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Effect of Spacing and NPK Levels on Yield, Cost Economics, Nutrient Uptake and Soil Nutrient Status in Gaillardia (*Gaillardia pulchella* Foug.)

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ABSTRACT

Investigations were carried out to study the effect of different spacing and NPK levels on yield, benefit cost ratio, total plant nutrient uptake and available soil nutrients in gaillardia (*Gaillardia pulchella* Foug.) at College of Horticulture, Bengaluru during 2015-16. Hundred flowers weight (395 g), flower yield per plant (408.52 g) were found to be statistically higher in 60 × 60 cm spacing. However, height flower yield per hectare (11.35 t) was found in 45 × 30 cm spacing. Among varied levels of NPK, F_4 (125% RDF - 225:120:90 NPK kg/ha) recorded highest 100 flowers weight (334.66 g), flower yield per plant (362.93 g) and flower yield per hectare (15.20 t). Highest cost benefit ratio (2.46) was observed in S_1F_4 (45 × 30 cm, 225:120:90 kg NPK/ha) treatment combination. Maximum (99.25, 17.32 and 103.67 kg/ha) total plant uptake of N, P and K respectively was registered in plants spaced at 60 × 60 cm spacing (S_3) and maximum total plant N, P and K uptake was observed (115.06, 19.57 and 119.64 kg/ha, respectively) in treatment F_4 (225:120:90 kg/ha). Among different spacing levels maximum available soil N, P and K (292.45, 28.17 and 135.19 kg/ha, respectively) was registered in plants spaced at 60 × 60 cm spacing (S_3). Among varied levels of NPK F_4 (225:120:90 kg/ha) recorded higher available soil N, P and K (286.56, 23.29 and 126.98 kg/ha, respectively).

Keywords Gaillardia, Spacing, NPK levels, Plant uptake, Cost benefit ratio.

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INTRODUCTION

Gaillardia (*Gaillardia pulchella* Foug.) a member of the family Asteraceae, is native of Central and Western United States. Gaillardia is a flowering annual cultivated for its attractive flowers for varied uses like loose flowers, cut flowers, making garlands, veni, floral decorations, weddings, religious, ceremonial,

social occasions and landscape gardens. It is popularly known as blanket flower.

Successful production of gaillardia depends upon many factors like soil fertility, irrigation, plant density, plant protection measures. But manurial schedule and spacing plays a major role in crop production and productivity. Proper spacing helps in availability of nutrients, aeration and light intensity by which crop can express properly in terms of quantity and enhanced quality. Among essential nutrients, nitrogen, phosphorus and potassium are the most important and are required in sufficient quantities to attain better plant growth and flowering. Costs and returns analysis for various crops is help full to identify the suitable region for commercial production to ensure year around supply of flowers through extensive cultivation. Crop requirements, absorption pattern of nutrients and post harvest soil and plant nutrient status are quite important for fertilizer recommendation of a crop in a given agroclimatic situation. Keeping all these points in view, the present investigation on "Effect of spacing and NPK levels for yield, cost benefit ratio, nutrient uptake and soil nutrient status in gaillardia under Eastern dry zone condition" was carried out.

MATERIALS AND METHODS

Field experiment was conducted out in the Department of Floriculture and Landscape Architecture, College of Horticulture, UHS campus, GKVK, Bengaluru during 2015-16. Three different spacings,viz., S_1 (45 × 30 cm), S_2 (60 × 45 cm) and S_3 (60 × 60 cm) and four levels of nutrients,viz., F_1 (75% Recommended dose of fertilizers (RDF) - 112.5:60:45 NPK kg/ha), F_2 (100% RDF - 150:80:60 NPK kg/ha), F_3 (125% RDF - 187.5:100:75 NPK kg/ha) and F_4 (125% RDF - 225:120:90 NPK kg/ha) were planned and laid out in Factorial Randomized Complete Block Design (FRCBD) and replicated three times. Land was brought to a fine tilth by repeated ploughing and harrowing. After land preparation, layout was done as per treatments and forty days old healthy and uniformly grown seedlings were used for transplanting. Transplanting was done according to combination of the different spacing and NPK levels. Transplanting was done during evening hours and light irrigation was given immediately after transplanting. All other recommended agronomic package and practices were followed to grow a successful crop. From each treatment five plants were selected at random for recording growth parameters, yield parameters (flower yield/plant, flower yield/ha, 100 flower weight), total plant uptake of N, P and K, available soil N, P and K and benefit cost ratio was worked out using standard methods (Microjeldhal's method, Vandomolybdate method and Flame photometer methodare used for N, P and K estimation).

