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RESEARCH PAPER

Studies the effect of spacing and fertilizer levels on growth and bulb yield in *Polianthes tuberosa* at field experiment in Tumkur district, Karnataka

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Abstract : A field experiment was conducted to find out the effects of different levels of pant spacing and fertilizer dose on growth and bulb yield in tuberose (*Polianthes tuberosa* L.). The experiment consisted of twelve treatment combinations, comprising of three different plant spacing (S_1 - 45x30 cm, S_2 -30 x 30 cm and S_3 - 30 x 15 cm), four levels of fertilizers doses such as 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) and F_3 - 300:300:300 kg NPK/ha + FYM (25t/ha) with four replications and Factorial in a Randomized Complete Block Design (RCBD). The result of field experiments revealed that the significant difference on growth and bulb parameters as affected by different plant spacing and fertilizers levels. The plant spacing of 30 x 30 cm with fertilizers levels of 250:250:250 kg NPK/ha+ FYM (25t/ha) were found to be optimum for better growth and recorded significant maximum plant height (55.26cm), number of leaves per plant (115.74), number of side shoots per pant (22.64) and early sprouting of bulbs (10.85days) as compared to control (45x30 cm spacing with application of FYM 25 t/ha only) in interaction. Whereas, bulb parameters recorded significant increase in size of mother bulb (4.97cm), size of daughter bulbs (4.19cm), numbers of bulbs per plant (18.01), number of bulblets per plant (15.02) and clump weight (515.15 g) at 45x30cm spacing with fertilizer level 250:250:250 kg NPK/ha + FYM (25 t/ha) as compared to control. Cultivation of tuberose at 45x30 cm plant spacing with the application of fertilizer dosage at 250:250:250 kg NPK/ha + FYM (25 t/ha) can be recommended to obtain superior quality bulbs and bulblets.

Key Words : Bulbs, Bulblets, Clump weight, *Polianthes tuberosa*, Spacing, Sprouting

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INTRODUCTION

Tuberose (*Polianthes tuberosa* L. Amaryllidaceae) is a native 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,

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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 successful cultivation is influenced not only by the high yielding variety, but also by various agro-techniques *viz.*, optimum spacing and fertilizer levels is particularly important for the cultivation of tuberose for obtaining good quality and quantity of bulbs and bulblets. At present, there is a constraint of elite planting material to increase the area under commercial cultivation. The optimum size (1.5 - 2.0 cm) and weight (223 g/clump) of mother bulbs recommended for planting (Biswas *et al*., 2002). To obtain higher yield and productivity of bulbs, the present experiment was undertaken to standardize optimum spacing and fertilizer levels for bulb multiplication in tuberose

Objective of research:

– Studies the effect of spacing and fertilizer levels on growth and bulb quality.

– Standardize the optimum spacing and fertilizer levels.

– Studies the effect of treatment combination of spacing and fertilizer on bulbs and bulblets yield.

MATERIAL AND METHODS

The experiment was conducted at Khombaradevanahalli village, Mayasandra hobli of Turveker taluk, Tumkur district, Karnataka during 2012-14 and observation recorded by Krishi Vigyana Kendra, Konehalli, Tiptur, Tumkur district. The soil status of experiment plot was red sandy loam with uniform fertility. Variety used for experiment in tuberose *viz.*, single type Prajwal. There were twelve treatment combinations, comprising of three different plant spacing (S_1 - 45x30cm, S_2-30 x 30cm 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 replications 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 for all the treatments. Observation were recorded on various growth parameter and bulb production and statistically analysed as per Sundararaj *et al*. (1972).

Treatment details :

Spacing (*S*):

S_1- 45cm x 30 cm, S_2-30 cm x 30 cm, 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).

Treatment combinations		
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)

RESULTS AND DISCUSSION

The comparative performance of growth and bulb production by effect of plant spacing and fertilizer levels were evaluated. The results are presented in Table 1 to 4.

Effect of spacing on growth and bulb yield :

Growth parameters such as plant height, number of leaves and number of side shoots at different stage of plant growth were significantly influenced by different spacing (Table 1, 2 and 3). The spacing S_2 (30 x 30 cm) was found to be optimum with maximum plant height at 180 DAP (53.57 cm), number of leaves at 360 DAP (111.78) and number of side shoots at 360 DAP (21.13), where as lowest plant height (51.80 cm), number of leaves (108.79) and number of side shoots (20.73) were

recorded in S_3 spacing (30 x15 cm). This is due to that more space available with lesser competition for nutrient, light interferences and moisture that have resulted in better photosynthetic activity and increased growth and development. Similar results were reported by Rajwal and Singh (2006) in double cultivars and Singh (1999) in single cultivars. 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. Similar results were reported by Mane *et al*. (2007) and Sadhu and Das (1978).

