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Standardisation of Agro-Techniques for Optimum Vegetative Parameters in Ornamental Sunflower

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ABSTRACT

An experiment was conducted at College of Horticulture, GKVK campus, Bengaluru, UHS, Bagalkot to study the vegetative parameters with different agrotechniques in ornamental sunflower. Plant height was highest with 162.43 cm. For ornamental crops minimum plant height with optimum quality of flowers is preferred. The treatment combination of M_1 (with mulch) + S_1 (60 cm x 40 cm) + F_3 (80:90:80 NPK kg ha^{-1}) recorded highest plant spread 4642.97 cm^2. M_1 (with mulch) + S_1 (60 cm x 40 cm) + F_1 (40:60:40 NPK kg ha^{-1}), produced highest number of leaves (26.93). Maximum leaf area 5328.23 cm^2 was with M_1 (with mulch) + S_2 (60 cm x 30 cm) + F_3 (80:90:80 NPK kg ha^{-1}). From the present investigation for better vegetative growth mulching can be followed with lower to higher spacing with higher fertilizer dose. But as higher fertilizer dose and mulching will increase the cost of cultivation for this short duration crop optimum agrotechniques to be followed would be M_2 (without mulch) + S_2 (60 cm x 30 cm) + F_2 (60:75:60 NPK kg ha^{-1}).

Key words: *Ornamental, Mulching, Spacing, Fertilizers, Vegetative*

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is native to North America and belongs to the family *Compositae*. In the early ninetees, sunflower regained popularity as a cut flower crop. Historically sunflower was first used as a garden plant, then as a flowering pot plant and more recently as a specialty cut flower. The type of flowers grown for the specialty cut flower market are usually field grown flowers with poor shipping characteristics. This crop is very easy to grow and has wide adaptability. In any crop, genotypes, soil, cultural practices and their interactions exert profound influence on productivity and quality of crops. However, it is not possible to manipulate the environment for better crop growth, but one can manipulate the micro climate of the field to certain extent by adopting suitable cultural practices. Crop production and the resultant yield is a complex phenomenon interacted by several factors.

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In the present investigation an attempt was made to identify the best genotypes suitable for ornamental cut flower production in sunflower and to study the impact of agrotechniques on quality parameters in ornamental sunflower. The yield can be manipulated by taking advantage of their combined actions. Hence three factors *viz*., plastic mulching, spacing and fertilizer levels were studied in the present experiment.

Review of literature

In marigold (*Tagetes erecta* L.) cv. Pusa narangi gainda, combination of higher dose of fertilizers (300:150:150 kg NPK/ha) and black polythene mulching produced significantly maximum plant height (137.46 cm), maximum number of branches (33.33) per plant Gavhane *et al*.[4]. Among interactions S_2 (45 x 30 cm) with F_3 (225:150:75 kg NPK/ha) recorded highest flower diameter (9.08 cm) in china aster *cv*. Kamini[2]. Plant height (61.83 cm) and plant spread (678.68 cm^2) in china aster were highest under fertigation with 120 per cent of recommended dose of fertilizer with 50 (µ) thickness black polythene mulch[15]. Hemalatha[5] reported that in *Gomphrena globosa*, T_4 with spacing (30 x 30 cm + 216: 72: 72 NPK kg ha^{-1} produced high statured plant (69.17 cm) and produced more number of branches per plant (12.00). Spacing of 30 x 20 cm + single row + mulching gave maximum plant height of 68.73 cm in rabi season with maximum number of leaves (9.27) and leaf area of 159.70 cm^2 [6].

MATERIAL AND METHODS

An experiment was conducted at College of Horticulture, GKVK campus, Bengaluru, UHS, Bagalkot. Split Split Plot design was followed by adopting Fisher's method of analysis of variance technique as given by Panse and Sukhatamane by using SAS package V9-3 available at statistical cell, IIHR. The experiment consisted of three replications and eighteen treatments. The experiment consisted of main factor, sub factor and sub sub factor.

