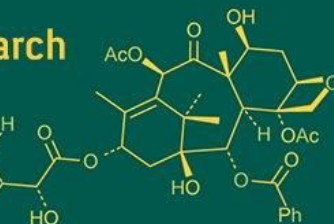
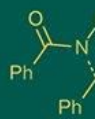


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Studies of propagation methods of marigold (*Tagetes erecta* L.) on growth, yield, and quality of flowers

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Abstract

Generally, marigold is propagated by seeds. However, true-to-type plants can not be obtained through seed propagation because it is an often-cross-pollinated crops. Hence for the perpetuation of all characteristics of a particular plant and to obtain a true-to-type plant, one should follow asexual propagation i.e. cutting. The overall studies indicated that the propagation method by seed (P₁) was found beneficial in increasing the growth and yield of marigolds. However, the propagation method by cuttings (P₂) had a significant influence on the flowering characteristics of marigolds. The variety Shaunak Orange was found to be significantly superior to the other varieties under study.

Keywords: Marigold, seed propagation, tip cutting, growth, yield and quality

Introduction

Marigold (*Tagetes erecta* L.) is an immensely popular annual flower crop widely grown throughout the world. Marigold has its importance and is called a 'poor man's crop'. It is a universally popular seasonal flower grown as an ornamental, loose, or cut flower, bedding, pot, or landscape plant, easy to cultivate with worldwide adaptability to varying soil and climatic conditions. Marigold with its bright colors ranging from yellow to orange is the best combination in any colour scheme. Generally, marigold is propagated by seeds. However, true-to-type plants can not be obtained through seed propagation because it is an often cross pollinated crop. Hence for the perpetuation of all characters of a particular plant and to obtain true-to-type plant, one should follow asexual propagation i.e. cutting. The main hurdles in the cultivation of marigolds are the lack of standard varieties and standard packages of practices. However, comparatively, merge work on the propagation of marigolds has been reported. Therefore, the present investigation was undertaken to assess the growth, quality, and yield performance of different marigold varieties propagated sexually and asexually.

Materials and Methods

The present investigation on "Studies of propagation methods of marigold on growth, quality & yield of flowers" was initiated in 2010 at Modibaug Garden of Horticulture Section, College of Agriculture; Pune. The experiment was laid out in Randomized Block Design (Factorial). Ridges and furrows having a gross plot size of 162 m² were prepared. The trial was laid out in the RBD (factorial) with eight treatments replicated 4 times. The soil of the plot selected for the experiment was medium to deep black, well-drained with good texture. Seedling and cuttings of different cultivars under study viz., Pusa Narangi Gaiinda, Innova Orange, Shaunak Orange, and Local were obtained for transplanting in the main field. Seedlings were raised on raised beds in May 2010 and then used as experimental material. After one month plants having a height of 15 cm were pinched to encourage the development of lateral branches. In July 2010, tip cuttings of 7 cm length were prepared with the help of a secateur. The tip cuttings were treated with radix powder to enhance the rooting and were planted in trays containing a mixture of sand, soil, and FYM in equal proportion. At the same time, marigold seeds of all four varieties under study were sown in seedling trays. The tray bowls were filled with garden soil, sand, and FYM as recommended for seed germination in a nursery. The spacing of 45 cm X 45 cm was maintained among the experimental plants. The observations on growth characteristics, flowering, and yield were recorded and analyzed statistically.

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Results and Discussion

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tense. The results should be given here without any references.

Table 1: Percentage of survival of cuttings

Sr. No	Varieties	Percentage of survival of cuttings	Percentage of survival of seedlings
1	Pusa narangi Gaiinda (V ₁)	58.5	78.5
2	Shaunak Orange(V ₂)	73.5	75.5
3	Innova Orange (V ₃)	78.5	91.5
4	Local (V ₄)	65.5	70

Table 2: Plant Height (cm)

