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Effect of Transplanting Time and Spacing on Growth and Flower Yield in Gaillardia (*Gaillardia pulchella* Foug.) cv. Local

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ABSTRACT: Transplanting time and spacing influences flowering and many other aspects of plant growth and development in flower crops. Therefore, the present study aimed to evaluate the effect of transplanting time and spacing on growth and flower yield in gaillardia cv. Local using RBD (factorial) design comprising two factors *i.e.*, Factor 1- transplanting time (P) *viz.*, P_1 -First week of December, P_2 -First week of January and P_3 -First week of February and Factor 2- Spacing (S) *viz.*, S_1 -90 × 60 cm, S_2 -60 × 60 cm, S_3 - 60 × 45 cm and S_4 -45 × 45 cm. Experiment was conducted for three years (2018-19, 2019-20 & 2020-21). Treatments were repeated thrice. Among different time of transplanting, P_1- First week of December significantly influenced growth and yield parameters. With regards to different spacing, the seedlings transplanted at 90 × 60 cm (S_1) improved growth as well as yield attributes. However, S_4 - 45 × 45 cm gave higher yield per hectare. Interaction effect of P_1S_2 *i.e.* transplanted during first week of December at 60 × 60 cm recorded significantly maximum plant spread, whereas maximum flower diameter, average weight of flowers and flower yield per plant observed with P_1S_1 *i.e.* transplanted during first week of December at 90 × 60 cm. The treatment combination P_1S_4 *i.e.* seedlings transplanted during first week of December at 45 × 45 cm recorded significantly maximum flower yield per hectare.

Keywords: Gaillardia**,** transplanting time, spacing, growth, flower yield.

INTRODUCTION

Gaillardia (*Gaillardia pulchella* Foug.) popularly known as blanket flower belongs to the family Asteraceae (Baily, 1947). It is one of the most popular flower in India because of its easy cultivation, wide adaptability to varying soils and climatic conditions with long duration of flowering and attractive flower colours available in single or semi-double type. Flowers are used as both loose as well as cut flowers. There are about 12 species, out of which *Gaillardia pulchella* Foug. and *Gaillardia cristata* are of horticultural importance (Bose and Yadav 1989). In landscaping, they are useful for filling up any odd corners as well as open areas (Saniya *et al.*, 2021).

It substitutes chrysanthemum and marigold due to availability of gaillardia flowers during *summer* months at that time no any other flowers are easy and economically available in the market. It can withstand high light intensities, high temperature and drought better than most of the flowering plants. It is grown throughout year in many parts of country.

Planting time influences flowering and many other aspects of plant development. Though gaillardia can be grown throughout the year, the climate has its own effect on plant growth and flower yield (Patil *et al.*, 2005; Sharma *et al.*, 2015). Optimum spacing regulates the proper utilization of solar energy, avoids competition in the uptake of nutrients caused by the collision of root systems, facilitates proper intercultural operations etc. (Chaudhari *et al.*, 2020).

Due to lack of scientific investigation under local agro-climatic condition on its standardization of horticultural practices, the present study was under taken to know the appropriate planting time and suitable spacing in which gaillardia crop performs well and provide better returns with the objectives, (i) To find out appropriate transplanting time (ii) To find out suitable spacing and (iii) To find out interaction effect, if any

MATERIALS AND METHODS

A. Experimental site

The present investigation was carried out at Horticultural Research Farm, B. A. College of Agriculture, A.A.U., Anand during the year 2018-19, 2019-20 and 2020-21. Anand is situated in the Western Indian state of Gujarat and geographically at 22°35' North latitude and 72°56' East longitude with an

altitude of about 45.1 m above the mean sea level. The climate of middle Gujarat zone is semi-arid and subtropical type. October to May is sunny months generally receiving an average of eight hours sunshine per day. Temperature during hot weather commences by end of February and ends by about middle of June. Winter sets in the middle of October and continues till the end of February. Monsoon is generally starts from second fortnight of June and retreats by middle of September with an annual rainfall of 860 mm. The soil of the experimental site was loamy sand, locally known as *"Goradu"*.

B. Experimental design and treatments

The experimental design was RBD with factorial concept with three replications. The recommended dose of FYM @ 10 t/ha and 100:50:50 NPK kg/ha were applied. Full dose of FYM along with 50 % N, 100 % P and K at the time of transplanting for respective treatments and remaining 50 % split dose of N at one month after transplanting. All observations regarding growth and yield parameters of gaillardia were recorded.

