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Effect of Spacing and Fertilizer Levels on Growth, Flowering and Spike Yield in Tuberose (*Polianthes tuberosa* L.) cv. Shringar under Field Experiment

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Abstract **– A field experiment were conducted to study the effects of spacing and fertilizer levels on growth, flowering and spike yield in Tuberose (*Polianthes tuberosa)* cv. Shringar. The experiment consisted of twelve treatment combinations, comprising of three spacing (S_1 - 45x30cm, S_2 - 30x30cm and S_3 - 30x15 cm), four levels of fertilizers doses (F_0 - Only FYM (25t/ha), F_1 - 200:200:200 kg NPK/ha.+ FYM, F_2 - 250:250:250 kg NPK/ha + FYM and F_3 - 300:300:300 kg NPK/ha + FYM) with four replication and Factorial in a Randomized Complete Block Design (RCBD). The result of field experiments**

revealed that the significant difference on growth, flowering and spike yield as affected by spacing and fertilizers levels. The spacing of 30x30cm with fertilizers levels of 250:250:250 kg NPK/ha+ FYM were found to be optimum for better growth were recorded and significant plant height(55.26cm), maximum number of leaves per plant(115.74), maximum number of side shoots per plant(22.64) and early sprouting of bulbs(10.85days) as compared to S_1F_0treatment interaction. Whereas, Spike characters such as early spike emergence (56.50 days) with maximum spike length (80.00 cm), rachis length (25.00 cm), spike girth (2.58 cm), weight of spike (122.65 g) and number of florets per spike (54.80) were significantly influenced by spacing and fertilizer levels and also flower characters such as early flowering (68.75 days) with maximum length of floret (6.33 cm), diameter of floret (3.24 cm), weight of 100 florets (121.67 g), duration of flowering (17.60 days) and cumulative spike (4.39 spike/pl/year) were significantly influenced by spacing and fertilizer levels found to be optimum at S_2F_2 level(30x30cm spacing with fertilizer 250:250:250 kg NPK/ha + FYM).

Flower characters such as early flowering (68.75 days) with maximum length of floret (6.33 cm), diameter of floret (3.24 cm), weight of 100 florets (121.67 g), duration of flowering (17.60 days) and cumulative spike (4.39 spike/pl/year) were significantly influenced by spacing and fertilizer levels found to be optimum at S_2F_2 level (30x30cm spacing with fertilizer 250:250:250 kg NPK/ha + FYM).

Keywords **– Tuberose cv. Shringar, Plant Spacing, Fertilizer Doses, Growth, Flowering, Spike Yield.**

I. INTRODUCTION

Tuberose (*Polianthes tuberosa* L. Amaryllidaceae*)* is anative of Maxico, it is essentially a florist's flower and leading commercial crop because of its multipurpose uses as cut flower, loose flower as well as its potential in perfume industry. Tuberose flowers are considered to be diuretic and emetic.

Dried tuberose bulbs in the powdered form are also used as a remedy for gonorrhea. The flower spike is used as a cut flower in vases, whereas, the individual florets are harvested for making garlands and venis(Singh et al., 1996). Its natural flower oil remains as one of the most expensive of the perfumery raw material. Tuberose concrete and absolute are great demand due to its expensive and high grade perfumery qualities. Tuberose grows successfully in the warm plains of India. The commercial cultivation of tuberose in India is confined to West Bengal (Ranaghat, Kolaghat and Panskura), Karnataka, Andhra Pradesh, Tamil Nadu and Maharashtra. The Indian Institute of Horticultural Research, Bangalore, released hybrid variety of tuberose viz., single type Shringar is known to yield 40 per cent more than Maxican single. The successful cultivation is influenced not only by the high yielding variety, but also by various agro-techniques viz., optimum spacing and fertilizer levels. So spacing between plants is particularly important for the cultivation of tuberose to maximize flower quality and quantity characteristics. Therefore, inter and intra row spacing together with a balanced supply of nutrients for obtaining optimum quality and quantity of tuberose flowers.

