 100 /30 cm bed without mulch of 3 rows planting at 30 × 30 cm	18.23	11.59	2.63	102.40	6.00
T_8: 100 /30 cm bed without mulch of 3 rows planting at 30 × 15 cm	35.14	26.77	2.67	97.96	7.50
T_9: 70 /50 cm bed with mulch of 2 rows planting at 30 × 30 cm	15.25	11.52	3.18	107.86	8.50
T_{10}: 70/50 cm bed with mulch of 2 rows planting at 30 × 15 cm	27.89	19.14	2.47	99.19	6.50
T_{11}: 70/50 cm bed without mulch of 2 rows planting at 30 × 30 cm	14.92	10.83	2.96	100.81	7.00
T_{12}: 70 /50 cm bed without mulch of 2 rows planting at 30 × 15 cm	26.93	18.55	2.70	96.44	6.50
T_{13}: 70 /30 cm bed with mulch of 2 rows planting at 30 × 30 cm	17.19	12.59	2.52	104.31	6.00
T_{14}: 70 /30 cm bed with mulch of 2 rows planting at 30 × 15 cm	31.10	20.35	2.26	98.97	7.00
T_{15}: 70 /30 cm bed without mulch of 2 rows planting at 30 × 30 cm	17.00	12.19	2.27	100.80	7.00
T_{16}: 70 /30 cm bed without mulch of 2 rows planting at 30 × 15 cm	30.82	19.73	2.19	98.60	6.50
S. Em.±	0.77	0.29	0.16	2.46	0.53
C.D. @ 0.05	2.32	0.87	0.47	7.36	1.60
T_{17}: Farmers practice of ridge and furrow planting at 30 × 30 cm with RDF @100: 50: 50 kg $N:P_2O_5:K_2O$ ha^{-1} without mulch	11.46	7.43	2.42	72.96	4.00
Dunnett's CD @0.05	3.50	1.32	0.70	11.12	2.39

Table 3. Economics of tuberose cultivation as influenced by raised bed system, mulching and planting geometry

Treatments	Flower yield (t/ha)	Bulb yield (t/ha)	Gross return (₹ /ha)	Total Cost of cultivation (₹ /ha)	Net return (₹ /ha)	B:C
T_1: 100 /50 cm bed with mulch of 3 rows planting at 30 × 30 cm	18.91	13.03	828193	328400	499793	1.52
T_2: 100 /50 cm bed with mulch of 3 rows planting at 30 × 15 cm	33.92	20.52	1428152	358400	1069752	2.98
T_3: 100 /50 cm bed without mulch of 3 rows planting at 30 × 30 cm	17.21	11.69	750452	317700	432752	1.36
T_4: 100 /50 cm bed without mulch of 3 rows planting at 30 × 15 cm	31.87	19.71	1350567	347700	1002867	2.88
T_5: 100 /30 cm bed with mulch of 3 rows planting at 30 × 30 cm	18.67	11.32	786869	328400	458469	1.40
T_6: 100 /30 cm bed with mulch of 3 rows planting at 30 × 15 cm	46.03	27.28	1926841	358400	1568440	4.38
T_7: 100 /30 cm bed without mulch of 3 rows planting at 30 × 30 cm	18.22	11.59	778651	317700	460951	1.45
T_8: 100 /30 cm bed without mulch of 3 rows planting at 30 × 15 cm	35.13	26.77	1589669	347700	1241968	3.57
T_9: 70 /50 cm bed with mulch of 2 rows planting at 30 × 30 cm	15.25	11.51	687913	328400	359513	1.09
T_{10}: 70/50 cm bed with mulch of 2 rows planting at 30 × 15 cm	27.89	19.14	1219684	358400	861284	2.40
T_{11}: 70/50 cm bed without mulch of 2 rows planting at 30 × 30 cm	14.92	10.82	664194	317700	346494	1.09
T_{12}: 70 /50 cm bed without mulch of 2 rows planting at 30 × 15 cm	26.92	18.55	1178796	347700	831096	2.39
T_{13}: 70 /30 cm bed with mulch of 2 rows planting at 30 × 30 cm	17.18	12.58	767405	328400	439004	1.34
T_{14}: 70 /30 cm bed with mulch of 2 rows planting at 30 × 15 cm	31.09	20.34	1339906	386200	953706	2.47
T_{15}: 70 /30 cm bed without mulch of 2 rows planting at 30 × 30 cm	17.00	12.18	753859	317700	436159	1.37
T_{16}: 70 /30 cm bed without mulch of 2 rows planting at 30 × 15 cm	30.81	19.73	1319096	347700	971395	2.79
T_{17}: Farmers practice of ridge and furrow planting at 30 × 30 cm with RDF @100: 50: 50 kg $N:P_2O_5:K_2O$ ha^{-1} without mulch	11.46	7.43	492422	167700	174722	1.04

Selling price of flower: ₹ 40/kg and bulbs ₹ 20/kg

Effect on yield parameters of tuberose

The treatments having 100/30 cm bed system with mulch of 3 rows planting at 30 × 15 cm recorded significantly higher flower yield (46.04 t/ha) and bulb yield (27.29 t/ha) (T_6) and was superior over all the treatments and least flower yield (11.46 t/ha) and bulb yield (7.43 t/ha) was recorded in farmers practice (T_{17}) and data are presented in Table 2. This higher flower yield and bulb yield per hectare might be due to higher planting density leading to efficient utilization of resources and also lower isolation space between the raised beds besides favourable microclimate under much. Similar results were in conformity with Khan *et al*. (2016) in tuberose where in they obtained higher flower and bulb yield per unit area in closer spacing than wider.

Effect on flower quality parameters of tuberose

Superior flowers having significantly higher flower diameter (3.18 cm), 100 floret weight (107.86 g) and shelf life (8.50 days) were recorded in the treatments having 70 /50cm bed system with mulch of 2 rows planting at 30 × 30 cm. (T_9) and were on par with (T_6) whereas the least flower diameter (2.42 cm), 100 floret weight (72.96 g) and shelf life (4.00days) were recorded

in farmers practice (T_{17}) and data are presented in Table 2. This could be due the wider space between the plants and between the raised beds besides the favourable microclimate under mulch might have influenced the plant to grow vigorous with more of photosynthates The results fully support the findings of Desai *et al*. (2017) and Suseela *et al.,* (2016) in tuberose where in they obtained superior quality flowers having higher flower diameter, floret weight and good shelf life in widely spaced plants.

Economic analysis

The economic analysis of the various treatments with respect to their output revealed that treatment T_6: 100 /30cm bed with mulch of 3 rows planting at 30 × 15 cm recorded higher BC ratio (4.38) and was superior over all the treatments and data are presented in Table 3. This might be mainly due to the higher yield of both flowers and bulbs resulting in higher gross (₹ 19, 26,841) and net returns (₹ 15, 684, 40). While the least BC ratio of 1.04 was observed in farmers practice ((T_{17}) due to lower yield of both flowers and bulb leading to lesser gross (₹ 4, 92,422) and net returns (₹ 1, 74,722).

Conclusion

It was concluded that planting 3 rows of tuberose bulb at 30 x 15 cm on 100/30 cm wide raised beds with plastic mulching was found optimum for higher growth, yield, and quality of tuberose besides higher net returns.

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