Main factor: Mulching

1) Plastic mulch 50 (µ) (M_1) 2) Without mulch (M_2)

Sub factor: Spacing (cm)

1) 60 cm x 40 cm (S_1) 2) 60 cm x 30 cm (S_2) 3) 60 cm x 20 cm (S_3)

Sub-Sub factor: Fertilizers (NPK kg/ha)

1) 40:60:40 kg/ha (F_1) 2) 60:75:60 kg/ha (F_2) 3) 80:90:80 kg/ha (F_3)

The experiment was laid out with the above stated factors into plots measuring 6.72 sq.mts each with 4 rows in each plot of 2.8 mts length and 2.4 mts width with 37.33 plants in each plot. Minimum distance of 60 cm was maintained between the plots. There were totally 54 plots. Basal dose of 50% Nitrogen in the form of urea + full dose of Phosphorous (SSP) & Potassium (MOP) were applied at the time of sowing and top dressing of 50% Nitrogen was taken up at 30-35 days after sowing. After sowing, plastic mulch (25 µ) was applied to the plots where ever mulching treatment was applicable. Irrigation was provided 2 days before sowing and immediately after sowing and thereafter at 8-10 days interval and 45 days after sowing earthing-up was done to the crop.

RESULTS AND DISCUSSION

Plant height, plant spread, number of leaves and leaf area were significantly higher with M_1 (with mulch) as compared to M_2 (without mulch). Mulching might have helped plants in obtaining optimum growth through controlling of weeds, conserving soil moisture and optimum soil temperature Table 1**.**The present findings are in accordance with Yathindra[15] in China aster.

Plant height was highest with S_3 (60 cm x 20 cm) 144.75 cm. It may be attributed to the intra plant competition for light, moisture, space and aeration (Table 1). Similar results were also reported by Sunitha[13] in marigold and Yathindr[15] in China aster.

Spacing of plants at S_1 (60 cm x 40 cm) favoured increased plant spread 4092.59 cm^2. Similar results were also reported by Hemalatha[5] in gomphrena which may be attributed to increased area for plant growth and spread. (Table 1)

Spacing of plants at S_1 (60 cm x 40 cm) resulted in maximum number of leaves (7.24). Similarly spacing of plants at S_1 (60 cm x 40 cm) resulted in increased leaf area (71 cm^2). (Table 1) It may be attributed to the more area for plant development resulting in more number of leaves per plant. Similar

results were also reported by Kumari[6] in gladiolus and Mane *et al.*[7] in tuberose.

Application of fertilizers at F_3 (80:90:80 NPK kg ha^{-1}) increased the plant height, plant spread and leaf area. Similar results were also reported by Dorajirao[3] in garland chrysanthemum and Munikrishnappa[8] in china aster.

Treatment combination of mulching and spacing *viz;* M_1 (with mulch) + S_3 (60 cm x 20 cm) 149.82 cm revealed highest plant height among all the combinations. Similar results were also reported by Bhattacharjee and Vinayananda (1989) in dahlia, and Yathindra[15] in china aster. The treatment combination of M_1 (with mulch) + S_1 (60 cm x 40 cm) 4233.23 cm^2 followed by M_1 (with mulch) + S_2 (60 cm x 30 cm) 3990.52 cm^2, M_2 (without mulch) S_1 (60 cm x 40 cm) 3951.95 cm^2 and M_1 (with mulch) S_3 (60 cm x 20 cm) 3839.52 cm^2 produced maximum plant spread. (Table 2)These findings are in line with Huh and Kim (1994) in carnation.

Maximum leaf area among all the treatments was recorded with M_1 (with mulch) + S_1 (60 cm x 40 cm), M_2 (without mulch) + S_1 (60 cm x 40 cm), M_1 (with mulch) + S_3 (60 cm x 20 cm) and M_1 (with mulch) + S_2 (60 cm x 30 cm). (Table 2) These findings are in line with Yathindra[15].

