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Studies on response of marigold (*Tagetes erecta* L.) cv. Calcutta double to season and spacing

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Abstract
The present investigation entitled "Studies on response of marigold (*Tagetes erecta* L.) cv. Calcutta double to season and spacing" was conducted at the College of Horticulture, Dapoli in 2024-25. The experiment was laid out in a Factorial Randomized Block Design under open field condition with four replications and nine treatment combinations. The study involves three planting season (P_1- IInd fortnight of June, P_2- IInd fortnight of October, P_3- IInd fortnight of January) and three different spacing (S_1- 30 x 30 cm, S_2- 45 x 30 cm, S_3- 60 x 30 cm). The study discovered that marigold planted during treatment P_1S_1 (IInd fortnight June at spacing of 30 x 30 cm) recorded the maximum plant height (105.80 cm). The number of leaves per plant (459.65), plant spread (N x S: 54.30 cm, E x W: 64.05 cm), leaf area (43.62 cm^2), Field longevity of flowers per plot (18.05 days), flower size (59.23 mm), weight of a flower (9.85 g) and weight of 100 flowers per plot (994.75 kg) noted their maximum in treatment P_2S_3 (IInd fortnight of October at spacing of 60 x 30 cm). Treatment P_2S_2 (IInd fortnight of October at spacing of 45 x 30 cm) achieved early flower emergence (51.45 days), 50% flowering (84.83 days) and highest post-harvest shelf life (8.75 days). Treatment P_2S_1 (IInd fortnight of October at spacing of 30 x 30 cm) recorded the maximum yield per plot (29.12 kg) and yield per hector (53.93 t).

Keywords: African marigold, calcutta double, season, spacing, growth, flowering, yield

Introduction
The marigold (*Tagets spp.)* is a prominent annual flowering plant that belongs to the Asteraceae family that has been appreciated for its decorative, therapeutic and agricultural values. Marigolds are indigenous to Mexico and Central America and they are majorly cultivated in tropical and subtropical regions due to their wide adaptability and multifunctional uses. "African marigold" (*Tagetes erecta* L.) and "French marigold" (*Tagets patula* L.) are primarily grown species of marigold, on the other hand *T. tenuifolia* (the striped marigold), *T. lucida* (the sweet-scented marigold), *T. minuta* and *T. lacera* are some other important species of marigold. Among the various *Tagets spp.* African marigold *i.e., Tagetes erecta* L. has gained global popularity for its adaptability and ornamental values. Flowers of this species has vibrant, compact and large flower heads rich in antioxidants and carotenoids content especially lutein. Lutein widely utilized in nutraceutical and food industries. High aesthetic values are also associated with marigolds. The aromatic oil also extracted from marigold, is called as "Tagets oil". It is used for the preparation of high-grade perfumes and also as insect repellent. In addition, farmers used to plant marigold on their farm's boundaries to control nematodes as it suppresses the nematode population in the field. The coloured pigment extracted from its flower is used in poultry feed in order to improve the colour of egg yolk as well as broiler's skin.

Materials and Methods
The present investigation was conducted at the Nursery No. 04, College of Horticulture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (M. S.) during 2024-25. The experiment was laid out in Factorial Randomized Block Design (FRBD) along with four replications and two factors *viz.*, Factor A – Planting season as P_1- IInd fortnight of June, P_2- IInd fortnight of October, P_3- IInd fortnight of January and factor B - Spacing as S_1- 30 x 30 cm, S_2-

45 x 30 cm, S_3- 60 x 30 cm. The experimental material of African marigold namely Calcutta double was collected from Bhalari Hitech Ropvatika, At. Post: Atit, District.: Satara. During each planting 162 m^2 sized experimental plot was divided into 12 sub-plots of size 3.6 m x 1.5 m was prepared for planting. Plant population was varied according to varying planting distance *viz.*, 60, 40, 30 plants per sub-plot per spacing. A distance of 1.5 m was kept in between two experimental plots and distance of 0.9 m was maintained in between two replications. The research analyzed the interaction effect of two factors, emphasizing on vegetative, flowering, quality, yield and post-harvest parameters which were documented at the conclusion of the experiment. The information that has been collected were examined by applying the standard analysis of variance method as described by Panse and Sukhatme in 1995 [3].

