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Effect of spacing and crop duration on growth, flowering and bulb production in tuberose (*Polianthes tuberosa* L.) cv. Double

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ABSTRACT

Field experiments were conducted at Junagadh during 2002-05 to study the response of spacing (45 x 45, 45 x 30, 45 x 15, 30 x 30 and 30 x 15 cm) and crop duration (first year crop, first ratoon and second ratoon) on growth, flowering, cut flower yield and bulb production in tuberose cv. Double. The widest spacing (45 cm x 45 cm) registered the highest values for plant height (46.18 cm), number of leaves per clump (67.25), spike length (89.64 cm), spike diameter (0.95 cm), diameter of open flower (4.6 cm), rachis length (34.8 cm), number of spikes per clump (4.1), number of florets per spike (48.2), number of bulbs per clump (18.40) and number of bulblets per clump (31.60). It also induced early spike emergence and flowering. A planting distance of 30 x 30 cm realized the highest cut flower yield (2.72 lakh ha^{-1}) and that of 30 cm x 15 cm recorded the highest bulb production (22 lakh ha^{-1}). Ratoon crops showed higher plant height, number of leaves, bulbs, bulblets and spikes per clump and cut flower yield as well as bulb production over the first year crop. Early spike emergence and flowering was also noted in ratoon crops compared to the first year crop. However, spike and flower quality was inferior to that of first year crop with regard to spike length and diameter, number of florets per spike, diameter of open flower and rachis length.

Key words: Tuberose, spacing, crop duration, growth and flowering

INTRODUCTION

Gujarat is endowed with a diverse agroclimate conducive for growing different flower crops throughout the year. Gujarat has made rapid strides in floriculture, evident from 61% increase in area from 7,118 ha (2005-06) to 11,473 ha (2008-09) and over 100% increase in flower production from 42,182 tonnes in 2005-06 to 85,216 tonnes in 2008-09 (Anon., 2009). Major flowers grown in the state are roses, spider lily, marigold, jasmine and tuberose. Among these, tuberose is valued by the aesthetic world for its beauty, elegance and pleasant fragrance. Long flower spikes are excellent cut flowers for table decoration. Individual florets are much in demand for preparation of artistic garlands, floral ornaments, bouquets and for button holes. The 'concrete' and 'absolute' prepared from tuberose florets are valuable perfumery products. In fact, India is the second largest producer and exporter of tuberose concrete to the world market. Though tuberose is cultivated on a commercial scale in Gujarat, there are no standard recommended packages of practices available for the Saurashtra region of Gujarat. It is well established that flower and bulb production in tuberose is strongly influenced by planting density and crop duration, besides other factors. Keeping this in mind, the present experiment was undertaken to evaluate the response of spacing and crop duration on growth, flowering, cut flower yield and bulb production in tuberose.

MATERIAL AND METHODS

The present investigation was undertaken at the Jambuvadi Fruit Research Station, Department of Horticulture, Junagadh Agricultural University, Junagadh. The effect of five different spacings (45 x 45, 45 x 30, 45 x 15, 30 x 30 and 30 cm x 15 cm) on growth, cut flower yield and bulb production in tuberose was evaluated in a Randomized Block Design with four replications. Medium sized bulbs (1.8 to 2.4 cm in diameter) of tuberose cultivar 'Double' were planted in the first week of June 2002 and retained for the next three years [first year crop, second year crop (first ratoon) and third year crop (second ratoon)]. The experimental field was brought to a fine tilth by ploughing and harrowing. The gross plot size was 2.70 m x 2.70 m. However, net plot size varied with the spacing employed (Table1).

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Well decomposed farm yard manure @15 t ha^{-1} was uniformly applied and thoroughly mixed with the soil. The crop was fertilized with 150 kg N, 25 kg P_2O_5 and 25 kg K_2O ha^{-1}. Half dose of nitrogen as urea, and full doses of phosphorus as single super phosphate and potassium as muriate of potash, were applied at the time of planting. The remaining half of nitrogen was applied in two equal splits at 45 and 90 days after planting. The same dose of fertilizers was repeated for ratoon crops, as well. Five plants were selected randomly from the net plot in each treatment and replication and tagged for recording observations. Plants were grown under uniform cultural practices. Observations were recorded on fourteen plant characters, viz., plant height, number of leaves per clump at first flower emergence, number of bulbs, bulblets and spikes per clump at final harvest, days to first spike emergence and first flower opening from the date of planting, spike length and diameter (cm), number of florets per spike, diameter of open flower (cm) and rachis length (cm). Cut flower and bulb yield (lakh ha^{-1}) were calculated on per hectare basis to reflect the yield per unit area. Plant height (cm) was measured from the ground level to the tip of the longest leaf at harvest. Data obtained were tested for critical difference (CD) among various treatments (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Vegetative growth parameters

Data presented in Table 2 reveal that different spacings and crop duration had significant influence on growth of tuberose in the first year crop and ratoon crops.