RESULTS AND DISCUSSION

Effect of spacing on yield, total plant nutrient uptake and available soil nutrient

Flower production in gaillardia was significantly influenced by the increasing spacing levels. Hundred flowers weight and flower yield per plant recorded maximum (395 g and 408.52 g, respectively) in wider spacing (S_3- 60 × 60 cm) and were minimum (249.00 g and 216.48 g, respectively) in closer spacing (S_1- 45 × 30 cm). Maximum yield per plant at wider spacing might be due to fact that, in wider spacing the number of branches per plant was more which in turn lead to more number of flowers per plant and flower yield per plant. Flower yield per hectare was increased with decreasing levels of spacing. It was recorded maximum (16.03 t) in S_1 (45 × 30 cm) which was statistically on par (12.01 t/ha) with S_2 (60 × 45 cm) and minimum (11.35 t) in S_3 (60 × 60 cm) (Table 1). This might be due to the more plant population per unit area in closer spacing as compared to wider spacing. Similar findings reported in annual chrysanthemum (Dorajeerao *et al.* 2012).

Significant effect of different levels of spacing on total N, P and K uptake in gaillardia was observed. Maximum total plant uptake of N, P and K (99.25, 17.32 and 103.67 kg/ha, respectively) was registered in plants spaced at 60 × 60 cm spacing (S_3) and minimum (82.73, 13.58 and 86.69 kg/ha, respectively) was recorded in S_1 (45 × 30 cm) (Table 2). Whereas, higher available soil N, P and K (292.45, 28.17 and

Table 1. Effect of spacing and NPK levels on 100 flowers weight (g), flower yield per plant (g), and yield per hectare (t) in gaillardia. NS= Non-significant, F= NPK levels, S=Spacing, S × F= Spacing × NPK levels.S_1= 45 × 30 cm, F_1= 112.5:60:45 kg NPK/ha, S_2= 60 × 45 cm, F_2= 150:80:60 kg NPK/ha, S_3= 60 × 60 cm. F_3= 187.5:100:75 kg NPK/ha, F_4= 225:120:90 kg NPK/ha.

Treatment	100 flowers weight (g)					Yield per plant (g)					Yield per hectare (t)				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	224.00	236.00	263.00	273.00	249.00	176.40	199.88	234.45	255.19	216.48	13.06	14.80	17.36	18.90	16.03
S_2	280.00	290.00	316.00	336.00	336.00	270.90	296.88	331.34	367.41	316.63	10.03	11.99	12.27	13.75	12.01
S_3	343.00	356.00	380.00	395.00	395.00	353.56	384.97	429.35	466.20	408.52	9.82	10.69	11.92	12.95	11.35
Mean	282.33	294.00	319.66	334.66		266.95	293.91	331.71	362.93		10.97	12.49	13.85	15.20	
Source			SEm ±		CD at 5%			SEm ±		CD at 5%		SEm ±		CD at 5%	
S			2.40		7.06			2.34		6.86		0.29		0.85	
F			2.78		8.16			2.70		7.92		0.33		0.98	
S × F		4.81		NS			4.68		13.72		0.58		NS		

135.19 kg/ha, respectively) was registered in plants spaced at 60 × 60 cm spacing (S_3) and it was recorded minimum (237.38, 11.64 and 110.34 kg/ha) in S_1 - 45 × 30 cm spacing (Table 3).