Treatment details are as under:

Factor 1 – Transplanting time (P)
1. P_1 -First week of December
2. P_2 -First week of January
3. P_3 -First week of February
1. P_1 -First week of December
Factor 2 – Spacing (S)
1. S_1 -90 × 60 cm
2. S_2 -60 × 60 cm
3. S_3 -60 × 45 cm
4. S_4 -45 × 45 cm

RESULTS AND DISCUSSION

A. Growth parameters

Effect of transplanting time. The differences in growth parameters *viz*., plant height, number of branches per plant and plant spread due to time of transplanting were found significant in pooled**.** The data indicated that (Table 1) significantly the highest plant height (69.22 cm), number of branches per plant (16.94), plant spread N-S (86.57 cm) and plant spread E-W (75.61 cm) were recorded with the treatment P_1(First week of December) in pooled. It might be due to favorable growing conditions which might have resulted in luxuriant growth of these vegetative characters when transplanted in first week of December. These results were supported by Patil *et al.* (2005); Sharma *et al.* (2015); Vaagdevi *et al.* (2020) in gaillardia.

Effect of spacing. In pooled, the differences in growth parameters due to spacing was found significant. The data showed that significantly higher plant height (70.18 cm), number of branches per plant (16.20), plant spread N-S (76.63 cm) and plant spread E-W (66.73 cm), (Table 1) were recorded under the treatment S_1 (90 × 60 cm). This increase in growth characters might be due to the availability of more space which provided better penetration of light, more aeration and ultimately increased photosynthetic activity resulting into significant effect on different growth characters. Similar findings were also reported by Chaudhary *et al.* (2020) in gaillardia, Singh and Sangama (2001).

Interaction effect of transplanting time and spacing. The interaction effect (P × S) showed non-significant influence on plant height and number of branches per plant (Table 1). The significantly maximum plant spread N-S (91.22 cm) and plant spread E-W (83.60 cm) were found in pooled with P_1S_2 *i.e.*, transplanted during first week of December at 60 × 60 cm (Table 2). It might be due to seedlings transplanted during first week of December at 60 × 60 cm provides favorable growing conditions which enhances growth characters. These results were also in accordance with findings of Patil *et al.* (2005); Vaagdevi *et al.* (2020); Chaudhary *et al.* (2020) in gaillardia.

Table 1: Effect of transplanting time and spacing on plant height, number of branches per plant and plant spread (N-S and E-W) of gaillardia cv. Local at peak flowering stage (Pooled of three years).

Treatments	Plant height (cm)	Number of branches per plant	Plant spread (N-S) (cm)	Plant spread (E-W) (cm)
Factor 1: Transplanting time (P)				
1st week of December (P_1)	69.22	16.94	86.57	75.61
1st week of January (P_2)	66.42	15.05	67.21	58.62
1st week of February (P_3)	62.76	12.61	65.74	52.74
S.Em±	0.72	0.51	1.15	1.01
$lsd_{0.05}$	2.03	2.03	3.26	2.85
Factor 2: Spacing (S)				
90 × 60 cm (S_1)	70.18	16.20	76.63	66.73
60 × 60 cm (S_2)	66.18	14.95	75.13	65.23
60 × 45 cm (S_3)	65.20	14.17	72.09	60.54
45 × 45 cm (S_4)	62.98	14.14	68.85	56.79
S.Em±	0.83	0.27	1.33	1.16
$lsd_{0.05}$	2.35	0.77	3.76	3.29
P x S	NS	NS	Sig.	Sig.
C.V %	6.53	9.56	9.46	9.72

Table 2: Interaction effect of transplanting time and spacing on plant spread (N-S & E-W) of gaillardia cv. Local.

	N-S (cm)				E-W (cm)			
S / P	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4
P_1	90.63	91.22	83.81	80.63	80.69	83.60	73.03	65.13
P_2	73.02	63.14	66.50	66.17	65.06	54.39	55.78	59.23
P_3	66.24	71.01	65.96	59.75	54.45	57.70	52.81	46.00
S.Em±	2.30				2.01			
$lsd_{0.05}$	6.52				5.70			
C.V %	9.46				9.72			

B. Yield parameters

Effect of transplanting time. In pooled, the days taken for 50 % flowering showed non-significant influence due to different time of transplanting (Table 3). Maximum flower diameter (5.25 cm), average weight of 20 flowers (39.64 g), shelf life (12.19 hrs), number of flowers per plant (214.17), flower yield per plant (426.27 g) and flower yield per hectare (12.97 t) was recorded when transplanting was done during first week of December (Table 3). It might be due to enhanced growth components and translocation of more photosynthates from vegetative to reproductive parts under congenial climatic conditions. This trend was also reported by Ahmed *et al.* (2015) in sunflower, Nagaraju *et al.* (2004) in China aster, Patil *et al.* (2005); Sharma *et al.* (2015) in gaillardia.

Effect of spacing. The seedlings transplanted at 90 × 60 cm (S_1) showed maximum flower diameter (5.20 cm), average weight of 20 flowers (41.72 g), number of flowers (212.86) and flower yield per plant (447.45 g) in pooled. Whereas, shelf life was found non-significant (Table 3). This increase in floral characters might be due to that low density planting provides favorable condition for maximum size, weight and number of flowers per plant. However, treatment S_4 (45 × 45 cm) had recorded significantly higher flower yield per hectare (10.96 t) in pooled. It might be due to closer spacing accommodate a higher number of plants per unit area which ultimately increased flower numbers and yield. Similar finding was also reported by Kumar *et al.* (2020); Massoud (2008) in marigold, Awchar *et al.* (2010); Hugar (1997); Chaudhary *et al.* (2020) in gaillardia.