Results and Discussion

Vegetative Parameters

At 120 days after transplanting, numbers of vegetative parameters were evaluated and recorded significant interaction impact of season and spacing throughout the study, this includes plant height, number of leaves per plant, plant spread and leaf area. When the marigold was planted during IInd fortnight June at 30 x 30 cm planting distance (P_1S_1) the maximum plant height 105.80 cm was recorded, while the lowest plant height of 84.15 cm was observed in IInd fortnight of January at planting distance of 60 x 30 cm (P_3S_3). However, other vegetative metrics such as number of leaves per plant (459.65), plant spread (N x S: 54.30 cm, E x W: 64.05 cm) and leaf area (43.62 cm^2) noted their maximum during IInd fortnight of October at planting distance of 60 x 30 cm (P_2S_3). Despite this, planting during IInd fortnight of June at 30 x 30 cm planting distance (P_1S_1) recorded minimum number of leaves per plant (351.65), plant spread (N x S: 48.75 cm, E x W: 49.98 cm) and leaf area (33.28 cm^2). Obtained results might be due to the presence of conducive environmental conditions and rate of inter-plant competition during particular planting. The similar results were also recorded by Singh, (2023) [7] in China aster, Lakshmi *et al.,* (2014) [2] and Samantaray (1992) [4] in African marigold and Kumar *et al.,* (2025) [1] on annual chrysanthemum (*Glebionis coronaria* L.)

Flowering parameters

Throughout the investigation notable difference among various treatment combinations has been recorded. May be due to moderate temperature and planting density which favors development of physiological stress and triggers floral development, planting during IInd fortnight of October at planting distance of 45 x 30 cm (P_2S_2) achieved early flower emergence in 51.45 days and 50% flowering in 84.83 days. On the other hand, planting during IInd fortnight of June at 60 x 30 cm planting distance (P_1S_3) recorded comparatively late flower emergence in 60.13 days and 50% flowering in 91.20 days. Field longevity of flowers per plot *i.e.,* 18.05 days was higher during IInd fortnight of October along with the spacing of 60 x 30 cm (P_2S_3), while minimum 11.95 days was recorded in IInd fortnight June planting at 30 x 30 cm planting distance (P_1S_1). The primary cause of these variations in the field longevity of various treatment combinations were the available climatic conditions and the mechanical damage occurred during flower harvesting. Likewise, equivalent results were documented by Sruthi *et al*., (2016) [8] and Lakshmi *et al.,* (2014) [2] in African marigold and Sonali in French marigold.

Quality Parameters

During the course of study, quality of flower was greatly influenced by the interaction of planting season and spacing. The maximum flower size (59.23 mm), weight of a flower (9.85 g) and weight of 100 flowers per plot (994.75 kg) was recorded during IInd fortnight of October along with planting distance of 60 x 30 cm (P_2S_3). Conversely, planting during IInd fortnight of June at 30 x 30 cm planting distance (P_1S_1) showed the minimum values for flower size (51.16 mm), weight of a flower (8.53 g) and weight of 100 flowers per plot (810.00 kg). The observed variations in quality parameters across different treatment combinations may be the result of wider planting spacing and October planting (treatment P_2S_3), which promotes healthy flower development under stable climatic conditions with lower transpiration losses and interplant competition. This directly helps in larger flower head development and maintains higher fresh weight of individual marigold flower. In Pusa Narangi Gainda, Singh *et al*. (2015) [6] found a similar outcome.

Yield Parameters

The yield aspects such as the yield per plot and yield per hector were evaluated at the end of experiment. The IInd fortnight of October along with planting distance of 30 x 30 cm (P_2S_1) noticed the maximum yield per plot (29.12 kg) and yield per hector (53.93 t). On the other hand, minimum yield per plot (12.76 kg) and yield per hector (23.62 t) was recorded during IInd fortnight of June along with planting distance of 60 x 30 cm (P_1S_3). The observed changes in yield characteristics highlight how an increase in the number of plants per unit area, along with October's optimal climate, leads to an increase in yield per unit area. The similar findings were also documented by Lakshmi, *et al.,* (2014) [2] in African marigold, Singh *et al.,* (2015) [6] in Pusa Narangi Gainda, Kumar *et al.,* (2025) [1] on annual chrysanthemum (*Glebionis coronaria* L.).