The treatment combinations of M_1 (with mulch) + F_3 (80:90:80 NPK kg ha^{-1}) favoured highest plant height 156.41cm**.** Similarly M_1 (with mulch) + F_3 (80:90:80 NPK kg ha^{-1}) followed by F_2 (60:75:60 NPK kg ha^{-1}) produced maximum plant spread. (Table 3) Similar results were reported by Oyinlola *et al.*[9] in sunflower and Munikrishnappa[8] in china aster.

Maximum leaf area 233.02 cm^2 was recorded in the mulched plants at higher level of fertilizers F_3 (80:90:80 NPK kg ha^{-1}). (Table 3) Increased leaf area might be due to factors such as soil moisture conservation by mulching, less competition by weeds, optimum level of nutrition uptake which may have led to promote cell division and cell elongation eventually leading to more leaf area. These findings are in line with Gavhane *et al.* [4] and Yathindra[15].

The treatment combinations of S_3 (60 cm x 20 cm) F_3 (80:90:80 NPK kg ha^{-1}) favoured highest plant height 154.69 cm. (Table 4) The results show that the closer to optimum spacing with higher fertilizer dose increased plant height. These results are in line with Hemalatha[5] in gomphrena.

While plant spread was highest with the treatment combination of S_1 (60 cm x 40 cm) + F_3 (80:90:80 NPK kg ha^{-1}) 4528.45 cm^2. (Table 4) The results are in conformity with the findings Hemalatha[5] in gomphrena and Sushma *et al.*[14] in heliconia.

Among all the treatments, combinations of S_1 (60 cm x 40 cm) + F_1 (40:60:40 NPK kg ha^{-1}), F_2 (60:75:60 NPK kg ha^{-1}) and F_3 (80:90:80 NPK kg ha^{-1}) produced maximum number of leaves (26.77, 26.10 and 26.00 respectively) (Table 4). The increase in the number of leaves may be attributed to the effective nutrient uptake at this spacing thereby stimulating auxillary buds resulting in more number of leaves irrespective of spacing levels. While maximum leaf area was recorded at S_2 (60 cm x 30 cm) spacing with higher level of fertilizers F_3 (80:90:80 NPK kg ha^{-1}). Similar results were reported by Siddanagowda[12], Shekhawat *et al.* [11] and Qahar *et al.*[10] in sunflower.

The three way interaction results between mulching, spacing and fertilizer levels on plant height at 60 DAS recorded maximum plant height with M_1 (with mulch) + S_3 (60 cm x 20 cm) + F_3 (80:90:80 NPK kg ha^{-1}) 162.43 cm in comparison to other levels of interaction (Table 5). For ornamental crops minimum plant height with optimum quality of flowers is preferred. In the present investigation minimum plant height was recorded by the treatment without mulch with recommended spacing of 60 cm x 30 cm and recommended dose of fertilizer of (60:75:60 NPK kg ha^{-1}).

The treatment combination of M_1 (with mulch) + S_1 (60 cm x 40 cm) + F_3 (80:90:80 NPK kg ha^{-1}) recorded highest plant spread recording 4642.97 cm^2 which was at par M_1(with mulch) + S_1 (60 cm x 40 cm) + F_2 (60:75:60 NPK kg ha^{-1}), M_1 (with mulch) + S_2 (60 cm x 30 cm) + F_3 (80:90:80 NPK kg ha^{-1}), M_1 (with

mulch) + S_3 (60 cm x 20 cm) + F_3 (80:90:80 NPK kg ha^{-1}), M_2 (without mulch) + S_1 (60 cm x 40 cm) + F_3 (80:90:80 NPK kg ha^{-1}) and M_2 (without mulch) + S_1 (60 cm x 40 cm) + F_2 (60:75:60 NPK kg ha^{-1}) 4642.97, 4597.39, 4558.80, 4508.39, 4413.93 and 4341.19 cm^2 respectively (Table 5)**.** With the increase in height and plant spread there is increase in internodal length but not the number of flowers, Qahar *et al*. [10] in sunflower.

