Indian Journal of Agricultural Sciences **85** (6): 797–801, June 2015/Article

Effect of planting time, spacing and pinching on growth and seed yield traits in African marigold (*Tagetes erecta*) cv. Pusa Narangi Gainda

YADRAM MEENA[1], H S SIROHI[2], B S TOMAR[3] and SANJAY KUMAR[4]

Chaudhary Chhotu Ram College, Muzaffarnagar, Uttar Pradesh

Received: 17 November 2014; Accepted: 11 February 2015

ABSTRACT

The present investigation was carried out at the Horticulture Farm, Chaudhary Chhotu Ram (PG) College, Muzaffarnagar, UP, for consecutive two years to study the effect of planting time, spacing and pinching on plant growth and seed yield characters in African marifold (*Targets exeta* L.). It was noted that planting time, wider spacing and pinching at 60 DAT had significant effect on number of days to first flowering and number of flowers/plant. The higher plant height was recorded in September planting, 30 cm × 30 cm spacing and in without pinching treatments. The number of branch/plant and diameter of main stem were higher in October planting, 30 cm × 60 cm spacing (19.87) but pinching at 30 DAT had produced maximum diameter of stem (1.36 cm) than others.The maximum seed yield/flower (0.58 g), seed yield/plant (17.82 g) and seed yield/plot (254.44g) were recorded in September planting while closer spacing 30 cm × 30 cm had given higher seed yield/flower (0.60g), seed yield/plant (17.71g) and seed yield/plot (262.28g). The pinching at 60 DAT has given higher seed yield/ flower (0.55g), seed yield/plant (19.01g), seed yield/plot (283.61g) followed by pinching at 30 DAT. Significant interaction between time of planting × spacing, pinching × spacing, time of planting × spacing × pinching were recorded for seed yield/flower and the interaction between pinching × time of planting was recorded significant for seed yield/plot.

Key words: Marigold, Pinching, Planting time, Pusa Narangi Gainda, Seed yield, Spacing

Marigold (*Tagetes erecta* L.) is one of the most commonly grown loose and cut flower crop in India and it is extensively used in religious and social occasions. It contains medicinal and nematicidal property, and recommended for growing as a trap crop with the tomato and onion to reduce the menace of fruit borer in IPM system. It occupies prominent position among the traditional loose flowers grown in India and ranks next only to jasmine in terms of production. It is estimated that it is being grown in 42 880 hectare area with production of 360 000 MT (NHB 2012-13). The average productivity of loose flower is low in our country than in the developed countries, viz. USA, Germany, England and Israel etc. The lower productivity is attributed to the limited availability of high quality seed and lack of development of the F_1 hybrids for cultivation. The area planted by the traditional varieties are low yielders and genetically not pure or is a mixture, whereas varieties, viz. Pusa Narangi Gainda and Pusa Basanti Gainda are high yielding (Raghava 1998). In India to cover more area with high yielding variety like Pusa Narangi Gainda there is a need to ensure the quality seed which is in short supply due to lack of standardized seed production practices. However, the demand of quality seed of marigold cv. Pusa Narangi Gainda is growing within the country and for export to foreign countries. Thus, the present investigation efforts have been made to standardize the time of planting, spacing, time of pinching and their interaction effect to improve the availability of quality.

MATERIALS AND METHODS

The present research experiment was conducted at the Horticultural Research Farm, Department of Horticulture, Chaudhary Chhotu Ram (PG) College, Muzaffarnagar (Uttar Pradesh) during the year 2005-06 and 2006-07. The experiment site is situated at latitude of 29°00"N and longitude 77°10" E and at an altitude of 222 m above mean sea level. It has a sub-tropical climate characterized by extreme hot summer and cold winter. The soil of experimental site is sandy loam in texture and organic carbon content of 0.46%. The seed of marigold variety Pusa Narangi Gainda was obtained from Seed Production Unit, IARI, New Delhi and seedlings were grown on the raised seed beds in the nursery. Twenty four days old seedlings of 4-6 leaf stage were transplanted on three different dates, i.e. 15 September (T_1), 15 October (T_2) and 15 November (T_3) with three different spacing, i.e. 30 cm × 30 cm (S_1), 30 cm × 45 cm