Post Harvest Parameters

The outcomes of the investigation revealed that the different treatment combinations had significantly different post-harvest shelf life at room temperature. The highest shelf life (8.75 days) was noted when planted during IInd fortnight of October at the spacing of 45 x 30 cm (P_2S_2). In contrast lowest shelf life (6.95 days) was recorded during IInd fortnight of June along with planting distance of 30 x 30 cm (P_1S_1). The observed alterations in post-harvest features are might be attributed to October planting spaced moderately or widely apart, which produces large flower head with thick petals and strong calyx development. In such flowers, cool and dry harvesting environment minimizes the rate of post-harvest losses or wilting.

Table 1: Effect of season and spacing on vegetative and flowering parameters of African marigold.

Treatment	Vegetative Parameters					Flowering parameters		
	Plant height (cm)	No. of leaves per plant	Plant spread (cm)		Leaf area (cm^2)	Days required for flower emergence	Days required for 50% flowering	Field longevity of flowers per plot (Days)
			N x S	E x W				
P_1S_1	105.80	351.65	48.75	49.98	33.28	58.08	88.45	11.95
P_1S_2	102.59	358.23	49.98	51.03	36.67	57.60	87.80	13.45
P_1S_3	102.46	358.90	51.55	61.68	37.13	60.13	91.20	14.50
P_2S_1	86.85	430.40	51.23	53.90	39.47	54.05	85.90	13.88
P_2S_2	88.80	442.70	53.43	56.35	41.67	51.45	84.83	16.30
P_2S_3	84.33	459.65	54.30	64.05	43.62	56.98	86.58	18.05
P_3S_1	87.10	377.25	49.00	51.80	36.98	54.68	85.83	13.45
P_3S_2	87.98	382.95	50.70	53.80	38.36	52.18	85.10	14.20
P_3S_3	84.15	389.55	53.88	62.42	42.08	58.10	89.35	17.28
S.Em±	0.85	3.42	0.41	0.42	1.01	0.51	0.48	0.38
CD @ 5%	2.48	9.99	0.21	1.24	2.96	1.50	1.40	1.10
Result	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG

Table 2: Effect of season and spacing on quality, yield and post-harvest parameters of African marigold.

Treatment	Quality Parameters			Yield Parameters		Post-harvest parameter
	Flower size (mm)	Weight of single flower (g)	Weight of 100 flowers per plot (g)	Yield (kg/plot)	Yield (t/ha)	shelf life at ambient temperature (days)
P_1S_1	51.16	8.53	810.00	17.60	32.60	6.95
P_1S_2	56.23	9.08	881.25	15.24	28.22	7.13
P_1S_3	56.55	9.60	954.25	12.76	23.62	6.98
P_2S_1	56.63	9.68	949.75	29.12	53.93	7.50
P_2S_2	57.28	9.70	957.00	20.35	37.69	8.75
P_2S_3	59.23	9.85	994.75	15.99	29.61	7.88
P_3S_1	55.18	9.60	896.25	27.21	50.39	7.38
P_3S_2	56.83	9.15	892.00	18.08	33.48	8.13
P_3S_3	58.38	9.73	950.00	15.17	28.10	8.38
S.Em±	0.70	0.19	17.23	0.59	1.08	0.23
CD @ 5%	2.05	0.55	50.28	1.71	3.16	0.66
Result	SIG	SIG	SIG	SIG	SIG	SIG

Conclusion

According to the findings of this study, it is concluded that, the growth and development of African marigold was significantly influenced by planting season and spacing. Particularly, the planting during IInd fortnight of October along with spacing of 30 x 30 cm (P_2S_1) produces the highest yield per plot and yield per hector. In accordance with these results, it is possible to improve the economic results of marigold production in the Konkan agroclimatic conditions by adjusting the planting season and spacing. However, this conclusion is based on data from a single year experiment, it is necessary to conduct the same experiment for at least two years again to validate the findings before being recommended.

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