	Plant height (cm)				
Treatment	15 DAP	30 DAP	45 DAP	60 DAP	At Final Harvest
Seed (P ₁)	13.33	29.36	63.46	76.33	90.22
Cutting (P ₂)	10.24	24.61	56.18	67.5	80.38
S.E. +	0.3	0.69	1.69	1.18	2.44
C.D. at 5%	0.88	2.05	4.98	3.48	7.2
Varieties					
V ₁	12.85	27.85	67.03	78.65	95.99
V ₂	8.08	19.03	36.25	43.62	49.46
V ₃	13.35	32.67	70.67	90.27	101.57
V ₄	12.86	28.39	65.35	75.13	94.19
S.E.+	0.42	0.98	2.39	1.67	3.46
C.D. at 5%	1.24	2.9	7.05	4.92	10.18
Interaction P x V					
P ₁ V ₁	14.49	29.39	71.1	84.05	101.76
P ₁ V ₂	8.9	20.46	37.39	45.02	51.49
P ₁ V ₃	14.97	35.54	74.9	96.27	107.4
P ₁ V ₄	14.95	32.07	70.47	80.01	100.22
P ₂ V ₁	11.21	26.31	62.96	73.26	90.22
P ₂ V ₂	7.26	17.6	35.11	42.22	47.42
P ₂ V ₃	11.74	29.8	66.43	84.28	95.74
P ₂ V ₄	10.76	24.72	60.23	70.25	88.16
S.E.+	0.6	1.39	3.39	2.36	4.89
C.D. at 5%	NS	NS	NS	NS	NS

Table 3: Plant Spread (cm)

	Plant Spread (cm)				
Treatment	15 DAP	30 DAP	45 DAP	60 DAP	At Final Harvest
Seed (P ₁)	13.88	23.57	30.77	37.31	49.05
Cutting (P ₂)	15.42	25.58	32.36	39.16	51.34
S.E. +	0.38	0.6	0.52	0.59	0.64
C.D. at 5%	1.13	1.77	1.54	1.76	1.88
Varieties					
V ₁	14.52	24.03	31.68	38.26	50.23
V ₂	15.41	23.76	32.36	39.12	52.13
V ₃	14.17	26.11	31.55	38.27	50.11
V ₄	14.52	24.41	30.68	37.29	48.31
S.E.+	0.54	0.85	0.74	0.84	0.9
C.D. at 5%	NS	NS	NS	NS	NS
Interaction P x V					
P ₁ V ₁	13.9	23.11	31.17	37.38	49.02
P ₁ V ₂	14.64	22.38	31.57	38.1	51.11
P ₁ V ₃	13.18	25.13	30.81	37.36	48.95
P ₁ V ₄	13.83	23.65	29.54	36.42	47.11
P ₂ V ₁	15.15	24.95	32.2	39.15	51.45
P ₂ V ₂	16.18	25.13	33.14	40.14	53.15
P ₂ V ₃	15.16	27.08	32.3	39.18	51.27
P ₂ V ₄	15.21	25.17	31.82	38.17	49.51
S.E.+	0.77	1.2	1.04	1.19	1.28
C.D. at 5%	NS	NS	NS	NS	NS

Table 4: Number of primary branches

Treatment	Number of primary branches			
	30 DAP	45 DAP	60 DAP	At Final Harvest
Seed (P ₁)	6.1	7.91	9.87	12.12
Cutting (P ₂)	4.13	5.86	7.6	9.88
S.E. +	0.07	0.17	0.19	0.31
C.D. at 5%	0.2	0.5	0.58	0.9
Varieties				
V ₁	4.43	6.4	7.99	9.91
V ₂	6.6	8.35	11	13.66
V ₃	4.6	6.15	7.79	10.02
V ₄	4.73	6.65	8.16	10.41
S.E.+	0.09	0.24	0.27	0.44
C.D. at 5%	0.29	0.71	0.82	1.31
Interaction P x V				
P ₁ V ₁	5.35	7.5	8.98	11
P ₁ V ₂	7.65	9.5	12.16	14.91
P ₁ V ₃	5.6	7.05	8.91	11
P ₁ V ₄	5.8	7.6	9.41	11.58
P ₂ V ₁	3.5	5.3	7	8.83
P ₂ V ₂	5.75	7.2	9.83	12.41
P ₂ V ₃	3.6	5.25	6.66	9.05
P ₂ V ₄	3.65	5.7	6.91	9.23
S.E.+	0.14	0.34	0.39	0.63
C.D. at 5%	NS	NS	NS	NS

