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Effect of pinching and spacing on vegetative growth of African marigold (*Tagetes erecta* L.) Variety Pusa Narangi Gaiinda

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Abstract

The investigation was effect of pinching and spacing on growth and yield attributes of African marigold (*Tagetes erecta* L.) Pusa Narangi Gaiinda” was conducted during 2019-20 and 2020-21 at Research cum Instructional Farm, College of Agriculture and research institute, Raigarh, Chhattisgarh. The treatment comprised of three factors i.e. different planting season (C₁ : Kharif, C₂ : Rabi and C₃ : Summer), three spacing (S₁: 30 x 30 cm, S₂ : 45 x 45 cm, and S₃ : 50 x 50 cm) and Three level of pinching (P₀ : No pinching, P₁ :Single pinching and P₂ :Double pinching).Three factor experiment in laid out the randomized block Design (Factorial) with three replication. There were all together 27 treatment in this combinations. As far as spacing treatments i.e. S₁: 30 x 30 cm significantly higher plant height and earliest fist bud appearance during both the years. Flower yield per plant (g), flower yield per plot (kg) and yield (t/ha) was recorded maximum in this treatment during both the years and two year mean. The result indicated that the treatment P₂: double pinching performed significantly (maximum reduction of plant height), maximum duration of flower (days). In respect of Pinching in marigold is a process of increase in flower yield through the diversion of energy through breaking apical dominance in plants. Pinching increases the flower yield (20.89 t/ha) compared to non- pinching (18.10 t/ha) in marigold.

Keywords: Spacing, pinching, African marigold

Introduction

Marigold (*Tagetes erecta* L.) is one of the most important commercial flowers belong to family Asteraceae grown all over the world, Which accounts for more than half of the nation in loose flower production (Jyothi *et al.* 2018) [6]. It is native to South and Central America especially Mexico (Singh *et al.*, 2019) [18]. Marigold is one of the oldest cultivated flowering plants, being very popular in tropical and Sub- tropical countries as a garden plant, pots and herbaceous border for beautification (Singh *et al.*, 2017) [19]. Marigold are one of the most widely used loose flowers for making garlands during religious festivals and cultural functions, wreaths, floral decoration, flower baskets cut flowers, bedding and potting and also for making different products (Swaroop *et al.*, 2007) [20]. The growers are attracted towards marigold flower as it has a habit of free flowering, short duration to produce marketable flowers of attractive colours and good keeping quality

Chhattisgarh state is primarily a rice- growing region and the average farmers are poor and illiterate, as tribals constitute a major part of the population and they can diverse agriculture in floriculture. The domestic consumption of loose flowers, especially of marigold, China aster, Jasmine, Crossandra is increasing day by day. There is heavy demand for the flowers during the festival time like Dushehra, Diwali and during the marriage seasons. Most of the requirements are met by the growers/suppliers of Calcutta and Nagpur. There is a large gap between the supply and demand which the local growers may utilize to their advantage. Marigold is one of the dominating flowers in the flower market of Chhattisgarh. It is blessed with many natural advantages like abundant sunshine, favourable temperature for its growth. These congenial factors place the region in an ideal position to become a leading producer in national and international market. Kumar and Singh 2011 are of the opinion that closer spacing provides more number of plants but deteriorates the quality of flower and reduce yield per plant, whereas, wider spacing gives good quality flowers but lower yield. Pinching treatment at different times can help in achieving the twin objective of proper plant spread and flowering at different times for maintaining steady supply of flowers to the market over longer period resulting in more economic returns.