Maximum number of bulbs per plant (16.80) and bulblets per plant (14.02), size of mother bulb (4.68 cm), daughter bulbs (3.77 cm), weight of bulbs and bulblets per clump (455.10 g) were recorded at wider spacing (45x30 cm), where as lowest was recorded at a closer spacing 30 x15 cm (Table 4). This might be due to the fact that lesser competition between plants for source of light, moisture, space and nutrient and as consequence shows better physiological activities, which in turn is reflected in improvement of bulb yield. Sadhu and Das (1978) reported similar results in tuberose.

Effect of fertilizer levels on growth and bulb yield:

Growth parameters were significantly influenced by fertilizer levels (Table 1, 2 and 3). The maximum plant

Table 1 : Effect of spacing and fertilizer levels on sprouting of bulbs and plant height in *Polianthes tuberosa*

Treatments	Sprouting of bulbs	Plant height (cm) at different stage of plant growth					
		30 DAP	60 DAP	90 DAP	120 DAP	150 DAP	180 DAP
Spacing (S)							
45 x 30 cm (S_1)	11.52	11.99	18.69	28.77	38.91	46.671	52.40
30 x 30 cm (S_2)	11.83	12.96	20.05	29.40	39.99	47.75	53.57
30 x 15 cm (S_3)	12.45	11.58	18.28	27.27	37.55	46.10	51.80
S.E.±	--	0.14	0.21	0.31	0.32	0.35	0.26
C.D. (P=0.05)	NS	0.40	0.57	0.89	0.92	1.03	0.74
Fertilizer level (F)							
Only FYM (F_0)	13.96	10.26	16.90	26.30	37.33	44.32	50.05
200:200:200 kg NPK/ha + FYM (F_1)	12.14	12.08	18.67	28.57	39.10	46.71	52.57
250:250:250 kg NPK/ha + FYM (F_2)	11.05	14.01	21.85	31.17	41.10	49.11	54.72
300:300:300 kg NPK/ha + FYM (F_3)	12.54	12.39	19.85	28.97	39.21	47.20	53.14
S.E.±	---	0.16	0.23	0.36	0.37	0.42	0.31
C.D. (P=0.05)	NS	0.46	0.67	1.04	1.06	1.20	0.88
Interaction (SxF)							
S_1F_0	14.29	10.35	16.94	26.33	37.31	44.42	50.28
S_1F_1	10.55	11.11	17.47	27.15	38.22	45.44	51.32
S_1F_2	10.15	14.01	21.93	31.29	41.18	49.33	54.87
S_1F_3	12.51	12.48	18.46	28.73	39.12	47.33	53.18
S_2F_0	13.43	10.66	17.23	25.75	37.78	44.80	50.84
S_2F_1	12.46	13.61	21.26	30.64	40.65	48.70	54.54
S_2F_2	10.85	14.85	22.56	31.93	41.86	49.68	55.26
S_2F_3	12.29	12.71	19.13	29.24	39.66	47.80	53.59
S_3F_0	14.18	9.75	16.59	26.79	36.91	43.75	49.03
S_3F_1	13.61	11.47	17.83	27.89	38.45	45.98	51.82
S_3F_2	12.49	13.14	20.32	30.31	40.20	48.28	54.02
S_3F_3	12.82	11.96	18.42	28.34	38.72	46.48	52.67
S.E.±	---	---	---	---	---	---	---
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS

NS = Non-significant, DAP= Days after planting

height at 180 DAP (54.72 cm), number of leaves at 360 DAP (114.30) and number of side shoots at 360 DAP (22.45) were recorded at 250:250:250 kg NPK/ ha + FYM (25 t/ha). 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 25 t/ha). Similar results were found in gladiolus by Mohammad *et al*. (2014); Khalaj *et al*. (2012); Koley and Pal (2011) and Deswal *et al*. (1983) in Tubreose. This might be due to synthesis of protein, phospholipids, nucleotides, nucleic acids and certain enzymes which play important role in plant metabolism (Gowda *et al.*,1991) and Mukhopadhyay and Banker (1986).

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. Maximum number of bulbs (17.41 l/ha), bulblets (14.48 l/ha), size of mother bulb (4.98 cm), daughter bulbs (4.06 cm) and clump weight (498.33g) were recorded at optimum fertilizer levels (250:250:250 kg NPK/ha +FYM). whereas, least number of bulbs (15.15 l/ha), bulblets (12.53 l/ha), size of mother bulbs (3.96 cm), daughter bulbs (2.82 cm) and clump weight (320.00g) were recorded in control (only FYM) (Table 4). This might be due to the fact that optimum fertilizer dose encouraged plants to grow more vigorously and produce more metabolites. Similar results were reported by Jana and Bose (1980) and Singh (1999) in tuberose.