There is a scope of increasing flower yield and quality of flower of tuberose using plant spacing and fertilizer levels. Considering the present situations and above facts that the present investigation was undertaken with the following objective to determine the suitable combination of spacing and fertilizer dosefor better growth, flowering and spike yield of tuberose cv. Shringar

II. MATERIAL AND METHODS

The experiment were conducted atfarmer field of Khombaradevanahalli village, Mayasandra hobli, Turveker taluk, Tumkur district, Karnataka during 2013-14 and observation were recorded by Krishi Vigyana Kendra, Konehalli, Tiptur, Tumkur district. The soil status of experiment plot were red sandy loam with uniform fertility. There were twelve treatment combinations, comprising of three different plant spacing (S_1 - 45x30cm, S_2 -30x30cm and S_3 - 30x15 cm), four levels of fertilizer doses (F_0 - Only FYM (25t/ha), F_1 - 200:200:200 kg NPK/ha.+ FYM, F_2 - 250:250:250 kg NPK/ha + FYM and F_3 - 300:300:300 kg NPK/ha + FYM)

with four replication and Factorial in a Randomized Complete Block Design (RCBD).

Uniform sized bulbs having a diameter of 2.0 - 2.5 cm were selected and planted at 5 cm depth. Uniform cultural operations were followed by all the treatments plot. Observations were recorded on various growth parameters, floral parameters and spike yield and statistically analysed as per Sundararaj et al. (1972).

A. Treatment Details

Spacing(S): **S_1**- 45cm x 30cm, **S_2**- 30cm x 30cm, **S_3** - 30cm x 15cm

Fertilizer (F): **F_0** - Only FYM (25t/ha), **F_1**- 200:200:200 kg NPK/ha + FYM (25t/ha),
F_2- 250:250:250 kg NPK/ha + FYM (25t/ha), **F_3**- 300:300:300 kg NPK/ha + FYM (25t/ha)

Table 1: Showing Treatment combination

Treatments	Spacing(cm)	Fertilizer levels(kg/ha)
$T_1 = S_1F_0$	45x30	Only FYM (25t/ha)
$T_2 = S_1F_1$	45x30	200:200:200 kg NPK/ha + FYM (25t/ha)
$T_3 = S_1F_2$	45x30	250:250:250 kg NPK/ha + FYM (25t/ha)
$T_4 = S_1F_3$	45x30	300:300:300 kg NPK/ha + FYM (25t/ha)
$T_5 = S_2F_0$	30x30	Only FYM (25t/ha)
$T_6 = S_2F_1$	30x30	200:200:200 kg NPK/ha + FYM (25t/ha)
$T_7 = S_2F_2$	30x30	250:250:250 kg NPK/ha + FYM (25t/ha)
$T_8 = S_2F_3$	30x30	300:300:300 kg NPK/ha + FYM (25t/ha)
$T_9 = S_3F_0$	30x15	Only FYM (25t/ha)
$T_{10} = S_3F_1$	30x15	200:200:200 kg NPK/ha + FYM (25t/ha)
$T_{11} = S_3F_2$	30x15	250:250:250 kg NPK/ha + FYM (25t/ha)
$T_{12} = S_3F_3$	30x15	300:300:300 kg NPK/ha + FYM (25t/ha)

B. Treatment combination

Floret

Individual flowers in the spike

First spike emergence

The spike emergence were recorded by counting the number of days taken from planting of bulb to flower spike emergence.

First flowering

Number of days were taken from the date of planting to bulb and the opening of first basal floret in the spike were recorded.

Duration of flowering

The number of days were taken from the opening of first basal floret to opening of last floret were counted as duration of flowering of an individual spike.

Spike length:

Length of spike were measured from the base of the plant to tip of the last floret of the spike.

Spike girth

Girth of the spike were recorded from the node just below the basal floret.

Rachis length

It is measured the base of the origin of first basal floret to tip of the last floret.

Length of floret

Length of fully matured floret were measured.

III. Results And Discussion

The comparative performance of growth parameters, floral parameters and spike yield by effect of plant spacing and fertilizer levels were evaluated. The results are presented in Table 1, 2 and 3.

Effect of spacing on growth, flowering and spike yield:

Growth parameters such as plant height, number of leaves and number of side shoots were significantly influenced by different spacing (Table 1.). The spacing S_2 (30 x 30 cm) were found to be optimum with maximum plant height (53.57 cm), number of leaves (111.78) and number of side shoots (21.13). whereas lowest plant height (51.80 cm), number of leaves (108.79) and number of side shoots (20.73) were found in S_3 spacing (30x15 cm).

Effect of spacing did not significantly influence the number of days taken for sprouting of bulbs (Table 1.). It is due to the fact that, sprouting of bulbs is an initial process of growth which is completed within 10-14 days after planting by utilizing the stored food material. Planting density also did not show the significant difference on number of days taken for sprouting. Similar results were reported by Sadhu and Das (1978).