Table 5 (a): Flowering Character

Treatments	Days to first flower bud initiation	Days to first flowering	Days to 50% Flowering	Days to First harvest
Seed (P ₁)	34.98	42.22	66.6	53.6
Cutting (P ₂)	26.21	34.52	57.56	46.17
S.E. +	0.6	0.65	0.94	0.91
C.D. at 5%	1.78	1.92	2.78	2.69
Varieties				
V ₁	31.96	40.26	63.78	51.16
V ₂	25.83	33.58	55.53	44.95
V ₃	30.38	38.13	59.91	49.46
V ₄	34.21	41.5	69.08	53.96
S.E.+	0.85	0.92	1.33	1.29
C.D. at 5%	2.52	2.72	3.93	3.81
Interaction P x V				
P ₁ V ₁	36.83	44.61	69.33	55
P ₁ V ₂	30	37.42	58.25	48.5
P ₁ V ₃	34.67	41.76	64.42	53.5
P ₁ V ₄	38.42	45.08	74.41	57.42
P ₂ V ₁	27.09	35.92	58.25	47.34
P ₂ V ₂	21.66	29.75	52.83	41.42
P ₂ V ₃	26.09	34.5	55.41	45.42
P ₂ V ₄	30	37.92	63.75	50.51
S.E.+	1.21	1.31	1.89	1.83
C.D. at 5%	NS	NS	NS	NS

Table 5 (b): Flowering Characters

Treatment	Average diameter of flowers (cm)	Duration of flowering (Days)	Crop Duration(days)	Shelf life (days)
Seed (P ₁)	6.27	56.98	98.97	11.16
Cutting (P ₂)	7.77	46.43	88.08	12.52
S.E. +	0.16	0.91	1.61	0.23
C.D. at 5%	0.49	2.69	4.76	0.7
Varieties				
V ₁	5.38	58.54	101.74	11.83
V ₂	8.64	41.79	79.54	13.04
V ₃	7.39	50.5	92.25	11
V ₄	6.66	56	100.57	11.5
S.E.+	0.23	1.29	2.29	0.33
C.D. at 5%	0.69	3.81	6.73	0.99
Interaction P x V				
P ₁ V ₁	4.64	63.42	107.32	11.25
P ₁ V ₂	8.08	47.08	84.91	12.25
P ₁ V ₃	6.53	56.33	97.42	10.33
P ₁ V ₄	5.83	61.08	106.22	10.83
P ₂ V ₁	6.13	53.66	96.16	12.41
P ₂ V ₂	9.21	36.5	74.16	13.83
P ₂ V ₃	8.25	44.66	87.08	11.66
P ₂ V ₄	7.5	50.92	94.92	12.17
S.E.+	0.33	1.83	3.23	0.47
C.D. at 5%	NS	NS	NS	NS

Table 6: Yield Characters

Treatment	Av. no. of Flowers/plant	Yield of Flowers/plant(g)	Yield of Flowers/plot(kg)	Yield of Flowers/ha(q)
Seed (P ₁)	20.19	205.02	5.12	101.24
Cutting (P ₂)	17.17	175.52	4.38	86.67
S.E. +	0.12	1.36	0.03	0.67
C.D. at 5%	0.37	4.01	0.10	1.98
Varieties				
V ₁	16.59	128.68	3.21	63.54
V ₂	23.38	281.31	7.03	138.91
V ₃	17.54	186.22	4.65	91.95
V ₄	17.21	164.85	4.12	81.40
S.E.+	0.17	1.93	0.04	0.95
C.D. at 5%	0.52	5.68	0.14	2.80
Interaction P x V				
P ₁ V ₁	18.42	144.85	3.62	71.52
P ₁ V ₂	25.09	301.00	7.52	148.63
P ₁ V ₃	18.92	196.60	4.91	97.08
P ₁ V ₄	18.34	177.61	4.44	87.70
P ₂ V ₁	14.76	112.51	2.81	55.56
P ₂ V ₂	21.67	261.62	6.53	129.19
P ₂ V ₃	16.16	175.84	4.39	86.83
P ₂ V ₄	16.09	152.10	3.80	75.10
S.E.+	0.25	2.73	0.06	1.34
C.D. at 5%	0.74	8.03	0.20	3.96