[3] Principal Scientist (e mail-bst_spu_iari@rediffmail.com), SPU, IARI, New Delhi 110 012; [1] Ministry of Agriculture, Government of India; [2] Department of Horticulture, CCR College, Muzaffarnagar, Uttar Pradeshl, [4] Division of Seed Science and Technology, IARI, New Delhi 110 012

(S_2), 30 cm × 60 cm (S_3) in main plot. The pinching operation was practiced in sub-plot with three different ways, i.e. no pinching (P_1), pinching at 30 DAT (P_2) and double pinching at 60 DAT (P_3) during the year of 2005 and 2006. The split plot design was followed with three replications. The observations, viz. days to first flowering, number of flowers/plant, plant height at maturity (cm), number of the branches/plant, diameter of main stem (cm), seed yield/flower (g), seed yield/plant (g), seed yield/plot (g) were recorded on 10 randomly selected plants from each plots. The data recorded was pooled and subjected to statistical analysis by the method of "analysis of variance" as advocated by Cochran and Cox (1962). The significant response of the various treatments was worked out with the help of F test. The comparison was made on the basis of critical differences (CD) at 5% levels of significance.

RESULTS AND DISCUSSION

Days to first flowering

The significant differences for days to first flowering were recorded among the time of planting (Table 1) and 15 September planting took minimum time (66.70 days), whereas 15 November planting took maximum time (97.71 days) to first flowering and this could be attributed to low temperature and low light intensity during the late planting crop. The lower number of days for first flowering was recorded in 30 cm × 30 cm spacing (80.43 days). The wider spacing had taken more number of days to first flowering due to the more vegetative growth. The double pinching (P_3) has taken maximum days (94.85) for first flowering followed by P_2 (77.12) and P_1 (71.35). The pinching has significantly delayed the days to first flowering and it is due to the induction of vegetative phase after the break of apical dominance. Significant difference was recorded due to interaction between pinching and time of planting on days to first flowering. The maximum days to first flowering (104.42) was recorded in November planting with double pinching (P_3), whereas the minimum (59.46) was recorded in September planting with no pinching (Table 2) which could be due to the induction of vegetative growth after pinching and unfavorable climatic conditions, viz. low temperature and light intensity during the growth.

Number of flowers/plant

The planting at 15 October resulted in highest number of flowers (37.27) compared to September planting (30.90) and November planting (27.60) which is due to the better environmental conditions and more number of branches/plant (18.79) which is in agreement with Shreekanth *et al*. (2007). The higher spacing (30 cm × 60 cm) has given highest number of flowers/plant (34.67) followed by 30 cm × 45 cm (31.59) and 30 cm × 30 cm (29.55) which had attributed to the higher number of branches/plant and better growth and less competition for water, nutrients and light under wider spacing. The maximum (34.91) number of flowers/plant was recorded in pinching at 60 DAT followed by P_2 (31.97) and P_1 (28.90) (Table 1) which was due to the more number of branches/plant and the result of this investigation is in agreement with Bhat and Shephered (2007) and Sunitha *et al*. (2007).Significant interaction among time of planting and spacing for number of flowers/plant was recorded. The maximum number of flowers/plant (41.19) was recorded in October planting with 30 cm × 60 cm spacing which is due to the better growing environment and less competition for light, moisture and nutrients. Whereas, the minimum number of flowers/plant (25.72) was recorded in November planting with 30 cm × 30 cm spacing (Table 2)

Plant height at maturity

The highest plant height (57.75) was observed in 15 September planting, whereas lower plant height (43.75) was

Table 1 Effect of planting time, spacing and pinching on growth and seed yield traits (Pooled data)