Table 1. Planting density and net plot size under different spacings

Sl. No.	Spacing (cm)	Planting density (number of plants/ha)	Net plot size (m)
S_1	45 x 45	49383	1.80 x 1.80
S_2	45 x 30	74074	2.10 x 1.80
S_3	45 x 15	148148	2.40 x 1.80
S_4	30 x 30	111111	2.10 x 1.80
S_5	30 x 15	222222	2.40 x 2.10

Table 2. Influence of spacing and crop duration on vegetative growth parameters in tuberose cv. 'Double'

Spacing(cm)	Plant height (cm)			No. of leaves per clump		
	First year crop	Ratoon crop		First Second ratoon	Ratoon crop	
		Firs ratoon	year crop		First ratoon	Second ratoon
S_1 (45 x 45)	46.18	52.63	58.82	67.25	82.70	98.00
S_2 (45 x 30)	44.15	49.30	56.82	60.75	74.95	91.70
S_3 (45 x 15)	35.76	42.86	43.74	46.95	60.00	76.10
S_4 (30 x 30)	41.72	48.99	55.79	57.80	69.60	87.80
S_5 (30 x 15)	30.09	33.66	33.45	36.60	46.15	57.50
CD *(P = 0.05)*	5.36	5.40	4.53	8.36	12.75	11.91

Growth parameters, viz., plant height and number of leaves per clump increased with increase in spacing. The widest spacing of 45 cm x 45 cm was at par with 45 cm x 30 cm and recorded the highest values for plant height (46.18 cm) and number of leaves per clump (67.25). This may be due to greater available space to every plant for availing sufficient nutrients, soil moisture and solar radiation, factors which may have restricted the plants in closer spacings. This is in accordance with findings of Malik *et al* (2009). These attributes progressively increased in ratoon crops compared to the first year crop. This could be ascribed to formation of bulblets in the first year crop that could develop into bulbs in the ratoon crop which, in turn promoted plant growth during the ratoons.

Flowering traits

Flowering traits also differed significantly under various plant spacings and crop durations in the first year crop as well as in ratoon crops (Table 3). However, days to spike emergence, days to first flower opening and spike diameter were not affected by spacing in the second ratoon crop. It was also observed that days to spike emergence and days to first flower opening decreased with increase in spacing. On the other hand, spike length, spike diameter, diameter of open flower and rachis length increased with increase in spacing. Wider spacings, viz., 45 cm x 45 cm and 45 cm x 30 cm were on par and induced early spike emergence with higher spike length and diameter as compared to closer spacings (45 cm x 15 cm and 30 x 15 cm). Earliest spike emergence (205.75 days) and maximum spike length (89.64 cm) and diameter (0.95 cm) were observed under a spacing of 45 cm x 45 cm. Better growth and subsequent differentiation may have contributed to improved spike characters under wider spacing. Similar results were obtained by Tyagi *et al* (2008). Early spike emergence was recorded in ratoon crops compared to the first year crop. This might be due the well established root system in ratoon crops. Nevertheless, spikes had smaller diameter in both ratoon crops compared to the first year crop.

Wider spacings also resulted in early opening of flowers, with higher diameter of open flower and rachis length. The spacing of 45 cm x 45 cm registered minimum days to flower opening (229.2 days) and maximum diameter of open flowers (4.6 cm) and rachis length (34.8 cm). Better leaf growth under wider spacing may have accelerated photosynthesis during the vegetative period and its translocation of photosynthesis to various metabolic sinks during the reproductive period could be responsible for

improvement in floral attributes. These results are in line with those reported by Kumar and Singh (1998). Early flowering was observed in ratoon crops compared to that in the first year crop. However, flower quality (with regard to diameter of open flowers and rachis length) was inferior to the first year crop.

Cut flower yield and Bulb production

An appraisal of data furnished in Table 4 indicates that cut flower yield and associated traits were significantly affected by planting distance and crop duration in the first year crop and ratoon crops. Number of spikes per clump and number of florets per spike increased with increase in spacing. Maximum number of spikes per clump (4.1) and number of florets per spike (48.2) were obtained in bulbs planted at a spacing of 45 cm x 45 cm. Ratoon crops recorded higher number of spikes per clump than the first year crop, whereas, the first year crop registered higher number of florets compared to the ratoon crops. Cut flower yield increased with decrease in spacing and highest cut flower yield (2.72 lakh/ha) was recorded under a spacing of 30 x 30 cm, which was at par with 45 cm x 15 cm spacing in both the first year crop and in ratoon crops. These results are in agreement with earlier findings of Kadam *et al* (2005). Higher cut flower yield was observed in ratoon crops as compared to the first year crop.

Bulb production also varied significantly with different spacings and crop durations in the first year crop and ratoon crops (Table 5). Number of bulbs and bulblets per clump increased with increase in spacing. The widest spacing of 45 x 45 cm was at par with 45 cm x 30 cm and the highest number of bulbs (18.40) and bulblets (31.60) per clump. Number of bulbs and bulblets per clump under each spacing were correspondingly higher in ratoon crops compared to the first year crop. Bulb yield increased with decrease in spacing. Highest bulb yield (22.00 lakh/ha) was obtained with a spacing of 30 cm x 15 cm. This is in close conformity with observations of Singh (2003). Ratoon crops showed a progressive increase in bulb yield for each successive spacing compared to the first year crop. This may be ascribed to the fact that well established clumps had higher number of daughter bulbs which in turn produced more number of spikes thereby resulting in higher cut flower yield and bulb yield compared to the first year crop.