Growth attributes

Results from Table 1, 2, 3, & 4 presented that the variety Innova Orange (78.5%) has a higher percentage of survival of cuttings and survival of seedlings than other varieties. The plants propagated by seed (P₁) exhibited maximum plant height at 15, 30, 45, and 60, days after transplanting and at final harvest which was significantly superior to the plant propagated by cutting (P₂) over the same interval of time. The variety Innova Orange (V₃) attained a maximum plant height at 15, 30, 45 and 60 days after transplanting and at final harvest stage (13.35 cm, 32.67 cm, 70.67 cm, 90.37 cm, and 101.27 cm respectively) which was significantly superior over Shaunak Orange (V₂) but at par with Pusa Narangi Gaiinda (V₁) & Local variety (V₄). It is also clear that the plant height increased from transplanting up to 45 days after transplanting at an increasing rate, while in

subsequent growth stages the rate was slowed down. Similar trend in increase in plant height have been reported by Bhati and Chitkara (1988) [2], Mehta *et al.* (1995) [8] and Gadage (2006) [7]. At 15, 30, 45, 60 days after transplanting and at final harvest stage, the maximum spread was recorded by plants propagated by cuttings which was significantly superior to the seed propagated plants at the same stages. The data in respect of mean spread of the plant as influenced by different marigold varieties produced non significant influence on spread of the plant at different growth stages. The present experimental results of plant spread are in line with the findings reported by Singh *et al.* (2004) [13], Parmar and Singh (1983) [10], and Gadage (2006) [7]. The maximum number of branches per plant at different growth stages was recorded in plants propagated by seed which was significantly superior to the plant propagated by cutting. The

variety Shaunak Orange (V_3) recorded the maximum number of primary branches at 30,45,60 days after transplanting and at the final harvest stage (6.60 cm, 8.35 cm, 11.00 cm, and 13.66 cm respectively) which was significantly superior over the other varieties. The present findings conform with the work reported by Bhati and Chitkara (1988)^[2], Parmar and Singh (1983)^[10], Mehta *et al.* (1995)^[8], and Chezhiyan *et al.* (1985)^[4]. The given data showed that the interaction effect between propagation methods and varieties on all growth attributes was non significant.

Flowering attributes

Results from Table 5 (a) & Table 5 (b) illustrated that the treatment propagation by cuttings (P_2) recorded the least number of days (26.21 days) for first flower bud initiation which was significantly superior to propagation by seed (P_1). The variety Shaunak Orange (V_2) recorded the minimum number of days (25.83) for flower bud initiation followed by variety (V_3) Innova Orange (30.32) which was at par with (V_1) Pusa Narangi Gaiinda (31.96). The maximum number of days for flower bud initiation was recorded by Local variety (V_4). These results are in line with findings reported by many research workers. Mohanty *et al.* (2002)^[9] Singh *et al.* (2004)^[13] and Gadage (2006)^[7]. The treatment (P_2) propagation by cuttings recorded the least number of days (34.52 days) for first flowering which was significantly superior to the other treatment (P_1) propagation by seed. The least number of days for first flowering was recorded by V_2 (33.58 days) followed by V_3 (38.13 days). The maximum numbers of days for the first flowering were recorded by V_4 which was at par with V_1 . The present experimental results are in line with the findings reported by Khanvilkar (2003)^[14] and they observed that the variety Yellow Supreme showed early flowering and Orange Boom showed late, compared to the other cultivars. The treatment (P_2) propagation by cutting recorded the minimum number of days required for fifty percent flowering which was significantly superior to the plants propagated by seed (P_1). The variety Shaunak Orange (V_2) recorded the minimum number of days (55.33 days) required for fifty percent flowering which was significantly superior to the remaining varieties. Gadage (2006)^[7] and Mehta *et al.* (1995)^[8] also had similar results. The propagation method P_2 recorded the minimum number of days to first harvest (46.17 days) which was significantly higher than that recorded with the propagation method P_1 . The variety Shaunak Orange (V_2) recorded (44.95 days) the minimum number of days for the first harvest which was significantly superior to the remaining varieties. The present experimental results are in line with the findings of work done by Gadage (2006)^[7] and Singh and Arora (1988)^[12] in which they reported that the number of days taken for first plucking was significant. The propagation method (P_2) by cuttings recorded the maximum diameter of the flower (7.77 cm) which was significantly higher than that recorded with the other propagation methods (P_1) by seeds. The variety Shaunak Orange had flowers with a maximum diameter (8.64 cm) which was significantly superior to the other varieties. These results are in agreement with those of Aradhana Singh (2006)^[1] who reported that the flowers of cultivars Pusa Narangi Gaiinda had a diameter of 5.91 cm. The plants propagated by seeds (P_1) had a maximum flowering duration (56.98 days) which was significantly superior to plants propagated by cuttings

