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EFFECT OF PINCHING AND SPACING ON YIELD ATTRIBUTING PARAMETERS OF AFRICAN MARIGOLD (*TAGETS ERECTA* L.)

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Abstract

The present experiment was laid out during the winter season of the year 2016-17 at the Garden of Department of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (UP). There were four level of pinching *i.e.*, P_0 - Control (no pinching), P_1- pinching at 30 days after transplanting, P_2 - pinching at 40 days after transplanting and P_3 - pinching at 50 days after transplanting and three different spacing *i.e.*, D_1 (45cm X 20cm), D_2 (45cm X 30cm) and D_3 (45cm X 40cm), thus there was total twelve treatment. Effect of pinching and spacing was observed on yield attributing parameters like average number of flowers per plant, yield of flower per plant (Kg/plant), yield of flower per plot (Kg/plot), flower yield per hectare (tons/ha) of African marigold. Results of experiment revealed that average number of flower plants and yield of flower per plant was maximum in P_2D_3. Interaction effect of spacing and pinching was non-significant on yield of flower per plot and yield of flower per hectare. Yield of flower per plot was maximum at closest spacing and in P_2 treatment but yield of flower per hectare was maximum at closest spacing and in case of treatment P_3.

***Keywords*:** African marigold, Pinching, Spacing, Yield and Growth**.**

Introduction

In modern era marigold is an important commercial flower of India belongs to family 'Asteraceae' or 'Compositae'. It was originated in central and South America especially Mexico (Iltus, 1945). It spreads to different parts of the world during early part of 16th century from Mexico. Bailey (1963) mentioned that African marigold was put into cultivation in 1596 A.D. in Europe. In India it is thought to be introduced by Portuguese between 1502-1550 A.D. (Mehra, 1966).

Spacing is one of the very basic management practices prescribed for almost all the commercial crops. It is defined as row to row and plant to plant distance which defines the planting density. Plant density has a profound influence on plant development, growth, architecture and yield of many crops (Stoffella and Bryan, 1988). Proper spacing leads to optimum canopy exposure to light and also it provides uniform area for water and mineral uptake by roots. Pinching is defined as the removal of apex part of a plant. In most plant species, the axillary buds remain dormant due to inhibitory effect of growth of primary shoot apex, a phenomenon called Apical Dominance (Cline, 1991). Apical bud pinching breaks apical dominance and induces development of lateral branches, thereby altering the plant architecture for increased potential yield When cytokinin concentration increases in axillary buds, it breaks their dormancy (Wang and Li, 2008) but auxins exported from apical meristem may limit cytokinin concentration in these lateral buds and maintain apical control through hormonal interaction (Bangerth, 1994).

Material and Methods

The present experiment was laid out during the winter season of the year 2016-17 at the Garden of Department of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (UP). Geographically it is situated between 25.26 to 26.28 North Latitude, 79.31 to 80.34° East longitudes and at an elevation of 127.12 meter from mean sea level. The site is located in typical sandy loam belt of Indo-Gangetic plains of central part of Uttar Pradesh (Table-1).

Observations recorded: The following observations were recorded-

Average number of flowers per plant: The total number of flowers per plant was recorded from first harvest stage to last harvest stage.

Yield of flower per plant (Kg/plant): Weight of flower per plant was recorded by weighing flower at each harvesting. Weight of flowers per plant was recorded by taking the sum of the total weight of flower at each harvesting.

Yield of flower per plot (Kg/plot): The yield of harvested flowers from each plot at each plucking was taken with the help of the pan balance and recorded. Total flower yield per plot were calculated after last harvesting by adding the flower weight per plot at each plucking.

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Flower yield per hectare (tons/ha): Flower yield per hectare was calculated on the basis of yield of flower per plot. It was calculated by considering only 80 percent area (8000 m^2) was supposed to be under the layout plan. Flower yield was expressed in tons per hectare.

Statistical Analysis

The experimental data recorded on each aspect on each treatment (Table-2) were statistically computed in factorial RBD as following procedure which is given by Panse and Sukhatme (1985). For calculating standard error of mean and critical difference (t) value was taken at 0.05 level of significance.