The treatment combinations of M_1 (with mulch) + S_1 (60 cm x 40 cm) + F_1 (40:60:40 NPK kg ha^{-1}), M_1 (with mulch) + S_1 (60 cm x 40 cm) + F_3 (80:90:80 NPK kg ha^{-1}), M_2 (without mulch) + S_1 (60 cm x 40 cm) + F_1 (40:60:40 NPK kg ha^{-1}), M_1 (with mulch) + S_1 (60 cm x 40 cm) + F_2 (60:75:60 NPK kg ha^{-1}), M_2 (without mulch) + S_1 (60 cm x 40 cm) + F_2 (60:75:60 NPK kg ha^{-1}), M_2 (without mulch) + S_1 (60 cm x 40 cm) + F_3 (80:90:80 NPK kg ha^{-1}) and M_1(with mulch) + S_3 (60 cm x 20 cm) + F_3 (80:90:80 NPK kg ha^{-1}) produced plants with highest number of leaves (26.93, 26.80, 26.60, 26.13, 25.87, 25.80 and 25.80 (Table 5).

Maximum leaf area 5328.23 cm^2 was recorded with M_1 (with mulch) + S_2 (60 cm x 30 cm) + F_3 (80:90:80 NPK kg ha^{-1}) as compared to other interactions (Table 5). Results pertaining to improvement of growth parameters with treatment combinations of mulching, spacing and fertilizer levels were reported by Yathindra[15] in china aster; Shekhawat *et al*.[11] and Qahar *et al*. [10] in sunflower.

Table 1. Individual effect of mulching, spacing and fertilizer levels on plant height at different stages of crop growth.

Mulching levels (Main Factor)		At 60 DAS			
		Plant height (cm)	Plant spread (cm^2)	Number of leaves	Leaf area (cm^2)
M_1	With mulch	144.08	4021.22	25.02	4005.71
M_2	Without mulch	135.69	3214.01	24.11	3063.98
	CD (*P*=0.05)	1.85	115.62	0.73	129.86
	F-test	*	*	*	*

Spacing levels (Sub factor)		At 60 DAS			
		Plant height (cm)	Plant spread (cm^2)	Number of leaves	Leaf area (cm^2)
S_1	60 cm x 40 cm	136.28	4092.59	26.29	4183.63
S_2	60 cm x 30 cm	138.62	3611.46	24.06	3402.78
S_3	60 cm x 20 cm	144.75	3148.79	23.36	3018.12
	CD (*P*=0.05)	1.49	169.89	0.55	301.10
	F-test	*	*	*	*

Fertilizer levels (Sub-sub factor)		At 60 DAS			
		Plant height (cm)	Plant spread (cm^2)	Number of leaves	Leaf area (cm^2)
F_1	40:60:40 NPK kg ha^{-1}	133.51	2977.27	24.58	3083.65
F_2	60:75:60 NPK kg ha^{-1}	136.50	3765.07	24.32	3354.75
F_3	80:90:80 NPK kg ha^{-1}	149.64	4110.51	25.11	4166.14
	CD (*P*=0.05)	1.43	115.68	0.87	146.18
	F-test	*	*	NS	*

*** - Significant at *P* = 0.05 NS - Non significant at *P* = 0.05**

Table 2. Effect of different levels of mulching with spacing on vegetative parameters in ornamental sunflower