(P_2). The variety Pusa Narangi Gaiinda as compared to other varieties had a significantly longer duration of flowering (58.54 days). These results are in close affinity with the observations recorded by Aradhana Singh (2006)^[1] who observed that the variety Pusa Narangi Gaiinda had a significantly longer duration of flowering (64.13 days). The maximum crop duration was exhibited by the seed propagation (P_1) method (98.97 days), which was significantly superior to the cutting propagation (P_2) method (88.08 days). The variety Pusa Narangi Gaiinda (V_1) had the highest crop duration (101.74 days) which was significantly superior to other varieties. These results are in line with the findings of work done by Aradhana Singh (2006)^[1] under varietal performance of marigold hybrids which observed that the hybrid variety Pusa Narangi Gaiinda had significantly highest crop duration (107.94 days). These results are in close conformity with those of Barigdad and Patil (1997)^[15] who reported that cv. Meghami propagated by cutting had a crop duration of (75.23 days). These results are in line with the findings of work done also by Gadage (2006)^[7]. The maximum shelf life of flowers was exhibited by plants propagated by cuttings (12.52 days) which was significantly higher than that of plants propagated by seeds (11.16 days). The variety Shaunak Orange had a maximum shelf life of flowers (13.04 days), which was significantly superior to all the remaining varieties. The interaction effect of propagation methods and varieties on all flowering attributes was non-significant.

Yield characters

The results of Table 6 reported that the yield in terms of the average number of flowers per plant, yield of flowers per plant, per plot, and per hectare was significantly higher in plants propagated by seed (P_1) as compared to that of plants propagated by cutting (P_2). The maximum number of flowers per plant (20.19) observed in the propagation method (P_1) by seeds was significantly higher than that of plants propagated by cuttings (P_2) and the maximum numbers of flowers per plant were produced by the variety (V_2) Shaunak Orange (23.38). The maximum yield of flowers/plant (g) was produced by the seed propagated method (205.02 g) which was significantly higher than that of cutting propagated plants (175.52 g). The variety Shaunak-Orange produced maximum flower yield per plant (281.31 g) which was significantly higher than all other varieties under study. The maximum yield of flowers/plot (Kg) was produced by the seed propagation method (5.12 Kg) which was significantly superior to that of plants propagated by the cutting method. The variety Shaunak-Orange (V_2) produced maximum flower yield per plot (7.03 kg) which was significantly higher than all other varieties under study. The maximum yield of flowers per hectare (q) was recorded with the (P_1) seed propagation method (101.24 q/ha) which was superior to that of plants propagated by the (P_2) cutting propagation method (86.67 q/ha). The variety Shaunak-Orange (V_2) produced maximum flower yield (138.91 q/ha) which was significantly higher than the rest of the varieties under study. The given data showed that the interaction effect of propagation methods and varieties on all yield attributes was significant. Aradhana Singh (2006)^[1] studied the varietal performance of marigold hybrids and observed that the yield varied significantly with the varieties. These results are in agreement with the findings of Garage (2006) who reported that chrysanthemum cultivars

Red Gold, Suneel & Kirti propagated by rooted tip cutting recorded a yield of 21, 28, and 33 flowers per plant respectively. Dhiman (2003) ^[5] during his studies found that the chrysanthemum variety Thaichang propagated by cuttings recorded a yield of 165.7 g per plant. Similar results in the case of yield per plot and per hectare have been reported by Gaikwad *et al* (2002) ^[6]. From the overall assessment of the results, it can be concluded that the propagation method (P₁) by seed was found beneficial in increasing the growth and yield of marigolds. However, the propagation method (P₂) by cuttings had a significant influence on the flowering characteristics of marigolds. The variety Shaunak Orange was found to be significantly superior to the other varieties under study.

Conclusion

The studies overall showed that the seed propagation method (P₁) was effective in enhancing the growth and yield of marigolds.

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Conflict of Interest

All authors declare that they have no conflict of interest.

Authors Contribution Statement

All authors contributed throughout my research work.

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