Results and Discussion

Average number of flowers per plant: It is evident from the data presented in table-3 that average number of flowers per plant showed significant variation due to different levels of spacing and pinching. Average number of flowers per plant increased with the increase in spacing. It was maximum (55.12) in D_3 (45cm X 40cm) treatment *i.e.*, wider spacing followed by D_2 (45cm X 30cm) and D_1 (45cm X 20cm) with 48.57 and 42.74 *i.e.*, minimum with closer spacing D_3 varied significantly to D_2 and D_1.

Further increasing trend was observed in average number of flowers per plant from P_0 (no pinching) to P_3 (50 DAT). The average number of flowers per plant was observed 43.88 in P_0, 50.88 in P_1, 50.56 in P_2 and 50.44 in P_3 respectively. P_0 significantly differed to P_1, P_2 and P_3 while number of flowers per plant when examined among P_1, P_2 and P_3 was found statistically at par. The interactive effect of D x P was found to be significant. The treatment combination D_3P_2 (45cm X 40cm, pinching at 40 DAT) resulted in maximum (59.11) average number of flowers per plant and D_1P_0 (45cm X 20cm, no pinching) produce the minimum (41.23) average number of flowers per plant. Treatment combination D_3P_1 (45cm X 40cm, 30 DAT) revealed 58.10 flowers per plant showed at par value with D_3P_2 (45cm X 40cm, 40 DAT) treatment.

Yield of flower per plant (g): It is clear from table-3 of data that the different levels of spacing and pinching gave significant influence on average yield of flower per plant. The wider spacing D_3 (45cm X 40cm) showed the maximum (487.70g) as compared to other spacing D_2 (45cm X 30cm) and D_1 (45cm X 20cm) with 465.07 and 407.28g (minimum) respectively. The wider spacing D_3 differed significantly to D_1 and D_2 and similarly, this was also observed in D_1 and D_2 when compared with each other.

An increasing trend was observed in average yield of flowers per plant from control P_0 (no pinching) to P_3 (50 DAT). The influence of yield per plant was in succeeding order from P_0 (no pinching) with minimum (417.22g), P_1 (30 DAT) with 438.55, P_3 (50 DAT) with 456.83g and P_2 (40 DAT) with 500.77g (maximum), P_2 and P_3 were significant to P_1 and P_0 while P_2 was at par with P_3, in same way P_0 and P_1 were also found at par with each other. The interactive influence of D x P was found to be significant. The treatment combination D_3P_2 (45cm X 40cm, pinching at 40 DAT) resulted in maximum 593.09g average yield of flower per plant while it was minimum 384.35g in D_1P_1 (45cm X 20cm, 30 DAT) combination. P_1D_1 and P_2D_1 reflected average yield of flower with values 384.35g and 414.85g exhibit at par. All other treatment combinations showed significantly greater average yield of flower when compared with P_0D_1 (no pinching, 45cm X 20cm) interactive combination. No pinching treatment combination *i.e.*, P_0D_1, P_0D_2 and P_0D_3 did not differ significantly when compared with each other in ascending order of attitude whereas, P_0D_3 (430.08g) was significantly differed to P_0D_1 (401.38g) interactive treatment. But P_0D_2 (420.22g) and P_0D_3 (430.08g) were found to be at par. Similarly, P_0D_1 (401.38g) and P_0D_2 was also showed same attitude in this regard.

The reason behind more average number of flowers per plant and yield of flowers per plant might be that the greater number of branches and big size of flowers were produced by the plants at wider spacing. Thus, wide spacing resulted in to maximum number and yield of flower per plant. The findings are enclosed conformity with the reports of Natrajan and Vijay Kumar (2002) and Tiwari *et al*. (2010) in marigold. It is evident from the fact that the increased number of secondary branches per plant caused to have a greater number of flower and increasing yield accordingly. The pinching treatment significantly increased the utilization of nutrients uptake also that resulted into maximum profusion of primary and secondary branches which are causes of ultimately increased the number and yield of flower per plants. The reports are in concurrence with that of Jhosi *et al*. (2002) in marigold.