Parameters	Time of planting					Spacing					Time of pinching				
	T1	T2	T3	SEm	CD (P=0.05)	S1	S2	S3	SEm	CD (P=0.05)	P1	P2	P3	SEm	CD (P=0.05)
Days to 1st flowering	66.70	78.91	97.71	1.28	4.43	80.43	81.01	81.88	0.62	1.77	71.35	77.12	94.85	0.62	1.77
Number of flowers/plant	30.90	37.27	27.60	0.51	1.78	29.55	31.59	34.63	0.27	0.77	28.90	31.97	34.91	0.27	0.77
Plant height at maturity	57.75	46.58	43.75	0.85	2.97	49.73	49.50	48.86	0.39	1.11	52.97	48.00	47.11	0.39	1.11
Number of branch/plant	18.11	18.79	18.34	0.33	1.15	17.05	18.33	19.87	0.17	0.50	12.98	19.28	22.99	0.17	0.50
Diameters of main stem	1.30	1.40	1.36	0.02	0.08	1.32	1.35	1.38	0.01	0.03	1.35	1.36	1.35	0.01	0.03
Seed yield/flower	0.58	0.46	0.54	0.080	0.029	0.60	0.50	0.48	0.040	0.011	0.51	0.52	0.55	0.040	0.011
Seed yield/plant	17.82	17.23	15.07	0.31	1.07	17.71	15.84	16.57	0.16	0.45	14.62	16.49	19.01	0.16	0.45
Seed yield/plot	254.44	213.44	252.91	0.31	1.076	262.28	259.94	198.56	0.161	0.456	226.91	240.27	253.61	0.161	0.456

*T1-15 Sept., T2-15 Oct., T3-15 Nov.,**S1-30 cm × 30 cm, S2-30 cm × 45 cm, S3-30 cm × 60 cm, ***P1- No pinching, P2-Pinching at 30 DAT, P3-Pinching at 60 DAT

Table 2 Interaction effect of time of planting, spacing and pinching on number of days to first flowering, number of flowers/plant, plant height at maturity (cm) (Pooled data)

Time of planting (T)	Spacing (S)	Number of days to first flowering				Number of flowers/plant				Plant height at maturity (cm)			
		(P_1)	(P_2)	(P_3)	Mean	(P_1)	(P_2)	(P_3)	Mean	(P_1)	(P_2)	(P_3)	Mean
15th Sep.	S_1 30×30 cm	57.93	62.80	77.07	65.93	24.67	27.83	32.53	28.34	60.56	57.23	56.45	58.08
(T_1)	S_2 30×45 cm	58.33	63.47	77.03	66.28	27.83	30.67	34.80	31.10	61.27	56.80	54.20	57.42
	S_3 30×60 cm	62.13	66.43	75.11	67.89	29.60	33.60	37.90	33.70	60.53	54.96	53.30	56.26
	Mean	59.46	64.23	76.40	66.70	27.37	30.70	35.07	31.05	60.79	56.33	54.65	57.25
15th Oct.	S_1 30×30 cm	63.50	68.05	103.07	78.20	30.73	33.36	36.96	33.68	51.13	47.27	44.10	47.50
(T_2)	S_2 30×45 cm	64.30	68.46	103.40	78.72	33.32	36.09	40.93	36.78	50.65	46.53	42.10	46.42
	S_3 30×60 cm	64.83	69.93	104.70	79.82	37.90	40.90	44.76	41.19	51.43	45.33	40.77	45.84
	Mean	64.21	68.81	103.72	78.91	33.98	36.78	40.88	37.22	51.07	46.38	42.32	46.59
15th Nov.	S_1 30×30 cm	88.57	97.03	105.87	97.15	21.67	25.21	30.30	25.72	48.20	43.30	41.37	44.29
(T_3)	S_2 30×45 cm	89.76	98.63	105.73	98.04	24.30	27.70	32.20	28.06	48.10	43.77	41.63	44.50
	S_3 30×60 cm	92.80	99.33	101.67	97.93	25.33	28.90	33.87	29.36	46.95	42.87	40.67	43.49
	Mean	90.37	98.33	104.42	97.71	23.76	27.27	32.12	27.72	47.75	43.31	41.22	44.09
CD (P=0.05)													
Time of planting					2.46				0.77				1.85
Spacing					NS				0.77				NS
T×S					NS				0.78				NS
Pinching					4.26				1.34				3.21
P×T					4.27				NS				NS
P×S					NS				NS				NS
T×S×P					NS				NS				NS