Spike characters like spike length and rachis length were not influenced significantly by spacing, but early spike emergence (58.27 days) with maximum spike girth (2.28 cm), weight of spike (118.23 g) and number of florets per spike (50.93) were significantly influenced by spacing at 30x30 cm and 45x30 cm on far with each other (Table 2.). where as Flower characters like early flowering and duration of flowering were not influenced significantly by spacing, but maximum length of floret (5.66 cm), diameter of floret (2.92 cm), weight of 100 florets (110.42 g) and cumulative spike (4.22 spike/pl/year) were significantly influenced by spacing at 30x30 cm and 45x30 cm on far with each other (Table 3.). This might be due to the fact that more space available with lesser competition for soil nutrient, moisture and morelight which might have better photosynthetic activity and increased growth and development. Similar results were reported by Singh

(1999) in single cultivars, Neeraj Rajwal et.al. (2006) and Khalaj and Edrisi (2012) in double cultivars

Table 2: Effect of spacing and fertilizer levels on sprouting of bulbs, Plant height, Number of leaves and Number of side shoots per plant in tuberose (*Polianthes tuberosa* L.*)* cv. Shringar

Treatments	Sprouting of bulbs (days)	Plant height (cm)	Number of leaves/pl	Number of side shoots/pl
Spacing (S)				
45x30 cm (S_1)	11.52	52.40	109.50	20.88
30x30 cm (S_2)	11.83	53.57	111.78	21.13
30x15 cm (S_3)	12.45	51.80	108.79	20.73
S. Em ±	--	0.26	0.41	0.12
CD at 5%	NS	0.74	1.20	0.33
Fertilizer level (F)				
Only FYM (F_0)	13.96	50.05	105.49	20.28
200:200:200 kg NPK/ha + FYM (F_1)	12.14	52.57	109.81	20.88
250:250:250 kg NPK/ha + FYM (F_2)	11.05	54.72	114.30	22.45
300:300:300 kg NPK/ha + FYM (F_3)	12.54	53.14	110.49	21.98
S. Em ±	---	0.31	0.60	0.13
CD at 5%	NS	0.88	1.74	0.38
Interaction(SxF)				
S_1F_0	14.29	50.28	105.37	19.26
S_1F_1	10.55	51.32	107.62	20.59
S_1F_2	10.15	54.87	114.62	21.48
S_1F_3	12.51	53.18	110.52	21.00
S_2F_0	13.43	50.84	106.29	20.44
S_2F_1	12.46	54.54	111.44	21.33
S_2F_2	10.85	55.26	115.74	22.64
S_2F_3	12.29	53.59	113.42	21.11
S_3F_0	14.18	49.03	104.63	19.13
S_3F_1	13.61	51.82	108.49	20.71
S_3F_2	12.49	54.02	112.49	21.23
S_3F_3	12.82	52.67	109.61	20.85
S. Em ±	---	---	---	0.23
CD at 5%	NS	NS	NS	20.88

NS = Non-significant

Table 3: Effect of spacing and fertilizer levels on spike characters in tuberose (*Polianthes tuberosa* L.*)* cv. Shringar

Treatments	First spike emergence (days)	Spike length (cm)	Rachis length (cm)	Spike girth (cm)	Weight of spike (g)	No. of florets per spike
Spacing (S)						
45x30 cm (S_1)	58.27	76.69	21.96	2.34	118.31	50.93
30x30 cm (S_2)	59.24	77.29	22.49	2.28	118.23	51.18
30x15 cm (S_3)	61.30	76.08	21.33	2.16	115.77	48.18
S. Em ±	0.25	--	--	0.03	0.45	0.46
CD at 5%	0.80	NS	NS	0.09	1.50	1.32
Fertilizer level (F)						
Only FYM (F_0)	63.64	72.61	17.90	2.19	103.12	44.93
200:200:200 kg NPK/ha + FYM (F_1)	60.91	75.93	21.15	2.29	112.29	48.32
250:250:250 kg NPK/ha + FYM (F_2)	56.05	79.08	24.18	2.51	116.25	53.57
300:300:300 kg NPK/ha + FYM (F_3)	56.82	76.41	21.82	2.33	113.88	49.92
S. Em ±	1.38	0.54	0.81	0.04	0.81	0.53