Yield of flower per plot (Kg): It is clear from table-3 of data that the different levels of spacing and pinching gave significant influence on average yield of flower per plot. The closer spacing D_1 (45cm X 20cm) showed the maximum (14.66Kg) as compared to other spacing D_2 (45cm X 30cm) and D_3 (45cm X 40cm) with 11.16Kg and 8.78Kg (minimum) respectively. The closer spacing D_1 differed significantly to D_2 and D_3, similarly, this trend was also seen in D_2 and D_3 when compared with each other.

Further, it was observed that the higher number of days to pinching resulted in maximum flower yield in P_2 (40 DAT) with 12.50Kg per plot as compared to no pinching, it was minimum in P_0 (10.76Kg/plot). Treatment P_1 (30 DAT) and P_3 (50 DAT) showed statistically at par yield of marigold per plot *i.e.*, 11.08Kg/plot and 11.80Kg/plot when compared with P_0 (control) with 10.76Kg/plot. Treatments P_2 (12.50Kg/plot) and P_3 (11.80Kg/plot) were also showed at par value when compared with each other. The interactive influence of D x P was found to be non-significant.

Yield of flower per hectare (q/ha): It is clear from table-3 of data that the different levels of spacing and pinching gave significant influence on yield of flower per hectare (q/ha). The flower yield was recorded maximum in closer spacing D_1 (45cm X 20cm) with 250.01 (q/ha) followed by D_3 (45cm X 40cm) 230.09 q/ha and it was minimum in D_2 (45cm X 30cm) with 226.493 q/ha. Spacing D_1 was found significant with D_2 and D_3 but D_2 and D_3 showed at par values in this regard when compared with each other.

Further, it was observed that the higher number of days to pinching greatly influenced to flower yield per hectare resulted in maximum flower yield in P_3 (50 DAT) with 257.53q/ha followed by P_2 (246.20q/ha) and P_1 (224.06q/ha). It was minimum in P_0 (214.33q/ha). Treatment P_2 (40 DAT) and P_3 (50 DAT) showed significantly greater yield of marigold per ha *i.e.*, 246.20 q/ha and 257.53q/ha when compared with control P_0 (214.33q/ha) whereas, P_1 (30 DAT) with 224.06q/ha was at par with control P_0 (214.33q/ha). Similarly, P_2 (246.20q/ha) and P_3 (257.53q/ha) were also recorded at par values in this respect when compared with each other. Interaction effect of pinching and spacing was non-significant on yield of flower per hectare.

The reason against higher yield of flower per plot and per hectare might be because of the fact that the production of more branches caused to produce a greater number of flowers per plants, accordingly to remove apical dominance of main shoots. The findings are in consonance with observations Shyamal *et al*. (1990); Srivastava (2002); Maharnor *et al*. (2011); Badge *et al*. (2014) and Parhi *et al*. (2016) in marigold.

Conclusion

It could be concluded that marigold produces more average number of flowers per plant and more yield of flower per plant at wider spacing over closer spacing. Pinching after 30 days of transplanting also favours more production of average number of flowers and yield of flowers per plant. Yield of flowers per plot and per hectare is favoured by closer spacing over wider spacing. Pinching also favours yield of flowers per plot and per hectare.

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Table 1: Meteorological observations (weekly) during the period of Investigation 2016-17