Materials and Methods

The investigation entitled was carried out at the College of Agricultural and Research Station, Riagarh, Chhattisgarh during the years 2019-2020 and 2020-2021. The details regarding materials used and techniques employed in present investigation are briefly described in this chapter. Raigarh has located an elevation of 257 meter from the mean sea level in between 21⁰15 to 23⁰15 N latitude and 85⁰55 to 84⁰20 E longitude. Total geographical area of the district is 7086 km² out of which 145547.519 hectare is reserved forest, protected forest area is 52408.556 hectare and unclassified forest is 2313.617 hectare. The experiment was conducted in Factorial Randomized Block Design with 27 treatment combinations of three plant season, three spacing (30 x 30 cm, 45 x 45 cm, 50 x 50 cm) and three pinching levels viz., no pinching, single pinching and double pinching in African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gaiinda. There are 27 treatment combinations, Se₁S₁P₀ (Kharif season + 30 x 30 cm + No Pinching), Se₁S₁P₁ (Kharif season + 30 x 30 cm + single Pinching), Se₁S₁P₂ (Kharif season + 30 x 30 cm + double Pinching), Se₁S₂P₀ (Kharif season + 45 x 45 cm + No Pinching), Se₁S₂P₁ (Kharif season + 45 x 45 cm + single Pinching), Se₁S₂P₂ (Kharif season + 45 x 45 cm + double Pinching), Se₁S₃P₀ (Kharif season + 50 x 50 cm + No Pinching), Se₁S₃P₁ (Kharif season + 50 x 50 cm + single Pinching), Se₁S₃P₂ (Kharif season + 50 x 50 cm + double Pinching), Se₂S₁P₀ (Rabi season + 30 x 30 cm + No Pinching), Se₂S₁P₁ (Rabi season + 30 x 30 cm + single Pinching), Se₂S₁P₂ (Rabi season + 30 x 30 cm + double Pinching), Se₂S₂P₀ (Rabi season + 45 x 45 cm + No Pinching), Se₂S₂P₁ (Rabi season + 45 x 45 cm + single Pinching), Se₂S₂P₂ (Rabi season + 45 x 45 cm + double Pinching), Se₂S₃P₀ (Rabi season + 50 x 50 cm + No Pinching), Se₂S₃P₁ (Rabi season + 50 x 50 cm + single Pinching), Se₂S₃P₂ (Rabi season + 50 x 50 cm + double Pinching), Se₃S₁P₀ (Summer season + 30 x 30 cm + No Pinching), Se₃S₁P₁ (Summer season + 30 x 30 cm + Single Pinching), Se₃S₁P₂ (Summer season + 30 x 30 cm + double Pinching), Se₃S₂P₀ (Summer season + 45 x 45 cm + No Pinching), Se₃S₂P₁ (Summer season + 45 x 45 cm + Single Pinching), Se₃S₂P₂ (Summer season + 45 x 45 cm + Double Pinching), Se₃S₃P₀ (Summer season + 50 x 50 cm + No Pinching), Se₃S₃P₁ (Summer season + 50 x 50 cm + Single Pinching), Se₃S₃P₂ (Summer season + 50 x 50 cm + Double Pinching). The land was carried to a fine tilth. A spacing of 0.50 m between two replications and 1.00m between two plots was provided for lying out of irrigation channels and bunds respectively. The experimental land was divided into plots measuring 2 m x 2 m there were totally 81 plots. Timely and effective plant protection steps have been taken to protect experimental plants from pest and disease attacks. The obtained data had statistically analyzed adopting procedure as given by Panse, V.G. and Sukhatme, B.V. (1985).

Result and Discussion

The data on plant height cm at 30, 60 and 90 DAT influenced by spacing and pinching treatment are presented in Table: 1a. Different spacing showed significantly influence on plant height treatment S₁: 30 x 30 cm recorded significantly higher plant at 30 DAT (34.64, 36.85 and 34.25 cm) 60 DAT (38.30,

