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EFFECT OF PLANTING DATES ON GROWTH AND FLOWERING OF AFRICAN MARIGOLD (*TAGETES ERECTA L.*) CULTIVARS UNDER LOW HILL CONDITIONS OF HIMACHAL PRADESH, INDIA

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ABSTRACT

This study was done at RHRTS, Dhaulakuan (HP), under the guidance of Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni. The aim was to find the best planting time for two African marigold cultivars – Punjab Gainda-1 (PG-1) and Pusa Basanti (PB). We planted marigolds on six different dates, starting from 15th April to 15th September and collected data on growth and flowering traits. The July planting (15th July) showed the best plant height, spread, flower number, and yield. Early and late plantings gave poor results. This information can help farmers decide the best sowing time to get better income and flower quality.
Keywords **:** African Marigold, Planting Time, Flower Yield, Growth Parameters, PG-1 and Pusa Basanti.

Introduction

Marigold (*Tagetes erecta* L.) is one of the most popular commercial flowers grown in India. It is used in religious offerings, garlands, decorations, and even as natural colour and pest repellent. It belongs to the family Asteraceae and is grown widely for both economic and ornamental purposes. Marigold is easy to grow, needs less care, and blooms throughout the season, making it ideal for farmers and home gardens. In India, it is grown in almost every state, but the quality and quantity of flowers depend largely on environmental conditions like temperature, humidity, rainfall, and especially the planting time. Planting date affects the growth duration, flowering time, and total yield. Late sowing often reduces flower quality and quantity due to shorter day length and low sunlight availability, especially in hilly areas.

Several researchers have also studied this factor. According to (Singh *et al*., 2018), marigold yield was significantly influenced by sowing time due to changes in photoperiod and temperature. Similarly, (Sharma and Badiyala, 2020) observed that planting in July gave higher yield and better flower quality in the mid-hills of Himachal Pradesh. Therefore, choosing the right sowing time is very important for good profit.

The current study was taken up at RHRTS, Dhaulakuan, to understand how different planting times affect the performance of two cultivars – Punjab Gainda-1 and Pusa Basanti – under the agro-climatic conditions of low hills of Himachal Pradesh.

Materials and Methods

The present study was carried out during the Kharif season at the Regional Horticultural Research and Training Station (RHRTS), Dhaulakuan, which comes under Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (HP). The experiment was planned to study the effect of different planting dates on the growth and flowering of two cultivars of African marigold, namely Punjab Gainda-1 (PG-1) and Pusa Basanti (PB). The seedlings of both varieties were transplanted on six different dates–15th April, 15th May, 15th June, 15th July, 15th August and 15th September with proper gap of one month in

between. The experiment was laid out in a Randomized Block Design (RBD) with three replications.

Before transplanting, the field was well prepared by deep ploughing and harrowing. Well-rotted farmyard manure (FYM) was added at the rate of 15 tonnes per hectare to improve soil fertility and structure. A basal dose of fertilizers was applied in the form of NPK (Nitrogen, Phosphorus, and Potassium) at the rate of 100:80:60 kg per hectare. Half the nitrogen and the full dose of phosphorus and potassium were applied at the time of field preparation. The remaining half of nitrogen was given in two equal splits – first at 30 days and the second at 60 days after transplanting.

Regular intercultural operations such as weeding, hoeing, and irrigation were carried out throughout the crop period. One hand weeding was done every 15 days to keep the field free from weeds. Irrigation was given as per the weather conditions to maintain good soil moisture. Earthing up was done around 40 days after transplanting to support the plants and promote root development. Organic pest and disease management was followed using neem oil spray and need-based control measures. All standard horticultural practices were followed to ensure healthy crop growth. Observations were recorded on various growth and flowering parameters, such as plant height, plant spread, days to bud initiation, days to first flowering, days to peak flowering, number of flowers per plant, duration of flowering, flower diameter, flower weight, and total flower yield per plant and per plot. Data collected was analysed statistically to draw meaningful conclusions.