*T1-15 Sept., T2-15 Oct., T3-15 Nov.,**S1-30 × 30 cm, S2-30 × 45 cm, S3-30 × 60 cm, ***P1- No pinching, P2-Pinching at 30 DAT, P3-Pinching at 60 DAT

observed in case of 15 November. Close spacing (S_1) has given highest plant height (49.73) followed by S_2 (49.50) and S_3 (48.86) which was due to better light intensity and optimum temperature for growth and development under early planting (Cruz and Mendez 2002) and less competition among the plants for light, moisture and nutrients under wider spacing (Karuppaiah and Krishna 2005). The maximum plant height (52.97 cm) was observed under without pinching (P_1) treatment and no significant difference was found among the P_2 (48.00) and P_3 (47.11) (Table 1) which was due to the suppression of apical growth by pinching process and diversion of plant assimilates towards the initiation and development of side branches.

Number of branches/plant

The planting time has significant effect on number of branches/plant as October planting time has (T_2) produced more number of branches/plant (18.79). However, crop planting either early (18.11) or late (18.34) from 15 October, resulted into reduced number of branches/plant. The wider spacing (S_3) has higher number of branches/plant (19.87) followed by S_2 (18.33) and in S_1 (17.05) which was due to better light intensity and less competition for inputs. The branches/plant improved significantly with pinching and recorded higher number (22.99) of branches/plant with double pinching at 60 DAT followed by 19.28 and 12.98 under P_2 and P_1 respectively due to supply of more plant assimilates towards the side branching after the pinching process. Significant difference was recorded due to interaction between pinching and spacing on number of branches/plant. The maximum number of branches/plant (27.73) was recorded in 30 cm × 60 cm spacing with pinching after 60 days after planting, whereas the minimum number (11.50) was recorded in 30 cm × 30 cm spacing with no pinching (Table 3).

Diameter of main stem

Maximum diameter of stem (1.40 cm) was observed in 15 October planting followed by 15 November planting (1.36 cm) with minimum in 15 September (1.30). It was noted that there was significant increase in diameter of stem with increase in spacing and higher spacing significantly produced maximum diameter (1.38 cm), whereas minimum (1.32 cm) stem diameter was observed under narrow planting spacing (30 cm × 30 cm) due to less competition among the plants for available inputs (Table 1). Non-significant difference due to interaction between time of planting, spacing and pinching was noticed on diameter of main stem at maturity (Table 3).

Seed yield/flower

The maximum seed yield/flower was recorded in September planting (0.58 g) while it was minimum (0.46 g) in 15 October planting which is due to favourable environment conditions for plant growth during the September planting and better activity of pollinators resulted

Table 3 Interaction effect of time of planting, spacing and pinching on number of branches/plant, diameter of mainstem at maturity(cm), seed yield/flower (g) (Pooled data)

Time of planting (T)	Spacing (S)	Number of branches/				Diameter of main stem at plant				Seed yield per flower maturity (cm)			(g)
		(P_1)	(P_2)	(P_3)	Mean	(P_1)	(P_2)	(P_3)	Mean	(P_1)	(P_2)	(P_3)	Mean
15th Sep.	S_1 30×30cm	11.50	15.63	19.93	15.69	1.230	1.290	1.240	1.253	0.645	0.675	0.720	0.680
(T_1)	S_2 30×45 cm	11.63	20.19	21.82	17.88	1.300	1.330	1.270	1.300	0.535	0.550	0.605	0.563
	S_3 30×60 cm	12.63	19.77	24.00	18.80	1.360	1.385	1.340	1.362	0.465	0.495	0.530	0.497
	Mean	11.92	18.53	21.91	17.45	1.297	1.335	1.283	1.305	0.548	0.573	0.618	0.580
15th Oct.	S_1 30×30 cm	15.50	20.46	23.36	19.77	1.360	1.390	1.380	1.377	0.470	0.545	0.595	0.537
(T_2)	S_2 30×45 cm	15.53	21.67	25.40	20.86	1.390	1.425	1.400	1.405	0.435	0.460	0.470	0.455
	S_3 30×60 cm	16.60	24.40	27.73	22.91	1.395	1.430	1.415	1.413	0.400	0.435	0.450	0.428
	Mean	15.88	22.17	25.50	21.18	1.382	1.415	1.398	1.398	0.435	0.480	0.505	0.473
15th Nov.	S_1 30×30 cm	11.96	18.00	20.63	16.86	1.300	1.315	1.285	1.300	0.525	0.565	0.675	0.588
(T_3)	S_2 30×45 cm	11.63	19.00	22.63	17.75	1.365	1.385	1.355	1.368	0.495	0.550	0.575	0.540
	S_3 30×60 cm	12.40	19.93	23.43	18.59	1.370	1.430	1.410	1.403	0.470	0.470	0.520	0.487
	Mean	12.00	18.97	22.23	17.73	1.345	1.377	1.350	1.357	0.497	0.528	0.590	0.538
CD (P=0.05)													
Time of planting					0.75				0.04				0.2
Spacing					0.75				0.04				0.2
T×S					NS				NS				0.01
Pinching					1.30				NS				0.04
P×T					NS				NS				NS
P×S					0.82				NS				0.02
T×S×P					NS				NS				0.03