Table 2 : Effect of spacing and fertilizer levels on leaf production in *Polianthes tuberosa*

Treatments	Number of leaves per plant at different stage of plant growth					
	60 DAP	120 DAP	180 DAP	240 DAP	300 DAP	360 DAP
Spacing (S)						
45 x 30 cm (S_1)	21.49	33.48	57.92	75.49	92.31	109.50
30 x 30 cm (S_2)	22.01	35.78	60.63	77.78	94.19	111.78
30 x 15 cm (S_3)	20.24	30.38	56.42	74.77	91.81	108.79
S.E.±	0.33	0.36	0.57	0.75	0.62	0.41
C.D. (P=0.05)	0.95	1.04	1.65	2.16	1.79	1.20
Fertilizer level (F)						
Only FYM (F_0)	17.48	29.51	53.56	71.48	88.68	105.49
200:200:200 kg NPK/ha + FYM (F_1)	21.14	31.33	58.34	75.56	92.51	109.81
250:250:250 kg NPK/ha + FYM (F_2)	23.84	38.18	63.30	80.18	96.48	114.30
300:300:300 kg NPK/ha + FYM (F_3)	21.19	34.48	59.45	76.53	93.42	110.49
S.E.±	0.38	0.42	0.67	1.02	0.72	0.60
C.D. (P=0.05)	1.09	1.20	1.91	2.93	2.07	1.74
Interaction (SxF)						
S_1F_0	17.48	29.43	53.53	71.40	88.88	105.37
S_1F_1	19.48	31.53	55.38	73.52	90.48	107.62
S_1F_2	24.53	38.48	63.50	80.53	96.52	114.62
S_1F_3	20.50	34.48	59.30	76.53	93.36	110.52
S_2F_0	18.48	30.63	54.63	72.53	89.43	106.29
S_2F_1	21.48	35.46	60.53	77.48	94.42	111.44
S_2F_2	24.51	39.50	64.86	81.61	97.38	115.74
S_2F_3	23.48	37.42	62.53	79.62	95.53	113.42
S_3F_0	16.47	28.50	52.53	70.28	87.75	104.63
S_3F_1	20.38	29.97	57.13	74.33	91.52	108.49
S_3F_2	22.50	36.55	61.52	78.42	95.61	112.49
S_3F_3	21.50	33.48	58.53	75.58	92.48	109.61
S.E.±	---	0.73	1.15	1.66	1.24	1.12
C.D. (P=0.05)	NS	2.09	3.32	4.77	3.56	3.02

NS = Non-significant, DAP= Days after planting

Interaction of spacing and fertilizer levels on growth and bulb yield :

Growth parameters like plant height did not show any significant difference (Table 1). However, number of leaves and side shoots showed significant difference with respect to spacing and fertilizer interaction. Maximum number of leaves at 360 DAP (115.74) and side shoots at 360 DAP (22.64) were recorded in S_2F_2 treatment combination followed by S_1F_2 treatment and minimum number of leaves (104.63) and side shoots (19.13) were recorded in S_3F_0 interaction (Table 2 and 3). This might be due to optimum spacing with fertilizer doses encouraged for availability of more nutrients, light interference and soil moisture (Munikrishnappa, 1996 and Bhatacharjee *et al*., 1994)

Maximum number of bulbs per plant (18.01), bulblets per plant (15.02), size of mother bulbs (4.97 cm), daughter bulbs (4.19 cm) and weight of clump (515.15 g) were significantly recorded (Table 4) in S_1F_2 treatment combination. Where as minimum bulb parameters were recorded S_3F_0 interaction. This might be due to wider spacing with optimum fertilizer doses encouraged availability of more nutrient, soil moisture and light interference and also synthesis of protein, phospholipids, nucleotides, nucleic acids and certain enzymes, which play important role in plant metabolism. Similar results were reported by Khalaj *et al*. (2012) and Mukhopadhyay (1981).