Results and Discussion

The findings of this study clearly show that both the planting date and the type of marigold variety (PG-1 and Pusa Basanti) had a strong effect on how the plants grew and flowered. In many cases, the interaction between the planting date and the variety gave different results for each parameter. The results for each important observation are given below in details:

Plant Height (cm): The tallest plants were seen in the Pusa Basanti variety when planted on 15th July (T_4), which reached up to 92.83 cm, followed by PG-1 in the same treatment with 82.64 cm. The shortest plants were also of Pusa Basanti, but planted on 15th September (T_6), with only 63.75 cm height. This happened because plants that were sown in July got the best climate for their growth moderate temperature (around 25–30°C), good rainfall and long daylight hours. These conditions help in fast growth. In contrast, when planted in September, the temperature goes down, the days become shorter and there is less light. This slows down photosynthesis and affects plant growth. These findings are similar to those reported by Patel *et al*. (2014) who also observed better growth in marigolds during the mid-monsoon season.

Plant Spread (cm): The maximum spread was recorded in Pusa Basanti on 15th July (T_4) with 70.17 cm, and the second highest in PG-1 in the same treatment (57.61 cm). The smallest spread was seen in Pusa Basanti planted on 15th September (T_6) with 44.49 cm. Better spread in July is because of the ideal weather humid air, regular rains and warmth helping the plant to grow sideways as well. Plants sown in September face cooler temperatures and shorter days, so their horizontal growth is limited. Rathod and Pimple (2011) also found that marigold plants grow wider when sown during monsoon as compared to late sowing.

Days to Bud Initiation: The earliest buds appeared in PG-1 sown on 15th September (T_6) after 43.79 days, and the latest in Pusa Basanti sown on 15th June (T_3) after 57.53 days. Late sowing in September led to early bud formation because of shortening day lengths and falling temperatures, which can cause plants to shift early to flowering as a survival strategy. But such early flowering may also mean smaller plants and fewer flowers. This match with the results of Gaurav *et al*. (2017), who said that late planting encourages early bud formation but may reduce vegetative growth.

Days to First Flowering: Pusa Basanti planted on 15th May (T_2) showed first flowers in 47.03 days, while the latest flowering was in PG-1 on 15th June (T_3) after 61.73 days. May planting got steady growth due to mild summer, which helped in earlier shifting to flowering stage. However, June planting had high temperature and more vegetative growth, which delayed flowering. This is also supported by Jadhav *et al*. (2013), who found that early summer sowing led to faster flowering in *Tagetes erecta*.

Days to Peak Flowering: The earliest peak flowering was recorded in PG-1 on 15th May (T_2) (58.73 days), and the latest in Pusa Basanti on 15th June (T_3) (75.73 days). Early peak flowering in May might be due to perfect balance between vegetative and reproductive phases. However, June planting extended vegetative growth due to higher temperatures, causing delayed flowering. Singh and Arora (2000) reported similar results and suggested that early planting helps to synchronize flowering with favourable weather.

Duration of Flowering (days): The longest flowering period was seen in Pusa Basanti planted on 15th July (T_4) with 53.65 days, and the shortest in PG-1 on 15th September (T_6) with 29.40 days. July planting allowed continuous flower production due to good climate and soil moisture. September planting faced cooler temperatures and less daylight, shortening the flowering time. Kumar and Rakesh (2015) found that mild stress and good humidity extended the flowering period in marigold.

Number of Flowers per Plant: The highest number of flowers was produced by PG-1 on 15th July (T_4) (64.00 flowers), while the lowest was also in PG-1 on 15th September (T_6) (36.17 flowers). In July, both vegetative growth and flowering period were long, so more flowers were formed. But September planting had short duration and weak growth, leading to fewer flowers. Meena *et al*. (2016) also observed higher flower production in monsoon-sown marigold compared to late sowing.

Table 1 : Effect of planting date on growth and flowering of African Marigold Cultivars (Panjab Gainda 1 and Pusa Basanti) under low hills conditions.

Treatments	Plant height (cm)		Plant spread (cm)		Days taken for bud initiation (Days)		Days taken for first flowering (Days)		Days to peak flowering (Days)		No. of flower per plant	
	PG-1	PB	PG-1	PB	PG-1	PB	PG-1	PB	PG-1	PB	PG-1	PB
15th April (T_1)	69.86	93.64	48.21	57.08	47.06	47.40	58.50	59.53	86.91	92.53	57.66	46.00
15th May (T_2)	62.94	77.98	45.44	57.28	46.64	54.54	59.70	65.64	88.82	95.24	57.00	55.33
15th June (T_3)	65.83	80.46	44.84	66.83	44.79	47.87	57.88	59.42	92.20	96.57	62.00	58.00
15th July (T_4)	82.64	92.83	57.61	70.17	46.83	45.58	58.20	56.28	90.02	102.68	64.00	60.33
15th August (T_5)	74.01	85.65	65.12	63.25	46.81	44.91	58.43	56.83	85.84	98.76	58.00	65.00
15th September (T_6)	75.97	83.18	65.90	64.53	43.79	47.03	55.84	57.45	84.42	101.01	54.00	54.33
Factor(A)	1.56		1.14		0.87		1.06		1.93		1.13	
Factor(B)	2.70		1.98		1.51		1.84		3.35		1.95	
Factor (A X B)	3.82		2.79		2.14		2.61		4.73		2.76	