45.29 and 41.79 cm) 90 DAT (78.57, 81.42 and 80.00 cm respectively) during both the years 2019-2020 and 2020-21 and on the basis of mean data. However the lowest plant height was noted under treatment S₃: 50 x 50 cm at 30 DAT (31.05, 32.45 and 31.75 cm) 60 DAT (34.34, 42.95 and 38.64 cm) 90 DAT (70.47, 76.64 and 73.56 cm) during both the year and two years mean. Closer spacing of 30 x 30 cm recorded significantly maximum plant height as compared to wider spacing of 50 x 50 cm. More plant height might be due to heavy competition between plants for light which resulted in elongation of main stem and also might be due to the fact that the plants tend to grow vertically when they are crowded owing to shadowing effect of the plants on one another. The results are in conformity with the findings of (2018), Dweepjoti *et al.* (2018) [5], Karuppaiah *et al.* (2005) [7]. Among the no pinching treatment produced significantly taller plant at 30 DAT (35.89, 37.43 and 36.66 cm) 60 DAT (40.91, 46.45 and 43.68 cm) 90 DAT (77.82, 82.76 and 80.29 cm) respectively in both the years 2019-20 and 2020-21 and on the basis of mean data. However minimum plant height was recorded in double pinching at 30 DAT (29.85, 31.76 and 30.80 cm) 60 DAT (32.70, 41.13 and 36.92 cm) 90 DAT (70.86, 75.99 and 73.42 cm) during both the year and two years mean. Similar results were also reported by Mohanty *et al.* (2015) [11], Dalal *et al.* (2006) [3]. Interaction Table:1(b), (c) and (d) revealed that season Kharif produced significantly taller plant among all the season at 30, 60 and 90 DAT during both the years and mean of two years, whereas significantly smaller plant height was observed during Summer season. In case of different spacing at 30, 60 and 90 DAT significantly taller plant was recorded in treatment i.e. S₁: 30 x 30cm during both the years as well as on pooled mean basis and smaller plant height was observed in treatment i.e. S₃: 50 x 50 cm. Treatment i.e. C₁ x S₁ x P₀ recorded significantly taller plant at 30, 60 and 90 DAT during both the years and mean of two years. Similar results were obtained by Karuppaiah *et al.* (2005) [7] on *Tagetes patula*.

The result on plant spread was influence by different planting season; spacing and pinching are presented in Table: 2a and b. In case of spacing plant spread was showed significantly impact between the treatments for plant spread. Maximum plant spread (E-W and N-S) (33.94, 34.75, 34.35 and 33.03, 33.51 and 33.27 respectively) in observed in treatment i.e. S₃: 50 x 50 cm during both the years and on the basis of mean data followed by i.e. S₂: 45 x 45 cm. The minimum plant spread (E-W and N-S) (32.24, 33.07, 32.05 and 31.26, 31.74, 31.50 respectively) was found in the treatment i.e. S₁: 30 x 30 cm during this investigation. The result is in conformity with the findings of Sheena *et al.* (2017) [15], Baskaran *et al.* (2017) [1], Lakshmi *et al.* (2014) [9]. The data revealed that the plant spread (E-W and N-S) was significantly influence by the pinching. The maximum plant spread (E-W and N-S) was recorded in i.e. P₂: double pinching (33.13, 33.88 and 33.51) and (32.10, 32.58, 32.34 respectively) during both the years and followed by i.e. P₁: single pinching. The minimum plant spread (E-W and N-S) (31.99, 32.84 and 32.42) and 31.12, 31.16 and 31.37 respectively was found in the i.e. P₀: no pinching. Similar findings obtain by Dorajeeroo *et al.*, 2018 [4], in marigold.

Table 1a: Effect of different planting season x spacing x pinching on plant height (cm) of African marigold

Treatment	30 DAT			60 DAT			90 DAT		
	2019-20	2020-21	Pooled mean	2019-20	2020-21	Pooled mean	2019-20	2020-21	Pooled mean
Planting Season									
C ₁ : Kharif	39.69	40.93	40.31	44.15	50.73	47.44	82.16	84.62	83.39
C ₂ : Rabi	30.38	31.80	31.09	34.67	40.12	37.40	73.43	77.23	75.33
C ₃ : Summer	26.83	29.65	28.24	30.36	39.36	34.86	66.48	75.04	70.76
SEm±	0.46	0.58	0.41	0.55	0.53	0.35	1.84	1.06	1.14
CD at 5%	1.31	1.63	1.16	1.56	1.50	1.01	5.21	3.00	3.23
Spacing									
S ₁ : 30 x 30 cm	34.64	36.85	34.25	38.30	45.29	41.79	78.57	81.42	80.00
S ₂ : 45 x 45 cm	31.21	33.08	33.64	36.55	41.97	39.26	73.03	78.83	75.93
S ₃ : 50 x 50 cm	31.05	32.45	31.75	34.34	42.95	38.64	70.47	76.64	73.56
SEm±	0.46	0.58	0.41	0.55	0.53	0.35	1.84	1.06	1.14
CD at 5%	1.31	1.63	1.16	1.56	1.50	1.01	5.21	3.00	3.23
Pinching									
P ₀ : No Pinching	35.89	37.43	36.66	40.91	46.45	43.68	77.82	82.76	80.29
P ₁ : Single Pinching	31.16	33.20	32.18	35.58	42.62	39.10	73.40	78.14	75.77
P ₂ : Double pinching	29.85	31.76	30.80	32.70	41.13	36.92	70.86	75.99	73.42
SEm±	0.46	0.58	0.41	0.55	0.53	0.35	1.84	1.06	1.14
CD at 5%	1.31	1.63	1.16	1.56	1.50	1.01	5.21	3.00	3.23