Table 3 : Effect of spacing and fertilizer levels on number of side shoots per plant in *Polianthes tuberosa*

Treatments	Number of side shoots per plant at different stage of plant growth					
	60 DAP	120 DAP	180 DAP	240 DAP	300 DAP	360 DAP
Spacing (S)						
45 x 30 cm (S_1)	4.09	8.51	12.49	16.21	18.09	20.88
30 x 30 cm (S_2)	4.41	8.81	12.83	16.44	18.51	21.13
30 x 15 cm (S_3)	4.06	7.41	11.36	15.08	17.94	20.73
S.E.±	--	0.15	0.33	0.07	0.08	0.12
C.D.(P=0.05)	NS	0.43	0.95	0.22	0.22	0.33
Fertilizer level (F)						
Only FYM (F_0)	3.74	6.80	10.75	14.39	17.38	20.28
200:200:200 kg NPK/ha + FYM (F_1)	4.18	7.61	11.60	15.29	18.14	20.88
250:250:250 kg NPK/ha + FYM (F_2)	4.65	8.13	12.19	16.92	19.96	22.45
300:300:300 kg NPK/ha + FYM (F_3)	4.31	7.76	11.72	15.37	18.25	21.98
S.E.±	--	0.17	0.39	0.08	0.09	0.13
C.D.(P=0.05)	NS	0.50	1.12	0.23	0.26	0.38
Interaction (SxF)						
S_1F_0	3.57	6.84	10.75	14.57	16.39	19.26
S_1F_1	3.96	7.28	11.25	14.91	17.70	20.59
S_1F_2	4.68	8.13	12.24	15.97	19.04	21.48
S_1F_3	4.16	7.78	11.73	15.36	18.24	21.00
S_2F_0	3.89	7.04	11.03	14.26	17.54	20.44
S_2F_1	4.59	8.05	12.13	15.86	18.84	21.33
S_2F_2	4.81	8.31	12.35	16.11	19.23	22.64
S_2F_3	4.34	7.86	11.83	15.54	18.44	21.11
S_3F_0	3.76	6.56	10.46	14.34	16.20	19.13
S_3F_1	4.01	7.49	11.43	15.08	17.88	20.71
S_3F_2	4.46	7.95	11.98	15.69	18.64	21.23
S_3F_3	4.05	7.65	11.60	15.20	18.06	20.85
S.E.±	--	0.31	0.71	0.15	0.16	0.23
C.D.(P=0.05)	NS	0.92	2.04	0.44	0.45	0.66

NS = Non-significant, DAP= Days after planting

Table 4 : Effect of spacing and fertilizer levels on bulb quality, bulbs and bulblets yield in *Polianthes tuberosa*

Treatments	Size of mother bulbs(cm)	Size of daughter bulbs(cm)	Clump weight (g)	No.of bulbs/pl	No. of bulblets/ pl
Spacing (S)					
45x30 cm (S_1)	4.68	3.77	455.10	16.80	14.02
30x30 cm (S_2)	4.46	3.48	447.20	16.53	13.69
30x15 cm (S_3)	3.99	3.30	393.75	15.75	13.03
S.E.±	0.04	0.03	3.21	0.02	0.03
C.D. (P=0.05)	0.11	0.07	9.19	0.07	0.09
Fertilizer level (F)					
Only FYM (F_0)	3.96	2.82	320.00	15.15	12.53
200:200:200 kg NPK/ha + FYM (F_1)	4.48	3.49	421.67	16.21	13.42
250:250:250 kg NPK/ha + FYM (F_2)	4.98	4.06	498.33	17.41	14.48
300:300:300 kg NPK/ha + FYM (F_3)	4.58	3.76	435.05	16.82	13.89
S.E.±	0.04	0.03	3.61	0.03	0.04
C.D. (P=0.05)	0.12	0.08	10.36	0.08	0.11
Interaction (S x F)					
S_1F_0	3.96	2.82	315.10	15.32	12.76
S_1F_1	4.23	3.14	375.25	16.82	13.90
S_1F_2	4.97	4.19	515.15	18.01	15.02
S_1F_3	4.59	3.83	435.35	17.45	14.38
S_2F_0	4.05	3.06	355.05	15.10	12.51
S_2F_1	4.89	3.97	455.90	16.20	13.45
S_2F_2	4.10	4.07	505.50	17.70	14.70
S_2F_3	4.72	3.86	495.23	17.12	14.12
S_3F_0	3.88	2.56	290.00	15.02	12.33
S_3F_1	4.32	3.37	395.75	15.60	12.91
S_3F_2	4.08	3.91	475.17	16.51	13.72
S_3F_3	4.42	3.59	415.07	15.88	13.16
S.E.±	---	---	6.42	---	---
C.D. (P=0.05)	0.18	0.15	18.43	0.12	0.14

NS = Non-significant, Clump weight= Weight of bulbs and bulblets/clump

Conclusion :

Cultivation of tuberose at spacing 30 x 30 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 like maximum plant height, number of side shoots and leaves per plant. Whereas bulb parameters like size of mother bulb, daughter bulb, number of bulbs per plant, bulblets per plant and clump weight can be recommended at wider spacing 45x30 cm with fertilizer dose 250:250:250 kg NPK/ha + FYM (S_3F_2 treatment interaction) for obtaining superior quality bulbs.

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