Effect of NPK levels on yield, total plant nutrient uptake and available soil nutrients

Highest levels of NPK (225:120:90 kg/ha) significantly recorded maximum 100 flowers weight (282.33 g), flower yield per plant (266.95g) and flower yield per hectare (10.97 t/ha) and it was found minimum (282.33 g, 266.95 g/plant and 10.97 t, respectively) in F_1 (75% RDF). The growth of sink tissue and organs (in present case, the flower) depends on the supply of photosythates from source leaves. Application of NPK might have accelerated photosynthesis by increasing the source size (number of branches and leaf area), thereby providing the developing flowers with more photosythates, which might have resulted in increased cell division and cell expansion of flower tissues. Similar results were reported in gaillardia (Karetha *et al.* 2011).

Significant effect of varied levels of NPK on total N, P and K uptake in gaillardia. Maximum total plant uptake of N, P and K (115.06, 19.57 and 119.64 kg/ha, respectively) was registered in plants supplied with 225:120:90 NPK kg per hectare (F_4) and was minimum in F_1 (112.5:60:45 kg/ha) (69.39, 11.24 and 68.24 kg/ha, respectively) (Table 2). Among varied levels of NPK, F_4 (225:120:90 kg/ha) was recorded higher available soil N, P and K (286.56, 23.29 and 126.98 kg/ha, respectively) and it was recorded minimum (246.19, 16.81 and 114.65kg/ha)

Table 2. Effect of spacing and NPK levels on total N, P and K uptake (kg/ha) of gaillardia. NS= Non-significant, F= NPK levels, S=Spacing, S × F= Spacing × NPK levels. S_1= 45 × 30 cm, F_1= 112.5:60:45 kg NPK/ha, S_2= 60 × 45 cm, F_2= 150:80:60 kg NPK/ha, S_3= 60 × 60 cm. F_3= 187.5:100:75 kg NPK/ha, F_4= 225:120:90 kg NPK/ha.

Treatment	N uptake kg/ha					P uptake kg/ha					K uptake kg/ha				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	58.72	72.99	91.84	107.35	82.73	9.20	12.30	14.44	18.38	13.58	61.53	76.34	98.59	110.30	86.69
S_2	68.70	80.10	97.55	113.85	90.05	10.87	13.65	16.82	19.43	15.19	68.70	83.23	105.12	117.47	93.63
S_3	80.75	87.83	104.45	123.97	99.25	13.65	16.69	18.03	20.91	17.32	74.48	93.63	115.42	131.14	103.67
Mean	69.39	80.31	97.95	115.06		11.24	14.21	16.43	19.57		68.24	84.40	106.38	119.64	
Source			SEm ±		CD at 5%			SEm ±		CD at 5%		SEm ±		CD at 5%	
S			1.49		4.39			0.27		0.80		1.38		4.04	
F			1.73		5.07			0.31		0.92		1.59		4.67	
S × F			2.99		NS			0.54		NS		2.76		NS	

Table 3. Effect of spacing and NPK levels on available soil N, P and K (kg/ha) of gaillardia. NS = Non-significant, F = NPK levels, S =Spacing, S × F = Spacing × NPK levels. S_1 = 45 × 30 cm, F_1= 112.5:60:45 kg NPK/ha, S_2= 60 × 45 cm, F_2= 150:80:60 kg NPK/ha, S_3 = 60 × 60 cm. F_3= 187.5:100:75 kg NPK/ha, F_4= 225:120:90 kg NPK/ha.