Table 1b: Interaction effect of different planting season x spacing x pinching on plant height at 30 DAT (Pooled Mean)

Pinching	C ₁ : Kharif			C ₂ : Rabi			C ₃ : Summer		
	Spacing								
	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃
P ₀	56.64	48.92	40.30	32.39	32.25	31.79	29.37	29.55	28.75
P ₁	37.38	36.64	37.05	31.92	31.60	30.50	28.42	29.04	27.07
P ₂	34.30	35.42	36.14	30.46	30.48	28.44	27.35	28.89	25.74
SEm±	1.23								
CD at 5%	3.47								

Table 1c: Interaction effect of different planting season, spacing and pinching on plant height at 60 DAT of African marigold (Pooled Mean)

Pinching	C ₁ : Kharif			C ₂ : Rabi			C ₃ : Summer		
	Spacing								
	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃
P ₀	68.50	48.50	47.06	40.71	39.97	38.10	37.71	37.36	35.21
P ₁	47.25	43.99	45.56	36.68	37.24	37.48	34.67	35.45	33.55
P ₂	40.92	41.84	43.35	36.31	34.55	35.51	33.37	34.45	31.96
SEm±	1.06								
CD at 5%	3.0								

Table 1d: Interaction effect of different planting season x spacing x pinching on plant height at 90 DAT of African marigold (Pooled Mean)

Pinching	C ₁ : Kharif			C ₂ : Rabi			C ₃ : Summer		
	Spacing								
	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃
P ₀	95.79	86.86	83.24	81.40	79.66	78.11	75.18	72.51	67.05
P ₁	85.32	81.94	78.85	76.91	74.00	72.00	73.14	68.51	64.87
P ₂	82.50	79.34	74.09	75.43	71.61	65.45	72.19	67.31	62.34
SEm±	2.92								
CD at 5%	8.29								

Table 2a: Effect of different planting season x spacing x pinching on plant spread (E-W) and (N-S) in African marigold

Treatment	plant spread (E-W)			plant spread (N-S)		
	2019-20	2020-21	Pooled mean	2019-20	2020-21	Pooled mean
Planting Season						
C ₁ : Kharif	32.49	33.38	32.94	29.52	30.00	29.76
C ₂ : Rabi	34.83	35.60	35.22	33.84	34.33	34.09
C ₃ : Summer	30.44	31.29	30.86	31.61	32.09	31.85
SEm±	0.21	0.23	0.22	0.22	0.19	0.19
CD at 5%	0.61	0.65	0.63	0.63	0.53	0.53
Spacing						
S ₁ : 30 x 30 cm	31.57	32.46	32.01	30.69	31.17	30.93
S ₂ : 45 x 45 cm	32.24	33.07	32.65	31.26	31.74	31.50
S ₃ : 50 x 50 cm	33.94	34.75	34.35	33.03	33.51	33.27
SEm±	0.21	0.23	0.22	0.22	0.19	0.19
CD at 5%	0.61	0.65	0.63	0.63	0.53	0.53
Pinching						
P ₀ : No Pinching	31.99	32.84	32.42	31.12	31.61	31.37
P ₁ : Single Pinching	32.63	33.55	33.09	31.75	32.23	31.99
P ₂ : Double pinching	33.13	33.88	33.51	32.10	32.58	32.34
SEm±	0.21	0.23	0.22	0.22	0.19	0.19
CD at 5%	0.61	0.65	0.63	0.63	0.53	0.53

Table 2b: Interaction effect of different planting season x spacing x pinching in plant spread (E-W) of African marigold during (pooled mean)

Pinching	C ₁ : Kharif			C ₂ : Rabi			C ₃ : Summer		
	Spacing								
	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃
P ₀	33.18	33.79	34.05	33.71	32.75	32.99	29.10	30.40	31.79
P ₁	33.61	34.68	41.12	32.68	32.87	33.10	30.03	31.39	32.09
P ₂	33.46	33.98	39.08	32.44	32.84	33.07	29.95	31.19	31.85
SEm±	0.66								
CD at 5%	1.88								