Interaction effect of transplanting time and spacing. In pooled, the interaction effect (P × S) was found non-significant for days taken for 50 % flowering, shelf-life and number of flowers per plant. While, seedlings transplanted during first week of December at 90 × 60 cm (P_1S_1) recorded significantly maximum flower diameter (6.15 cm) and average weight of 20 flowers (46.75 g) (Table 4). The interaction effect of transplanting time and spacing presented in Table 5 showed that gaillardia transplanted during first week of December at 90 × 60 cm (P_1S_1) had recorded significantly maximum flower yield per plant (579.65 g) as compared to other treatments. It might be due to the seedlings transplanted during first week of December at 90 × 60 cm provides favorable growing conditions which enhances translocation of more photosynthates from vegetative to reproductive parts. While, seedlings transplanted during first week of December at 45 × 45 cm (P_1S_4) had recorded significantly maximum flower yield per hectare (14.93 t/ha) in pooled. It might be due to increased plant population under closer spacing which ultimately increased the yield per hectare. This trend was also reported by Sharma *et al.* (2022) in marigold, Sharma *et al.* (2015); Chaudhary *et al.* (2020) in gaillardia.

Table 3: Effect of transplanting time and spacing on yield parameters of gaillardia cv. Local at peak flowering stage (Pooled of three years).

Treatments	Days taken for 50 % flowering	Flower diameter (cm)	Avg. wt. of 20 flowers (g)	Shelf life (Hours)	Number of flowers per plant	Flower yield per plant (g)	Flower yield (t/ha)
Factor 1: Transplanting time (P)							
1st week of December (P_1)	78.97	5.25	39.64	12.19	214.17	426.27	12.97
1st week of January (P_2)	78.94	4.55	36.35	11.44	168.42	294.25	8.81
1st week of February (P_3)	78.69	4.08	32.51	10.75	143.41	235.08	7.11
S.Em±	1.19	0.13	1.25	0.19	7.85	6.00	0.18
$lsd_{0.05}$	NS	0.54	4.91	0.75	30.82	16.96	0.50
Factor 2: Spacing (S)							
90 × 60 cm (S_1)	78.07	5.20	41.72	12.07	212.86	447.45	8.28
60 × 60 cm (S_2)	78.88	4.77	35.46	11.51	186.36	334.10	9.27
60 × 45 cm (S_3)	79.07	4.54	33.87	11.22	158.98	270.56	10.02
45 × 45 cm (S_4)	79.44	4.01	30.74	11.03	143.14	222.03	10.96
S.Em±	0.55	0.12	0.65	0.25	2.28	6.93	0.20
$lsd_{0.05}$	NS	0.42	1.85	NS	6.46	19.58	0.58
P × S	NS	Sig.	Sig.	NS	NS	Sig.	Sig.
C.V %	2.04	8.74	9.64	4.30	6.78	11.31	11.21

Table 4: Interaction effect of transplanting time and spacing on flower diameter and avg. wt. of 20 flowers of gaillardia cv. Local (Pooled).

P \ S	Flower diameter (cm)				Avg. wt. of 20 flowers (g)			
	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4
P_1	6.15	5.37	4.94	4.56	46.75	41.35	37.03	33.46
P_2	4.90	4.83	4.63	3.87	42.83	32.98	32.48	29.72
P_3	4.57	4.10	4.04	3.63	36.04	32.04	32.09	29.06
S.Em±	0.13				1.13			
$lsd_{0.05}$	0.38				3.21			
C.V %	8.74				9.64			

Table 5: Interaction effect of transplanting time and spacing on flower yield per plant and flower yield per hectare of gaillardia cv. Local (Pooled).

P \ S	Flower yield per plant (g)				Flower yield per hectare (t/ha)				
	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1
P_1	579.65	458.01	364.94	302.50	10.73	12.72	13.51	14.93	10.73
P_2	436.18	292.08	259.52	216.20	8.07	8.11	9.20	9.88	8.07
P_3	326.51	252.21	198.12	163.49	6.04	7.00	7.33	8.07	6.04
S.Em±	12.00				0.36				
$lsd_{0.05}$	33.92				1.01				
C.V %	11.31				11.21				

CONCLUSIONS

From the three years of field study, it can be concluded that the farmers of Middle Gujarat agro climatic zone growing gaillardia crop cv. Local for getting flower in *summer* season are recommended to transplant the healthy seedlings at 45 × 45 cm during the first week of December for getting higher flower yield.

FUTURE SCOPE

In order to increase growth and flower yield in gaillardia, future studies have to be done further by employing the transplanting time and spacing treatment in different locality.

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Conflict of Interest. None.

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