CD at 5%	3.96	1.57	2.33	0.13	2.33	1.52
Interaction(SxF)						
S_1F_0	64.70	72.73	17.90	2.18	102.50	44.75
S_1F_1	64.63	74.28	19.40	2.30	106.65	47.08
S_1F_2	57.45	79.36	24.38	2.53	120.75	53.95
S_1F_3	60.05	76.40	22.15	2.33	113.45	49.95
S_2F_0	63.10	73.40	18.65	2.13	105.35	46.05
S_2F_1	63.88	78.60	23.90	2.38	114.55	50.93
S_2F_2	56.50	80.00	25.00	2.58	122.65	54.80
S_2F_3	63.87	78.68	22.40	2.48	118.56	52.92
S_3F_0	64.63	71.70	17.15	2.11	101.37	43.92
S_3F_1	61.02	74.90	20.15	2.22	110.53	47.95
S_3F_2	62.23	77.88	23.15	2.43	115.35	51.95
S_3F_3	61.00	75.68	20.90	2.28	111.67	48.87
S. Em ±	0.94	0.94	1.02	0.07	1.40	0.92
CD at 5%	2.85	2.70	2.93	0.21	4.02	2.63

NS = Non-significant

Table 4. Effect of spacing and fertilizer levels on flower characters and cumulative spikes per plant per year in tuberose (*Polianthes tuberosa* L.*)* cv. Shringar

Treatments	**First flowering (days)**	**Length of floret (cm)**	**Diameter of floret (cm)**	**Wt. of 100 florets (g)**	**Duration of flowering (days)**	**Cumulative spike/pl/yr (one year)**
Spacing (S)						
45x30 cm (S_1)	72.04	5.56	2.82	109.27	15.10	4.18
30x30 cm (S_2)	73.10	5.66	2.92	110.42	15.14	4.22
30x15 cm (S_3)	73.80	5.18	2.66	101.15	14.88	4.03
S. Em ±	--	0.04	0.06	0.82	--	0.01
CD at 5%	NS	0.12	0.16	2.35	NS	0.03
Fertilizer level (F)						
Only FYM (F_0)	76.84	4.73	2.35	91.61	12.00	3.86
200:200:200 kg NPK/ha + FYM (F_1)	73.34	5.38	2.76	104.36	14.17	4.06
250:250:250 kg NPK/ha + FYM (F_2)	69.88	5.89	3.13	117.58	17.67	4.38
300:300:300 kg NPK/ha + FYM (F_3)	71.76	5.48	2.83	107.57	16.33	4.16
S. Em ±	0.48	0.05	0.06	1.38	0.66	0.06
CD at 5%	1.38	0.14	0.18	3.96	1.89	0.17
Interaction(SxF)						
S_1F_0	75.45	4.73	2.36	91.67	13.35	3.71
S_1F_1	72.80	5.04	2.55	97.64	14.10	4.01
S_1F_2	69.60	5.83	3.15	118.50	16.80	4.32
S_1F_3	71.35	5.47	2.83	109.21	15.20	4.04
S_2F_0	76.17	4.87	2.47	94.64	13.52	3.94
S_2F_1	70.40	5.63	2.91	109.85	16.01	4.20
S_2F_2	68.75	6.33	3.24	121.67	17.60	4.39
S_2F_3	71.01	5.93	3.07	115.53	16.35	4.26
S_3F_0	76.82	4.59	2.24	88.49	13.00	3.91
S_3F_1	73.42	5.18	2.67	99.90	14.80	3.98
S_3F_2	70.53	5.63	2.99	112.56	16.00	4.17
S_3F_3	71.95	5.33	2.76	103.65	15.72	4.08
S. Em ±	0.81	0.09	0.03	1.85	0.75	0.35
CD at 5%	2.33	0.26	0.08	5.35	2.15	1.10

NS = Non-significant

Effect of fertilizer levels on growth, flowering and spike yield:

Growth parameters were significantly influenced by fertilizer levels (Table 1.). The maximum plant height (54.72 cm), number of leaves (114.30) and number of side shoots (22.45) were recorded at 250:250:250 kg NPK/ha+ FYM. Where as minimum plant height (50.05 cm), number of leaves (105.49) and number of side shoots (20.28) were recorded in control (only FYM). Similar results were found in gladiolus by Deswal et.al.(1983), Khalaj et.al.(2012), Koley et.al.(2011) and Mohammad et.al.(2014) in Tubreose. This might be due to synthesis of protein, phospholipids, nucleotides, nucleic acids and certain enzymes which play important role in plant metabolism. Nitrogen and phosphorus are important molecules of phospholipids, nucleotide, nucleic acids and certain coenzymes which play important role in plant metabolism and shortage of either N or P results in the reduction of auxin which leads reduction of growth (Hillman and Galston, 1961).Numbers of days taken for sprouting of bulbs were not significantly influence by fertilizer levels (Table 1.). The reason is same as explained in effect of spacing and external application of fertilizer might not influence the sprouting.