Table 2c: Interaction effect different planting season x spacing x pinching in plant spread (N-S) of African marigold during pooled mean

Pinching	C ₁ : Kharif			C ₂ : Rabi			C ₃ : Summer		
	Spacing								
	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃
P ₀	28.01	29.31	30.70	32.09	32.81	33.17	32.62	31.67	31.91
P ₁	28.94	30.30	30.84	32.52	33.03	40.04	31.59	31.79	32.01
P ₂	28.86	30.11	30.76	32.36	32.76	38.00	31.35	31.75	31.99
SEm±	0.57								
CD at 5%	1.60								

The date on number of primary branches at different spacing and pinching of plant growth i.e. 30, 60 and 90 DAT are presented in Table: 3a. Significant different were noted among different planting season in relation to number of primary branches at different growth stages both the years 2019-20 and 2020-21 and two years mean data. In respect to spacing showed significantly influence the number of primary branches per plant. Treatment i.e.S₃: 50 x 50 cm recorded significantly maximum number of primary branches at 30 DAT (10.33, 11.21 and 10.72 respectively) 60 DAT (12.38, 12.32 and 12.35 respectively) and 90 DAT (13.63, 13.43 and 13.53 respectively) followed by i.e.S₂: 45 x 45 cm during both the years and on the basis of mean data. However the lowest number of primary branches was recorded in treatment i.e. S₁: 30 x 30 cm at 30 DAT (9.31, 9.88 and 9.59 respectively), 60 DAT (11.01, 9.86 and 10.44 respectively) 90 DAT (12.40, 11.87 and 12.13 respectively). These results are in accordance with the findings Srivastava *et al.* (2005) [17]. Among single pinching produced significantly more number of primary branches in i.e.:P₁ at 30 DAT (10.22, 10.89 and 9.79 respectively), 60 DAT (12.22, 12.18 and 12.20 respectively) 90 DAT (13.52, 12.71 and 13.12 respectively) followed by i.e.:P₂ double pinching at 30 DAT (9.80, 10.47 and 10.07

respectively), 60 DAT (11.51, 11.24 and 11.38 respectively) 90 DAT (13.32, 12.83 and 13.08 respectively) during both the years and two years mean data. This result corroborates the findings of Chouhan *et al.* (2005) [2]. Interaction between climate and pinching on number of primary branches was recorded at Table 3b, c and d. The data revealed that Rabi season and single pinching found significantly higher number of primary branches but it was found at par with C₁ and P₀ at 90 DAT. Interaction between spacing and pinching showed significant impact on number of primary branches at 90 DAT during both the years. The data revealed that spacing.i.e.S₃: 50 x 50 cm and single pinching treatments were found significantly higher number of primary branches and it was found at par with S₁, S₃ and P₀. Interaction between different planting season, spacing and pinching treatment on at 90 DAT was significant during 2020-21 and pooled mean. Revealed that treatment i.e.C₂ x S₃ x P₁ (Rabi season, 50 x 50 cm and single pinching) recorded significantly maximum number of primary branches at 90 DAT during this investigation and mean basis of two years. Whereas, minimum number of primary branches was observed in i.e.C₃ x S₁ x P₀ (summer season, 30 x30 cm and No pinching)

Table 3a: Effect of different planting season x spacing x pinching on Primary Branch of African marigold