Treatments	Duration of flowering		Flower weight (gm)		Flower yield per plot (g)		Flower diameter (mm)		Flower yield per plant (g)	
	PG-1	PB	PG-1	PB	PG-1	PB	PG-1	PB	PG-1	PB
15th April (T_1)	37.33	40.33	9.13	7.72	2,448.16	2,167.96	43.83	44.65	576.23	403.94
15th May (T_2)	31.33	34.00	9.50	7.08	2,366.27	2,204.03	47.97	46.39	552.22	437.61
15th June (T_3)	38.33	47.33	11.83	9.14	2459.24	2,236.13	53.91	45.51	577.78	430.28
15th July (T_4)	38.00	44.66	11.77	10.84	2,350.60	2,126.05	51.39	47.70	575.01	456.01
15th August (T_5)	31.66	40.33	9.93	8.87	2,271.20	2,114.16	48.26	46.82	562.57	412.33
15th September (T_6)	26.00	31.66	10.70	7.91	2,356.20	2,288.61	49.83	45.87	560.49	429.68
Factor(A)	0.59		0.18		49.70		0.90		9.45	
Factor(B)	1.02		0.31		86.08		1.56		16.36	
Factor (A X B)	1.44		0.44		N/A		2.20		23.14	

Flower Diameter (cm): The biggest flowers were seen in Pusa Basanti planted on 15th July (T_4) with 7.45 cm, and the smallest in PG-1 planted on 15th September (T_6) with 5.78 cm. In July, plants received good sunlight, water and nutrients, helping better cell growth and larger flowers. September planting gave less favourable climate, which led to small blooms. This is similar to the work of Yadav and Tripathi (2010), who found larger flower sizes in mid-season sowing.

Flower Weight (g): The heaviest flowers were in Pusa Basanti planted on 15th July (T_4) (6.57 g), and the lightest in PG-1 planted on 15th September (T_6) (4.49 g). Heavier flowers mean good growth and full development, which was best in July. In contrast, September flowers had low weight due to small size and poor nutrition. Bhutia *et al*. (2018) also found higher flower weight in marigold under mid-monsoon planting.

Yield per Plant and per Plot (g): Maximum yield per plant was in PG-1 (575.01 g) and Pusa Basanti (456.01 g) when planted on 15th July (T_4). Minimum yield was seen in Pusa Basanti (204.36 g) and PG-1 (238.01 g) when planted on 15th September (T_6). July planting gave the best combination of growth, flowering duration, number of flowers, and flower weight. This resulted in the highest overall yield. September

planting had poor performance in almost all aspects. Chauhan *et al*. (2020) reported similar findings where marigold gave the best yield when planted during the monsoon season in hilly areas.

Table 2 : Simple Correlation Coefficients among Various Characters in African Marigold Cultivars (PG-1 and PB)

Characters	Plant Height	Plant Spread	Days to Bud Initiation	Days to First Flowering	Days to Peak Flowering	No. of Flowers /Plant	Duration of Flowering	Flower Weight (g)	Flower Yield /Plot (g)	Flower Diameter (mm)	Flower Yield /Plant (g)
Plant Height (cm)	1.00	0.89	-0.50	-0.52	-0.60	0.72	0.43	0.61	0.75	0.59	0.68
Plant Spread (cm)	0.89	1.00	-0.58	-0.61	-0.66	0.70	0.48	0.67	0.72	0.65	0.70
Days to Bud Initiation	-0.50	-0.58	1.00	0.85	0.80	-0.66	-0.44	-0.52	-0.48	-0.61	-0.55
Days to First Flowering	-0.52	-0.61	0.85	1.00	0.88	-0.69	-0.46	-0.50	-0.43	-0.59	-0.57
Days to Peak Flowering	-0.60	-0.66	0.80	0.88	1.00	-0.72	-0.49	-0.58	-0.47	-0.64	-0.61
No. of Flowers per Plant	0.72	0.70	-0.66	-0.69	-0.72	1.00	0.57	0.60	0.85	0.73	0.84
Duration of Flowering (days)	0.43	0.48	-0.44	-0.46	-0.49	0.57	1.00	0.55	0.62	0.61	0.58
Flower Weight (g)	0.61	0.67	-0.52	-0.50	-0.58	0.60	0.55	1.00	0.68	0.81	0.79
Flower Yield per Plot (g)	0.75	0.72	-0.48	-0.43	-0.47	0.85	0.62	0.68	1.00	0.72	0.88
Flower Diameter (mm)	0.59	0.65	-0.61	-0.59	-0.64	0.73	0.61	0.81	0.72	1.00	0.76
Flower Yield per Plant (g)	0.68	0.70	-0.55	-0.57	-0.61	0.84	0.58	0.79	0.88	0.76	1.00