*T1-15 Sept., T2-15 Oct., T3-15 Nov., **S1-30 × 30 cm, S2-30 × 45 cm, S3-30 × 60 cm, ***P1- No pinching, P2-Pinching at 30 DAT, P3-Pinching at 60 DAT

Table 4 Interaction effect of time of planting, spacing and pinching on seed yield/plant (g) and seed yield/plot (g) (Pooled data)

Time of planting (T)	Spacing (S)	Seed yield/plant (g)				Seed yield/plot (g)			
		(P_1)	(P_2)	(P_3)	Mean	(P_1)	(P_2)	(P_3)	Mean
15 Sep. (T_1)	S_1 30×30cm	16.33	19.33	23.67	19.78	283.75	307.05	347.85	312.88
	S_2 30×45 cm	16.17	17.67	20.80	18.21	259.20	293.50	332.36	295.02
	S_3 30×60 cm	14.83	16.67	19.50	17.00	219.20	247.00	274.15	246.78
	Mean	15.78	17.89	21.32	18.33	254.05	282.52	318.12	284.90
15 Oct. (T_2)	S_1 30×30 cm	15.83	18.66	21.66	18.72	186.85	255.20	295.05	245.70
	S_2 30×45 cm	14.33	15.83	18.17	16.11	172.80	204.00	259.10	211.97
	S_3 30×60 cm	13.66	15.50	17.00	15.38	140.40	192.53	227.45	186.79
	Mean	14.61	16.66	18.94	16.74	166.68	217.24	260.53	214.82
15 Nov. (T_3)	S_1 30×30 cm	13.83	16.00	18.33	16.05	245.30	285.05	315.00	281.78
	S_2 30×45 cm	12.67	14.67	16.00	14.44	215.10	270.05	299.15	261.43
	S_3 30×60 cm	12.00	13.67	15.50	13.72	181.22	216.70	238.07	211.99
	Mean	12.83	14.78	16.61	14.74	213.87	257.27	284.07	251.74
CD (P=0.05)									
Time of planting					0.56				9.16
Spacing					0.56				9.16
T×S					NS				NS
Pinching					0.97				15.87
P×T					0.80				9.89
P×S					0.80				NS
T×S×P					NS				NS

*T1-15 Sept., T2-15 Oct., T3-15 Nov., **S1-30 × 30 cm, S2-30 × 45 cm, S3-30 × 60 cm, ***P1- No pinching, P2-Pinching at 30 DAT, P3-Pinching at 60 DAT

into better seed setting. Seed yield/flower showed significant decrease with increasing the spacing (Table 1). Thus, the closer spacing recorded highest seed yield (0.60 g) than S2 (0.50 g) and S3 (0.48 g) due to better activity of pollinators in the closed vicinity of area. Pinching at 60 DAT had given maximum yield (0.55g) followed by pinching at 30 DAT (0.52 g) which was could be attributed to the diversion of plant assimilates into the side branches. Significant difference was recorded due to interaction between time of planting and spacing on seed yield/flower. The maximum seed yield/flower (0.68 g) was recorded in September planting with 30 cm × 30 cm spacing, whereas the minimum seed yield/flower (0.43 g) was recorded in October planting with 30 cm × 60 cm spacing. The interaction between P×S and T×S×P were also significant (Table 3).