Treatment	30days			60days			90days		
	2019-20	2020-21	Pooled mean	2019-20	2020-21	Pooled mean	2019-20	2020-21	Pooled mean
Planting Season									
C ₁ : Kharif	9.86	10.38	10.12	11.72	11.02	11.37	13.26	12.79	13.03
C ₂ : Rabi	11.32	11.98	11.65	12.88	11.95	12.41	14.50	14.21	14.36
C ₃ : Summer	8.30	9.11	8.66	10.60	10.65	10.63	11.46	10.83	11.15
SEm±	0.11	0.13	0.10	0.16	0.27	0.15	0.23	0.20	0.15
CD at 5%	0.30	0.36	0.28	0.45	0.76	0.44	0.65	0.56	0.43
Spacing									
S ₁ : 30 x 30 cm	9.31	9.88	9.59	11.01	9.86	10.44	12.40	11.87	12.13
S ₂ : 45 x 45 cm	9.83	10.39	10.11	11.81	11.43	11.62	13.20	12.53	12.87
S ₃ : 50 x 50 cm	10.33	11.21	10.72	12.38	12.32	12.35	13.63	13.43	13.53
SEm±	0.11	0.13	0.10	0.16	0.27	0.15	0.23	0.20	0.15
CD at 5%	0.30	0.36	0.28	0.45	0.76	0.44	0.65	0.56	0.43
Pinching									
P ₀ : No Pinching	9.45	10.12	9.79	11.46	10.20	10.83	12.38	12.29	12.34
P ₁ : Single Pinching	10.22	10.89	10.55	12.22	12.18	12.20	13.52	12.71	13.12
P ₂ : Double pinching	9.80	10.47	10.07	11.51	11.24	11.38	13.32	12.83	13.08
SEm±	0.11	0.13	0.10	0.16	0.27	0.15	0.23	0.20	0.15
CD at 5%	0.30	0.36	0.28	0.45	0.76	0.44	0.65	0.56	0.43

Table 3b: Interaction effect of different planting season x spacing x pinching on Primary Branch at 30 DAT of African marigold (Pooled Mean)

Pinching	C ₁ : Kharif			C ₂ : Rabi			C ₃ : Summer		
	Spacing								
	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃
P ₀	9.35	9.79	10.25	10.48	11.15	11.49	8.02	8.66	8.95
P ₁	9.96	10.17	11.10	10.59	11.85	14.51	8.45	9.14	9.22
P ₂	9.87	9.86	10.73	11.25	11.50	12.00	8.36	8.83	8.25
SEm±	0.30								
	0.84								

Table 3c: Interaction effect of different planting season x spacing x pinching on Primary Branch at 60 DAT of African marigold (Pooled Mean)

Pinching	C ₁ : Kharif			C ₂ : Rabi			C ₃ : Summer		
	Spacing								
	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃
P ₀	10.48	11.11	11.38	8.58	11.90	13.18	9.83	10.33	10.70
P ₁	11.10	11.94	13.41	11.94	13.53	14.89	10.40	10.93	11.68
P ₂	9.56	11.15	12.20	11.84	12.98	12.89	10.21	10.74	10.83
SEm±	0.46								
CD at 5%	1.32								

Table 3d: Interaction effect of different planting season x spacing x pinching in Primary Branch of African marigold at 90 DAT (pooled Mean)

Pinching	C ₁ : Kharif			C ₂ : Rabi			C ₃ : Summer		
	Spacing								
	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃
P ₀	12.29	12.52	12.22	12.86	13.87	14.20	10.53	11.22	11.32
P ₁	12.62	12.95	14.35	13.83	14.75	16.08	9.93	11.60	11.93
P ₂	12.53	12.67	15.09	13.59	14.33	15.70	11.03	11.88	10.86
SEm±	0.46								
CD at 5%	1.29								

The data pertaining to the number of secondary branches per plant were significantly influenced by different planting season; spacing and pinching are presented in Table: 4a, b, c. In respect to spacing showed significantly influence the number of secondary branches per plant. Treatment i.e.S₃: 50 x 50 cm recorded significantly maximum number of secondary branches at 30 DAT (10.24, 10.91 and 10.58 respectively) 60 DAT (16.23, 15.17 and 15.70 respectively) and 90 DAT (16.23, 15.58 and 15.91 respectively) followed by i.e.S₂: 45 x 45 cm during both the years and on the basis of mean data. However the lowest number of secondary branches was recorded in treatment i.e. S₁: 30 x 30 cm at 30