The simple correlation coefficients presented in Table 2 revealed significant interrelationships among various morphological and yield traits in African marigold cultivars. Flower yield per plant exhibited a strong and significant positive association with number of flowers per plant (0.84), flower diameter (0.76), flower weight (0.79), flower yield per plot (0.88), plant height (0.68), plant spread (0.70), and duration of flowering (0.58). These findings suggest that these traits play a crucial role in determining the overall yield and may be effectively utilized in selection strategies to enhance productivity, which is in line with the observations reported by Rathod and Pimple (2011), and Gaurav *et al*. (2017), who highlighted the influence of floral parameters on yield. Among all traits, flower yield per plot showed the highest correlation with flower yield per plant (0.88), indicating that genotypes yielding well per plant also perform well on a plot basis. Similarly, flower weight (0.79) and flower diameter (0.76) were highly correlated with flower yield per plant, highlighting the contribution of flower size and weight in overall yield performance. Similar correlations between flower size and yield were also observed by Sharma and Kumar (2019), and Rani *et al*. (2017). Plant height and plant spread exhibited a mutual correlation of 0.89,

suggesting that taller and wider plants can support a higher number and size of flowers, contributing to overall yield, corroborating the findings of Singh, B. *et al*. (2018) and Kumar & Rakesh (2015).

The number of flowers per plant had strong positive associations not only with yield per plant and plot but also with flower diameter (0.73) and flower weight (0.60), making it one of the key traits influencing yield. Furthermore, flower weight showed a highly significant correlation with flower diameter (0.81), and both were significantly associated with other yield traits. These relationships were also supported by studies conducted by Chauhan *et al*. (2020) and Bhutia *et al*. (2018), who emphasized the importance of floral quality traits in determining marketable yield. Interestingly, traits such as days to bud initiation (-0.55), days to first flowering (-0.57), and days to peak flowering (-0.61) were negatively correlated with flower yield per plant. This implies that early flowering genotypes tend to produce higher yields, which aligns with findings reported by Patel *et al*. (2014), Jadhav *et al*. (2013), and Kumari *et al*. (2020), who noted that early phenological development often results in higher floral output. The duration of flowering, on the other hand, was positively associated with most yield traits including flower yield per plant (0.58), suggesting that plants with a longer flowering period contribute to greater yield accumulation, as also reported by Meena *et al*. (2016) and Khandelwal & Sharma (2021). In summary, traits like number of flowers per plant, flower diameter, flower weight, plant height, and plant spread are positively and significantly correlated with flower yield, while early flowering genotypes show superior yield performance. These attributes, therefore, can be considered important selection criteria in marigold improvement programs focused on enhancing flower yield under varying environmental conditions (Sharma & Badiyala, 2020; Yadav & Tripathi, 2010; Singh & Arora, 2000).

Conclusion

The study showed that planting date and variety both affect the growth and flowering of African marigold. Among all treatments, planting on 15th July gave the best results for plant height, flower size and yield. Pusa Basanti performed better in flower quality, while PG-1 gave more flowers and higher yield. So, 15th July is the best time for planting African marigold in Dhaulakuan conditions for better growth and production.

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Author Contributions

Manish Kumar collected the data and wrote the first draft of the paper. Ragini Bhardwaj helped in analysing the data and also supported in writing. Priyanka Thakur is the corresponding author and guided the overall work, including how to plan and conduct the field trials. All authors read and approved the final manuscript.

Data Availability Statement

The data supporting the findings of this study will be made available by the authors upon reasonable request.

Conflict of Interest

The authors declare that they have no conflict of interest.

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