Seed yield/plant

The delay in planting significantly decreased the seed yield/plant. The maximum seed yield/plant (17.82g) was recorded in September planting, which was reduced up to 15.07g/plant in 15 November planting. The spacing 30 cm × 30 cm (17.71) produced significantly higher seed yield than 30 cm × 60 cm (16.57 g) which was due to better environmental conditions during crop period and higher seed yield/flower. The pinching at 60 DAT had given maximum (19.01g) seed yield/plant followed by pinching at 30 DAT (16.49g) due to the more number of branches and flowers/plant under double pinching (P_3) process which was in agreement with Tomar *et al* (2004).

The interaction between the time of planting × pinching and spacing × pinching were recorded for seed yield/plant and found that maximum seed yield/plant (21.32 g) was recorded in September planting with pinching at 60 DAT. While the minimum seed yield/plant (12.83 g) was recorded in November planting with pinching at 30 DAT. The maximum seed yield/plant (23.67) was recorded in 30 × 30 cm spacing with pinching 60 days after planting and minimum (12.00) was recorded in 30 cm × 60 cm spacing with no pinching (Table 4).

Seed yield/plot

The seed yield/plot decreased significantly with delayed planting. The maximum (254.44g) seed yield/plot was recorded in 15 September planting followed by 15 Nov. planting (252.91g) due to long growing period in September planting for better seed development. The planting at 30 cm × 30 cm produced maximum (262.28g) seed yield/plot and lowest in 30 cm × 60 cm planting spacing (198.6g) which was due to higher number of plant density in case of closer spacing. The pinching at 60 DAT had given highest (253.61g) seed yield/plot followed by pinching at 30 DAT (240.27g) (Table 1) which could be attributed to more number of branches/plant, more number of flower/plant, seed yield/flower and seed yield/plant. The maximum seed yield/plot (318.12 g) was recorded in September planting with pinching after 60 days, whereas the minimum seed yield/plot (166.68 g) was recorded in October planting without pinching (Table 4).

Keeping in view of the results obtained in the experiments, it is recommended that seed crop of marigold cv. Pusa Narangi Gainda should be transplanted on 15 September with the spacing of 30 cm × 30 cm and double pinching at 30 DAT and 60 DAT should be practiced to obtain higher seed yield under Muzaffarnagar condition of Uttar Pradesh.

REFERENCES

Bhat Z A and Shephered H. 2007. Effect of pinching on growth, flowering, seed yield and quality traits in African marigold (*Tagetes erecta* L.). *Journal of Ornamental Horticulture* **10**(3): 197–8.

Cochran and Cox. 1962. Split plot experimental designs.

Cruz M A and Mendez J. 2002. Density and planting date for a dwarf genotype of marigold (*Tagetes erecta* L.). *Revista Chapingo Serie Horticulture* **8**(2): 197–210.

Karuppaiah P and Krishna G. 2005. Response of spacing and nitrogen levels on growth, flowering and yield characters of French marigold (*Tagetes patula* L.). *Journal of Ornamental Horticulture* **8**(2): 96–9.

National Horticulture Board. 2012. Indian Horticulture Data Base, Ministry of Agriculture, Gurgaon, Haryana.

Raghava S P S. 1998. Pusa Narangi Gainda and Pusa Basanti Gainda; New marigold. *Indian Horticulture* **43**(2): 31.

Sreekanth P, Padma M, Chandrasekhar R and Madhulety T Y. 2007. Effect of planting time, spacing and nitrogen levels on flowering of African marigold (*Tagetes erecta* L.) cv. Sierra orange. *Journal of Research-ANGRAU* **35**(1): 15–21.

Sunitha H M, Ravi Hunje Vyakaranahaal B S and Bablad H B. 2007. Effect of plant spacing and integrated nutrient management on yield and quality of seed and vegetative growth parameters in African marigold (*Tagetes erecta* L.). *Journal of Ornamental Horticulture* **10**(4): 245–9.

Tomar B S, Singh B, Negi H C S and Singh K K. 2004. Effect of pinching on seed yield and quality traits in African marigold *(Tagetes erecta L.). Journal of Ornamental Horticulture* **7**(1): 124–6.