DAT (9.19, 9.62 and 9.41 respectively), 60 DAT (13.33, 13.69 and 13.51 respectively) 90 DAT (13.33, 13.76 and 13.55 respectively) during both the years and on the basis of mean data. These results are in conformity with the findings of Harpal *et al.* (2018), Lalit *et al.* (2020) ^[10] in marigold. Among single pinching produced significantly more number of secondary branches in i.e.:P₁ at 30 DAT (10.22, 10.69 and 10.45 respectively), 60 DAT (16.07, 14.53 and 15.30 respectively) 90 DAT (16.07, 15.21 and 15.64 respectively) followed by i.e.P₂: double pinching at 30 DAT (9.68, 10.44 and 10.06 respectively), 60 DAT (15.46, 14.46 and 14.96 respectively) 90 DAT (15.46, 15.08 and 14.27 respectively)

during both the years and on the basis of mean data. However the lowest number of secondary branches was noted under the treatment in i.e.:P₀ no pinching during both the years and on the basis of means data. This result corroborates the findings of Prakash *et al.*, (2016) [12], Joyti *et al.*, (2018) [6] in marigold. Interaction between spacing and pinching showed significant impact on number of secondary branches at 90 DAT during 2019-20 and 2020-21 presented in Table: 4b, c and d. The data revealed that spacing i.e.S₃: 50 x 50 cm and all double

pinching were found significantly maximum number of secondary branches and it was found at par with C₁ and P₀. Interaction between Planting season and pinching showed significant impact on number of secondary branches at 30 and 60 DAT during 2019-20 and 2020-21. The data revealed that planting season i.e.C₂: Rabi season and all single pinching treatments were found significantly maximum number of secondary branches and it was found at par with C₁, P₁ and P₂.

Table 4a: Effect of different planting season x spacing x pinching on Secondary Branches of African marigold

Treatment	30days			60days			90days		
	2019-20	2020-21	Pooled mean	2019-20	2020-21	Pooled mean	2019-20	2020-21	Pooled mean
Planting Season									
C ₁ : Kharif	9.73	9.92	9.82	14.74	14.49	14.61	14.74	15.01	14.87
C ₂ : Rabi	10.97	11.78	11.37	16.39	15.02	15.71	16.39	15.47	15.93
C ₃ : Summer	8.20	9.08	8.64	13.62	12.75	13.19	13.62	13.41	13.52
SEm±	0.19	0.18	0.14	0.31	0.38	0.25	0.31	0.28	0.22
CD at 5%	0.53	0.51	0.39	0.88	1.08	0.71	0.88	0.78	0.64
Spacing									
S ₁ :30 x 30 cm	9.19	9.62	9.41	13.33	13.69	13.51	13.33	13.76	13.55
S ₂ :45 x 45 cm	9.47	10.23	9.85	15.20	13.39	14.30	15.20	14.54	14.87
S ₃ :50 x 50 cm	10.24	10.91	10.58	16.23	15.17	15.70	16.23	15.58	15.91
SEm±	0.19	0.18	0.14	0.31	0.38	0.25	0.31	0.28	0.22
CD at 5%	0.53	0.51	0.39	0.88	1.08	0.71	0.88	0.78	0.64
Pinching									
P ₀ : No Pinching	9.00	9.64	9.32	13.23	13.27	13.25	13.23	13.60	13.41
P ₁ :Single Pinching	10.22	10.69	10.45	16.07	14.53	15.30	16.07	15.21	15.64
P ₂ : Double pinching	9.68	10.44	10.06	15.46	14.46	14.96	15.46	15.08	15.27
SEm±	0.19	0.18	0.14	0.31	0.38	0.25	0.31	0.28	0.22
CD at 5%	0.53	0.51	0.39	0.88	1.08	0.71	0.88	0.78	0.64

Table 4b: Interaction effect with different planting season x pinching in Secondary Branch of African marigold at 30 DAT two years means data.

	P ₀	P ₁	P ₂
C ₁ : Kharif	9.45	9.68	10.33
C ₂ : Rabi	10.53	10.99	12.58
C ₃ : Summer	8.22	8.87	8.80
SEm±	0.23		
CD at 5%	0.67		