Spike charactersand flower characters were significantly influenced by different levels of fertilizers. Spike characters (Table 2.) such as early spike emergence (56.05 days) with maximum spike length (79.08 cm), rachis length (24.18 cm), spike girth (2.51cm), weight of spike (116.25 g) and number of florets per spike (53.57) were significantly influenced by fertilizer levels found to be optimum at F_2level(250:250:250 kg NPK/ha + FYM).

Flower characters(Table 3.)such as early flowering(69.88 days) with maximum length of floret (5.89 cm), diameter of floret (3.13 cm),weight of 100 florets (117.58 g), duration of flowering (17.67days) and cumulative spike (4.38 spike/pl/year) were significantly influenced by fertilizer levels found to be optimum at F_2 level(250:250:250 kg NPK/ha + FYM). There was no advantage with more application of F_3 levels of fertilizer (300:300:300 kg NPK/ha + FYM). The increase in spike length and rachis length might be due to the fact that N helped in increasing the amount of assimilates that are needed for improvement in spike quality. Similar results were reported by Mukhopadhyay and Banker (1986),Battacharjee et. al. (1994),Gowda et.al.(1991) and Koley and Pal (2011)

Interaction of spacing and fertilizer levels on growth, flowering and spike yield:

Growth parameters like plant height and number of leaves did not show any significant difference (Table 1.). However number of side shoots showed significant difference with respect to spacing and fertilizer interaction. Maximum numbers of side shoots were recorded in S_2F_2 treatment combination (22.64) followed by S_1F_2 treatment (21.48) and minimum numbers of side shoots (19.13) were recorded in S_3F_0 interaction. This might be due to optimum spacing with fertilizer doses encouraged for availability of more soil nutrients, light interference and soil moisture.

Spike and flower characters were significantly influenced by spacing and fertilizer levels. Spike characters (Table 2.) such as early spike emergence (56.50days) with maximum spike length (80.00 cm), rachis length (25.00 cm), spike girth (2.58 cm), weight of spike (122.65 g) and number of florets per spike (54.80) were significantly influenced by spacing and fertilizer levels found to be optimum at S_2F_2 level (30x30cm spacing with fertilizer 250:250:250 kg NPK/ha + FYM).

Flower characters (Table 3.) such as early flowering (68.75 days) with maximum length of floret (6.33 cm), diameter of floret (3.24 cm), weight of 100 florets (121.67 g), duration of flowering (17.60 days) and cumulative spike (4.39 spike/pl/year) were significantly influenced by spacing and fertilizer levels found to be optimum at S_2F_2 level(30x30cm spacing with fertilizer 250:250:250 kg NPK/ha + FYM). This might be due to the combined effect of both nutrient and spacing.Best quality flower and spike parameters with increasing fertilizer levels up to F_2 levels were found to optimum, behind which spike and flower quality parameter were badly affected with F_3 levels. Poor spike quality parameter were found at S_3F_0 treatment combination.Similar results were reported by Mukhopadhyay (1981) and Khalaj et.al. (2012).

IV. Conclusion

Cultivation of tuberose cv. Shringar at spacing 30x30 cm with the application of fertilizer at 250:250:250 kg NPK/ha + FYM (S_2F_2 treatment interaction) can be recommended to optimum for better growth such as maximum plant height, number of side shoots and leaves per plant. Spike characters likespike length, rachis length, spike girth, weight of spike and number of florets per spike were found to be optimum at S_2F_2 leveland also flower characters like length of floret, diameter of floret, weight of 100 florets, duration of flowering and cumulative spike per plant per year were found to be optimum at S_2F_2 level(30x30cm spacing with fertilizer 250:250:250 kg NPK/ha + FYM),but its characters were affected with closer spacing (30x15 cm) and highest dose of fertilizers (300:300:300 kg of NPK/ha+ FYM).

It may be concluded that cultivation of tuberose (*Polianthes tuberosa* L.*)* cv. Shringar, the planting of bulbs at 30x30 cm spacing with application of fertilizer at 250:250:250 kg NPK/ha can be recommended to obtain higher productivity of superior quality flowers and spike yield.

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