Table 3. Influence of spacing and crop duration on flowering traits in tuberose cv. 'Double'

Trait	Spacing (cm)					
	S_1 (45 x 45)	S_2 (45 x 30)	S_3 (45 x 15)	S_4 (30 x 30)	S_5 (30 x 15)	CD (P = 0.05)
1. Days to spike emergence						
First year crop	205.7	210.2	225.0	215.2	234.7	19.71
First ratoon crop	189.0	194.0	208.5	198.7	216.2	18.67
Second ratoon crop	178.7	183.7	193.7	189.7	200.7	NS
2. Days to first flower opening						
First year crop	229.2	235.0	257.0	240.2	268.7	25.01
First ratoon crop	216.2	222.0	239.2	228.2	249.2	14.79
Second ratoon crop	203.0	210.5	221.7	216.2	228.5	NS
3. Spike length (cm)						
First year crop	89.6	87.0	74.9	84.2	66.4	7.08
First ratoon crop	82.4	77.2	62.3	70.8	53.0	7.15
Second ratoon crop	68.4	64.5	50.9	62.1	39.7	6.72
4. Spike diameter (cm)						
First year crop	0.95	0.92	0.87	0.90	0.82	0.06
First ratoon crop	0.83	0.78	0.72	0.75	0.65	0.04
Second ratoon crop	0.67	0.66	0.64	0.65	0.61	NS
5. Diameter of open flower (cm)						
First year crop	4.6	4.4	4.0	4.3	3.9	0.6
First ratoon crop	3.3	3.0	2.4	2.7	2.2	0.18
Second ratoon crop	2.6	2.8	2.1	2.5	1.5	0.14
6. Rachis length (cm)						
First year crop	34.8	33.0	30.4	32.1	28.9	3.2
First ratoon crop	27.2	24.9	19.5	21.7	17.8	1.58
Second ratoon crop	21.7	21.0	17.3	20.5	11.2	1.32

Table 4. Influence of spacing and crop duration on yield parameters in tuberose cv. 'Double'

Spacing(cm)	No. of spikes/clump			Number of florets/spike			Cut flower yield (lakh/ha)		
	First year crop	Ratoon crop		First year crop	Ratoon crop		First year crop	Ratoon crop	
		First ratoon	Second ratoon		First ratoon	Second ratoon		First ratoon	Second ratoon
S_1 (45 x 45)	4.1	4.6	5.0	48.2	40.7	35.0	1.99	2.21	2.46
S_2 (45 x 30)	3.1	3.5	4.0	46.2	37.1	32.5	2.27	2.57	2.94
S_3 (45 x 15)	1.5	2.0	2.1	40.7	30.9	25.8	2.26	2.93	3.05
S_4 (30 x 30)	2.9	2.9	3.0	44.3	33.3	31.7	2.72	3.24	3.25
S_5 (30 x 15)	0.9	1.0	1.1	34.0	26.3	17.6	1.94	2.16	2.38
CD *(P = 0.05)*	0.33	0.31	0.39	5.01	3.10	2.84	0.52	0.38	0.51

Table 5. Influence of spacing and crop duration on bulb production in tuberose cv. 'Double'

Spacing(cm)	No. of bulbs/ clump			No. of bulblets/clump			Bulb yield (lakh/ha)		
	First year crop	Ratoon crop		First year crop	Ratoon crop		First year crop	Ratoon crop	
		First ratoon	Second ratoon		First ratoon	Second ratoon		First ratoon	Second ratoon
S_1 (45 x 45)	18.40	24.05	28.10	31.60	38.80	44.00	09.09	11.88	13.88
S_2 (45 x 30)	16.55	21.95	25.10	28.15	34.90	39.40	12.26	16.26	18.59
S_3 (45 x 15)	12.05	15.65	17.65	23.20	28.10	30.40	17.85	23.19	26.15
S_4 (30 x 30)	14.20	18.85	21.00	26.00	31.85	34.85	15.78	20.94	23.33
S_5 (30 x 15)	9.90	12.45	14.15	18.50	21.95	23.90	22.00	27.67	31.44
CD *(P = 0.05)*	1.89	2.78	3.68	5.67	3.97	5.75	2.74	4.45	5.66

Ratoon crops registered higher cut flower yield and bulb production over the first year crop owing to better vegetative growth and higher number of spikes per clump. However, flower quality was inferior which can hinder better price realization in the increasingly quality conscious markets. Tuberose plants, when spaced at a distance of 30 cm x 30 cm, yielded maximum number of cut-flowers without any detrimental effect on flower quality.

From the present investigation it may be therefore inferred that for higher cut flower yield, planting distance of 30 cm x 30 cm and for higher bulb yield 30 cm x 15 cm be adopted for planting tuberose cv. 'Double' in the Saurashtra region of Gujarat. It is further recommended that fresh crop be planted for ensuring superior quality cut flowers.

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