Mulching x Spacing (Main factor x Sub factor)	At 60 DAS											
	Plant height (cm)		Mean	Plant spread (cm)		Mean	Number of leaves		Mean	Leaf area cm^2		Mean
	(M_1) With mulch	(M_2) Without mulch		(M_1) With mulch	(M_2) Without mulch		(M_1) With mulch	(M_2) Without mulch		(M_1) With mulch	(M_2) Without mulch	
(S_1) 60 cm x 40 cm	139.19	133.37	139.19	3916.69	3752.52	**3834.60**	26.62	25.96	**26.29**	4194.87	4172.39	**4183.63**
(S_2) 60 cm x 30 cm	143.23	134.01	143.23	3754.38	3172.34	**3463.36**	24.78	23.33	**24.73**	3865.08	2940.49	**3402.78**
(S_3) 60 cm x 20 cm	149.82	139.68	149.82	3798.25	2397.85	**3098.05**	23.67	23.04	**23.60**	3957.18	2079.07	**3018.12**
Mean	**144.08**	**135.69**	**144.08**	**3823.10**	**3107.57**	**3465.34**	**25.02**	**24.73**	**24.87**	**4005.71**	**3063.98**	**3534.84**
CD (*P*=0.05) to compare Mulching treatments at same level of spacing	**2.11**			**240.26**			**1.06**			**425.82**		
F-test	*			*			**NS**			*		
CD (*P*=0.05) to compare Mulching treatments at same or different levels of spacing	**2.25**			**216.80**			**0.88**			**362.86**		
F-test	*			*			**NS**			*		

*** - Significant at *P* = 0.05 NS - Non significant at *P* = 0.05**

Table 3. Effect of different levels of mulching with fertilizers on vegetative parameters in ornamental sunflower

Mulching x Fertilizers (Main factor x Sub factor)	At 60 DAS											
	Plant height (cm)		Mean	Plant spread (cm^2)		Mean	Number of leaves		Mean	Leaf area cm^2		Mean
	(M_1) With mulch	(M_2) Without mulch		(M_1) With mulch	(M_2) Without mulch		(M_1) With mulch	(M_2) Without mulch		(M_1) With mulch	(M_2) Without mulch	
(S_1) 60 cm x 40 cm	136.49	130.53	**133.51**	3209.56	2744.98	2977.27	25.64	25.02	**24.58**	3507.84	2659.45	**3083.65**
(S_2) 60 cm x 30 cm	139.35	133.65	**136.50**	4284.05	3246.08	3765.07	24.11	23.91	**24.69**	4007.16	2702.34	**3354.75**
(S_3) 60 cm x 20 cm	156.41	142.87	**149.64**	4570.05	3650.96	4110.51	25.31	24.91	**25.36**	4502.12	3830.16	**4166.14**
Mean	**144.08**	**135.69**	**139.89**	4021.22	3214.01	3617.61	**25.02**	**24.73**	**24.87**	**4005.71**	**3063.98**	**3534.84**
CD (*P*=0.05) to compare Mulching treatments at same level of spacing	**2.02**			**163.59**			**0.70**			**206.72**		
F-test	*			*			**NS**			*		
CD (*P*=0.05) to compare Mulching treatments at same or different levels of spacing	**2.68**			**197.69**			**0.99**			**241.43**		
F-test	*			*			**NS**			*		

*** - Significant at *P* = 0.05 NS - Non significant at *P* = 0.05**

Table 4. Effect of different levels of mulching with fertilizers on vegetative parameters in ornamental sunflower

Spacing x Fertilizer (Sub factor x Sub-sub factor)	At 60 DAS															
	Plant height (cm)				Plant spread (cm^2)				Number of leaves				Leaf area (cm^2)			
	(S_1) 60x40 cm	(S_2) 60x30 cm	(S_3) 60x20 cm	Mean	(S_1) 60x40 cm	(S_2) 60x30 cm	(S_3) 60x20 cm	Mean	(S_1) 60x40 cm	(S_2) 60x30 cm	(S_3) 60x20 cm	Mean	(S_1) 60x40 cm	(S_2) 60x30 cm	(S_3) 60x20 cm	Mean
(F_1) 40:60:40	131.06	130.85	138.62	**133.51**	3280.03	3083.52	2568.24	**2977.27**	26.77	26.00	26.10	**24.58**	2300.23	2311.60	2736.47	**3083.65**
(F_2) 60:75:60	133.91	134.64	140.96	**136.50**	4469.29	3560.81	3265.10	**3765.07**	23.60	23.80	24.77	**24.69**	4110.87	2987.63	2965.74	**3354.75**
(F_3) 80:90:80	143.88	150.37	154.68	**149.64**	4528.45	4190.05	3613.02	**4110.51**	23.37	22.23	24.47	**25.36**	4237.13	4909.12	3352.17	**4166.14**
	136.28	**138.62**	**144.75**	**139.89**	**4092.59**	**3611.46**	**3148.79**	**3617.61**	**26.29**	**24.73**	**23.60**	**24.87**	**4183.63**	**3402.78**	**3018.12**	**3534.84**
CD (*P*=0.05) to compare spacing treatments at same level of fertilizers	2.47				**200.36**				**0.85**				**200.36**			
F-test	*				*				*				*			
CD (*P*=0.05) to compare spacing treatments at same or different levels of fertilizers	2.31				**206.41**				**0.81**				**206.41**			
F-test	*				*				*				*			