Treat-ment	Available N (kg/ha)					Available P (kg/ha)					Available K (kg/ha)				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	193.71	220.00	258.82	277.00	237.38	9.91	10.70	12.11	13.86	11.64	104.49	107.67	114.11	115.08	110.34
S_2	258.19	262.82	282.93	284.93	272.22	15.00	18.00	20.00	23.86	19.22	113.50	117.55	118.41	121.89	117.84
S_3	286.67	290.04	295.33	297.78	292.45	25.53	26.00	29.00	32.17	28.17	125.97	132.85	137.93	144.00	135.19
Mean	246.19	257.62	279.02	286.56		16.81	18.23	20.37	23.29		114.65	119.35	123.45	126.98	
Source		SEm ±		CD at 5%		SEm ±		CD at 5%			SEm ±		CD at 5%		
S		5.44		15.97		1.20		3.54			1.85		5.43		
F		6.28		18.44		1.39		4.09			2.13		6.27		
S × F		11.72		NS		2.41		NS			7.34		NS		

in F_1 (112.5:60:45 kg/ha) (Table 3).

Fertilizer levels and spacings failed to show any significant effect together on the 100 flowers weight, flower yield per hectare, total plant N, P and K uptake and available soil N, P and K.

Effect of spacing and NPK levels on cost benefit ratio

Among the different treatment combinations, highest gross returns (Rs 283548 lakhs/ha) were obtained in S_1F_4 (45 × 30 cm, 225:120:90 kg NPK/ha) treatment combination, followed by (Rs 260501 lakhs/ha) S_1F_3 (45 × 30 cm, 187.5:100:75 kg NPK/ha). Least gross returns (Rs 147318 lakhs/ha) was obtained in S_3F_1 (60 cm × 60 cm, 112.5:60:45 kg NPK/ha) (Table 4) treatment combination. The highest net returns (Rs 201585 lakhs/ha) was obtained in S_1F_4 (45 × 30 cm, 225:120:90 kg NPK/ha) treatment combination, followed by (Rs 180520 lakhs/ha) S_1F_3 (45 × 30 cm, 187.5:100:75 kg NPK/ha). The least net returns (Rs 72714 lakhs/ha) were obtained in S_3F_1 (60 cm × 60 cm, 112.5:60:45 kg NPK/ha) treatment combination. The highest cost benefit ratio (2.46) was observed in S_1F_4 (45 × 30 cm, 225:120:90 kg NPK/ha) treatment combination, followed by S_1F_3 (45 × 30 cm, 187.5:100:75 kg NPK/ha) (2.26). The least cost benefit ratio (0.97) was obtained in S_3F_1 (60 cm × 60 cm, 112.5:60:45 kg NPK/ha) treatment combination. Similar cost benefit ratio founds in marigold (Ahirwar *et al*. 2012).

CONCLUSION

Based on all these findings in a spacing of 45 × 30

Table 4. Effect of spacing and NPK levels on economics of gaillardia. NS = Non-significant, F = NPK levels, S =Spacing, S × F = Spacing × NPK levels. S_1 = 45 × 30 cm, F_1 = 112.5:60:45 kg NPK/ha, S_2= 60 × 45 cm, F_2= 150:80:60 kg NPK/ha, S_3= 60 × 60 cm. F_3 = 187.5:100:75 kg NPK/ha, F_4 = 225:120:90 kg NPK/ha.

Treatments	Yield (kg/ha)	Total cost of cultivation (`/ha)	Gross returns (`/ha)	Net returns (`/ha)	Cost: Benefit ratio
S_1F_1	13067	76010	195999	119989	1.58
S_1F_2	14806	77992	222093	144101	1.85
S_1F_3	17367	79981	260501	180520	2.26
S_1F_4	18903	81963	283548	201585	2.46
S_2F_1	10033	74885	150498	75613	1.01
S_2F_2	10996	76867	164935	88068	1.15
S_2F_3	12272	78856	184079	105223	1.33
S_2F_4	13608	80838	204121	123283	1.53
S_3F_1	9821	74604	147318	72714	0.97
S_3F_2	10694	76586	160409	83823	1.09
S_3F_3	11927	78575	178899	100324	1.28
S_3F_4	12950	80557	194249	113692	1.41

cm and NPK of 225:120:90 kg per hectare was found good for gaillardia production with higher yield per hectare and cost benefit ratio.

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