The data on first bud appearance showed the significant difference with the spacing presented in Table 5a: The minimum days to first bud appearance (61.10, 61.47, 61.69) respectively was observed in treatments i.e. S₁: 30 x 30 cm followed by i.e.S₂: 45 x 45 cm both the years and pooled mean analysis However, maximum day to first bud appearance (64.08, 64.44, 64.26) respectively were recorded under treatment i.e. S₃:50 x 50 cm during both years and on the basis of mean data. In case of pinching, the results of first bud appearance showed significant effect between treatment during the first and second years as well as pooled mean data. The early bud appearance (60.82, 61.17 and 61.40 days) respectively was also reported significant difference with rest or other treatments. Whereas, maximum days required for first bud appearance (64.10, 64.50, 64.30) respectively were recorded under treatments i.e. P₂double pinching during both the years and two years mean. These findings are in corroboration with work of Khobragade *et al.* (2012) [8] in China Aster and Sharma *et al.* (2006) [14] in marigold. Interaction between spacing and pinching showed significant impact on first bud appearance during both the years 2019-20 and 2020-21and mean of two years in Table: 5b. The data revealed that spacing i.e.S₁: 30 x 30 cm and all no pinching treatment were found significantly earlier first bud appearance during this investigation. Interaction between spacing and pinching showed significant impact on first bud appearance during both the years 2019-20 and 2020-21and mean of two years presented in Table: 5b. The data revealed that spacing i.e.S₁: 30 x 30 cm and all no pinching treatment were found significantly earlier first bud appearance during this investigation.

Table 4c: Interaction effect with different planting season x spacing in secondary branch at 60 DAT of African marigold two years mean data.

2.92	2.92	2.92	2.92
8.29	8.29	8.29	8.29
2.92	2.92	2.92	2.92
8.29	8.29	8.29	8.29
2.92	2.92	2.92	2.92
8.29	8.29	8.29	8.29
2.92	2.92	2.92	2.92

Table 4d: Interaction effect with spacing x pinching on Secondary Branch at 90 DAT of African marigold (pooled mean)

	P ₀	P ₁	P ₂
S ₁ :30 x30 cm	11.38	14.58	14.57
S ₂ :45 x45 cm	13.69	14.29	14.90
S ₃ :50 x50 cm	14.66	17.02	15.41
SEm±	0.43		
CD at 5%	1.22		

Table 5a: Effect of different planting season x spacing x pinching on first bud appearance of African marigold

Treatment	first bud appearance		
	2019-20	2020-21	Pooled mean
Planting Season			
C ₁ : Kharif	65.03	65.44	65.23
C ₂ : Rabi	60.71	61.03	61.27
C ₃ : Summer	62.26	62.49	62.37
SEm±	0.31	0.28	0.32
CD at 5%	0.87	0.80	0.90
Spacing			
S ₁ :30 x 30 cm	61.10	61.47	61.69
S ₂ :45 x 45 cm	62.81	63.05	62.93
S ₃ :50 x 50 cm	64.08	64.44	64.26
SEm±	0.31	0.28	0.32
CD at 5%	0.87	0.80	0.90
Pinching			
P ₀ : No Pinching	60.82	61.17	61.40
P ₁ :Single Pinching	63.07	63.28	63.18
P ₂ : Double pinching	64.10	64.50	64.30
SEm±	0.31	0.28	0.32
CD at 5%	0.87	0.80	0.90

Table 5b: Interaction effect with planting season x pinching on first bud appearance of African marigold (Pooled mean)

	P ₀	P ₁	P ₂
C ₁ : Kharif	64.762	65.041	65.896
C ₂ : Rabi	58.477	61.750	63.571
C ₃ : Summer	60.951	62.738	63.429
SEm±	0.55		
CD at 5%	1.56		

Conclusion

On the basis of two years study it was concluded that Maximum plant height was obtained under the treatment i.e. C₁: Kharif season. Whereas, taller plant was obtained in treatment i.e. S₁: 30 x 30 cm spacing. Among the no pinching treatment produced significantly taller plant at 30, 60 and 90 DAT during this investigation. However, maximum plant spread (E-W and N-S) was observed in treatment i.e. S₃: 50 x 50 cm followed by i.e. S₂: 45 x 45 cm during both the years. The maximum plant spread (E-W and N-S) was recorded in i.e. P₂: double pinching followed by i.e. P₁: single pinching both the years and on the basis of mean data at 30, 60 and 90 DAT. Number of primary and secondary branches was produced more in treatment i.e. S₃: 50 x 50 cm followed by i.e. S₂: 45 x 45 cm. Among single pinching produced significantly more number of primary secondary branches in i.e. P₁ followed by i.e. P₂: double pinching at 30, 60 and 90 DAT. The minimum days to first bud appearance was observed in treatments i.e. S₁: 30 x 30 cm followed by i.e. S₂: 45 x 45 cm. However, the early bud appearance was also reported. The early bud appearance was also reported in treatments i.e. P₀: no pinching treatments.

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