*** - Significant at *P* = 0.05 NS - Non significant at *P* = 0.05**

Table 5. Interaction effects of different levels of mulching x spacing x fertilizer on vegetative parameters in ornamental sunflower

Mulching x Spacing x Fertilizer interaction (Main factor x Sub factor x Sub-sub factor)			At 60 DAS			
Mulching levels	**Spacing levels**	**Fertilizer levels**	**Plant height (cm)**	**Plant spread (cm^2)**	**Number of leaves**	**Leaf area (cm^2)**
(M_1) With mulch	**(S_1) 60 cm x 40 cm**	**(F_1) 40:60:40 NPK kg ha^{-1}**	133.71	3459.33	26.93	4444.67
		(F_2) 60:75:60 NPK kg ha^{-1}	135.14	4597.39	26.13	4051.80
		(F_3) 80:90:80 NPK kg ha^{-1}	148.73	4642.97	26.80	4088.13
	(S_2) 60 cm x 30 cm	**(F_1) 40:60:40 NPK kg ha^{-1}**	133.25	3269.47	25.00	2228.27
		(F_2) 60:75:60 NPK kg ha^{-1}	138.39	4143.28	24.53	4038.73
		(F_3) 80:90:80 NPK kg ha^{-1}	158.07	4558.80	24.80	5328.23
	(S_3) 60 cm x 20 cm	**(F_1) 40:60:40 NPK kg ha^{-1}**	142.51	2899.86	25.00	3850.60
		(F_2) 60:75:60 NPK kg ha^{-1}	144.54	4111.50	21.67	3930.94
		(F_3) 80:90:80 NPK kg ha^{-1}	162.43	4508.39	25.80	4090.00
(M_2)Without mulch	**(S_1) 60 cm x 40 cm**	**(F_1) 40:60:40 NPK kg ha^{-1}**	128.41	3100.73	26.60	3961.09
		(F_2) 60:75:60 NPK kg ha^{-1}	132.68	4341.19	25.87	4169.93
		(F_3) 80:90:80 NPK kg ha^{-1}	139.02	4413.93	25.80	4386.13
	(S_2) 60 cm x 30 cm	**(F_1) 40:60:40 NPK kg ha^{-1}**	128.46	2897.57	22.20	2394.93
		(F_2) 60:75:60 NPK kg ha^{-1}	130.89	2978.34	23.07	1936.53
		(F_3) 80:90:80 NPK kg ha^{-1}	142.67	3821.31	24.73	4490.00
	(S_3) 60 cm x 20 cm	**(F_1) 40:60:40 NPK kg ha^{-1}**	134.73	2236.62	21.73	1622.33
		(F_2) 60:75:60 NPK kg ha^{-1}	137.39	2418.71	22.80	2000.54
		(F_3) 80:90:80 NPK kg ha^{-1}	146.93	2717.65	24.60	2614.33
Mean			**139.89**	**3617.61**	**24.87**	**3534.84**
CD (*P*=0.05) to compare mulching x spacing x fertilizer levels			**4.20**	**351.00**	**1.50**	**489.11**
F-test			*	*	*	*

*** - Significant at *P* = 0.05** **NS - Non significant at *P* = 0.05**

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