Months and Date	Weak	Temperature (°C)		Relative humidity (%)		Wind velocity (Km/h)	Rainfall (mm)
		Max.	Mini.	Morning	Evening		
1-7 Oct	40	33.45	24.82	84.42	59	4.65	2.85
8-14 Oct	41	33.31	27.44	84.14	50.85	3.50	2.00
15-21 Oct	42	33.65	16.64	83.57	37.54	2.65	0.00
22-28 Oct	43	33.68	16.64	77.00	35.14	1.95	0.00
29 Oct - 4 Nov	44	31.05	13.76	85.14	38.28	2.28	0.00
05 -11 Nov	45	30.05	12.54	86.42	43.42	1.20	0.00
12-18 Nov	46	28.81	11.34	71.85	42.42	2.25	0.00
19-25 Nov	47	28.65	13.22	74.57	42.00	1.65	0.00
26 Nov - 2 Dec	48	21.42	12.24	99.71	77.42	2.62	0.00
3-9 Dec	49	20.01	10.17	99.28	62.85	2.87	0.00
10-16 Dec	50	22.85	7.87	90.71	42.14	2.95	0.00
17-23 Dec	51	24.14	8.85	93.00	36.00	4.07	0.00
24-31 Dec	52	20.04	10.42	96.85	73.14	4.48	0.05
01-07 Jan	1	19.91	5.98	88.14	53.00	3.74	0.00
08-14 Jan	2	21.14	6.40	91.28	52.14	3.42	0.00
15-21 Jan	3	18.40	9.58	94.28	57.57	9.30	3.88
22-28 Jan	4	24.00	9.67	93.71	43.14	3.00	0.00
29 Jan - 4 Feb	5	24.11	8.92	90.57	37.42	4.41	0.00
5-11 Feb	6	27.48	12.24	76.42	40.00	3.07	0.00
12-18 Feb	7	27.27	11.14	73.42	52.71	7.75	0.00
19-25 Feb	8	28.97	13.02	78.28	40.00	4.15	0.00
26 Feb - 4 March	9	25.72	12.25	76.85	52.71	5.64	0.08
05-11 March	10	30.77	13.37	75.00	43.85	4.67	3.3
12-18 March	11	36.86	18.13	70.57	53.57	5.65	0
19-25 March	12	39.25	21.61	68.57	43.71	5.25	0.57
26 March - 01 April	13	39.00	19.34	70.42	39.71	5.73	0.0
02-08 April	14	36.68	21.81	69.42	51.00	6.45	0.57

Table 2: Treatment combination

T_1	No pinching	45cm X 20cm	P_0D_1
T_2	No pinching	45cm X 30cm	P_0D_2
T_3	No pinching	45cm X 40cm	P_0D_3
T_4	Pinching at 30 DAT	45cm X 20cm	P_1D_1
T_5	Pinching at 30 DAT	45cm X 30cm	P_1D_2
T_6	Pinching at 30 DAT	45cm X 40cm	P_1D_3
T_7	Pinching at40 DAT	45cm X 20cm	P_2D_1
T_8	Pinching at 40 DAT	45cm X 30cm	P_2D_2
T_9	Pinching at 40 DAT	45cm X 40cm	P_2D_3
T_{10}	Pinching at 50 DAT	45cm X 20cm	P_3D_1
T_{11}	Pinching at 50 DAT	45cm X 30cm	P_3D_2
T_{12}	Pinching at 50 DAT	45cm X 40cm	P_3D_3

Table 3: Influence of spacing and pinching on average number of flower per plant, Yield of flower per plant (g), Yield of flower per plot (Kg) and Yield of flower per hectare (q/ha) of marigold (*Tegetes erecta* L.)

Treatments	Average number of flowers per plant	Yield of flower per plant (g)	Yield of flower per plot (Kg)	Yield of flower per hectare (q/ha)
Spacing				
D_1	42.74	407.28	14.66	250.01
D_2	48.57	465.06	11.16	226.49
D_3	55.11	487.70	8.78	230.08
CD at 5%	1.93	21.37	1.05	10.40
Pinching				
P_0	43.88	417.22	10.76	214.33
P_1	50.88	438.55	11.08	224.06
P_2	50.56	500.77	12.49	246.20
P_3	50.44	456.84	11.80	257.53
CD at 5%	2.22	24.68	1.21	12.00
Interaction effect (P X D)				
P_0D_1	41.23	401.38	14.45	236.66
P_0D_2	43.52	420.22	10.09	208.00
P_0D_3	46.91	430.08	7.74	198.33
P_1D_1	43.42	384.35	13.84	232.38
P_1D_2	51.13	441.33	10.59	212.61
P_1D_3	58.10	489.98	8.82	227.20
P_2D_1	42.72	414.85	14.94	258.76
P_2D_2	49.85	494.38	11.87	239.38
P_2D_3	59.11	593.09	10.68	240.45
P_3D_1	43.61	428.55	15.43	272.25
P_3D_2	51.39	504.33	12.10	**245.98**
P_3D_3	56.34	437.65	7.88	254.36
CD at 5%	3.85	42.75	NS	NS