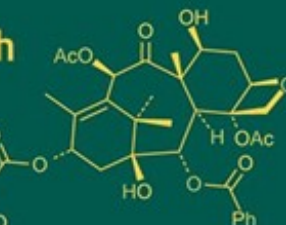


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Evaluation of Calendula (*Calendula officinalis* L.) genotypes for vegetative growth, chlorophyll content and flowering traits in hilly zone of Karnataka

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ABSTRACT

The present investigation entitled “Evaluation of Calendula (*Calendula officinalis* L.) Genotypes for Vegetative Growth, Chlorophyll Content and Flowering Traits in Hilly zone of Karnataka” was conducted during 2025–2026 at the Main Agricultural and Horticultural Research Station, Iruvakk, Department of Floriculture and Landscaping, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka. The experiment was laid out in a Randomized Complete Block Design (RCBD) with ten genotypes and three replications. The results revealed significant variation among the genotypes for vegetative growth, chlorophyll content and flowering traits. Fiesta Gitana Orange (G7) recorded the maximum plant height (34.58 cm), internodal length (3.58 cm), number of branches (28.33) and leaves per plant (72.40), along with the highest chlorophyll a (1.94 mg g⁻¹ fresh weight), chlorophyll b (0.69 mg g⁻¹ fresh weight) and total chlorophyll content (2.63 mg g⁻¹ fresh weight). Touch of Red Yellow (G4) recorded the maximum plant spread in both East–West cm) and North–South (29.76 cm) directions, while Bon Bon Yellow (G2) recorded the highest leaf area (27.87 cm²). Fiesta Gitana Creamy White (G9) recorded the maximum leaf length (19.19 cm) and highest leaf area index (1.92), whereas Touch of Red Orange (G5) recorded the maximum leaf width (4.84 cm). Among the flowering traits, Bon Bon Orange (G3) recorded the earliest flower bud initiation (26.33 days), first flowering (33.00 days) and 50 per cent flowering (48.40 days), besides recording the longest flowering duration (48.20 days). Hence, Fiesta Gitana Orange, Touch of Red Yellow, Bon Bon Yellow, Fiesta Gitana Creamy White, Touch of Red Orange and Bon Bon Orange were identified as promising genotypes for their respective desirable traits and may be utilized for further crop improvement, commercial cultivation and landscaping under the agro-climatic conditions of the study region.

Keywords: *Calendula officinalis* L., Vegetative growth, Chlorophyll content, Flowering traits

1. Introduction

Floriculture is an important branch of horticulture with growing significance in ornamental, landscaping and value-added flower industries. Increasing demand for flowers in gardens, decorations, social and religious functions has enhanced the commercial importance of ornamental crops. Among the various ornamental flowers, Calendula occupies a prominent place owing to its attractive yellow to orange flowers, prolonged blooming period, ease of cultivation, wide adaptability and medicinal importance, thereby making it an important ornamental crop in floriculture.

Calendula (*Calendula officinalis* L.) commonly known as pot marigold is an annual herbaceous plant cultivated globally and renowned for its striking yellow-orange blooms (Givol *et al.*, 2019). It is native to Southern Europe. Calendula is widely cultivated as an ornamental plant, particularly in Southern and Eastern Europe (Martin *et al.*, 2000) [1]. It is a prolific bloomer commonly grown for bedding and decorative purposes such as carpet bedding and herbaceous borders. In addition, calendula is commercially grown as a medicinal herb in Central Eastern and Southern Europe regions. Calendula was taken internally to treat fevers, promote menstruation and treat cancer. Most importantly, the flowers were made into extracts, tinctures, balms and salves and applied directly to the skin to help heal wounds and to soothe inflamed and damaged skin (Kemper, 1999) [2].

Calendula is a member of the Asteraceae family with a basic chromosome number, $X = 7, 8, 9, 11$ and 15. Generally, it is a tetraploid annual plant with chromosome number of $2n = 4x = 32$. The name “Calendula” is derived from the Latin word “Calendae” meaning the first day of each month, mainly due to longer duration of blooming of this plant. Since the calendula capitula get oriented towards the direction of the sun radiations, so it has become an astronomical sign “Leo” (Dinda *et al.*, 1998) [3]. It reaches up to 30-70 cm in height with branched stems, long tap roots along with numerous secondary roots. The leaves are hispid, acute, oblanceolate, alternate and sessile while the flower heads are surrounded by two rows of hairy bracts.

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Flower heads contain both disc and ray florets. The bisexual disc florets are centrally located and surrounded by rows of unisexual, pistillate ray florets.

Calendula is mainly grown for bedding, landscaping, loose and cut flowers, bouquets and floral arrangements. Besides its ornamental value, Flowers are being used in skincare products, as it has unique properties and assists the cell rejuvenation, wound healing, reducing inflammation, soothing and softening the skin (Muley *et al.*, 2009) [4]. The crop is also recognized for various pharmacological properties, including antioxidant, antimicrobial, *anti*- inflammatory and other therapeutic activities, which have contributed to its increasing utilization in pharmaceutical and cosmetic products (Silva *et al.*, 2021).

The performance of genotypes varies based on region, season and growing conditions. Consequently, a genotype that excels in one region may not perform as well in another with different climatic conditions. This underscores the need to evaluate available genotypes to identify high-yielding varieties suited to specific regions and it allows plant breeders to select highly diverse genotypes for further crop improvement. However, limited information is available on the comparative performance of different Calendula genotypes with respect to growth, flowering, pigment content and yield under specific agro-climatic conditions. Hence, the main objective of the investigation are as follows:

1. To assess the Calendula genotypes for growth attributes and chlorophyll content.
2. To assess the Calendula genotypes for flowering attributes.

2. Material and method

Calendula (*Calendula officinalis* L.) genotypes were evaluated in Randomized Complete Block Design (RCBD) with three replications at Main Agricultural and Horticultural Research Station (Experiment block), Department of Floriculture and Landscaping, Iruvakk under Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, during 2025–2026. The experimental site is situated in the Western Ghats and represents the Hilly Zone of Karnataka. The experiment comprised 10 different Calendula genotypes such as Bon Bon Apricot, Bon Bon Yellow, Bon Bon Orange, Touch of Red Yellow, Touch of Red Orange, Touch of Red Buff, Fiesta *Gitana* Orange, Fiesta *Gitana* Yellow, Fiesta *Gitana* Creamy White and Local. Seeds of all genotypes were sown separately in pro trays and healthy, uniform, and vigorous seedlings of Calendula were transplanted into the main field at 30 days after sowing (DAS) in the main field. A spacing of 30 cm between the rows, 30 cm between the plants was maintained. Each plot was of 2.4m length and 2.4 breadth. Fertilizer was applied as per standard recommendation. Farm yard manure was applied at the rate of 2 kg m⁻². Fertilizer dose of 30:20:20 g m⁻² N:P: K (30:20:20 g m⁻²) was applied in the form of urea, SSP and MOP. Before transplanting, half of the nitrogen (15 g/m²) and full dose of potassium and phosphorus (20 g/m²) were mixed into the soil. The remaining half of the nitrogen (15 g/m²) was top-dressed 30 days after transplanting. Observations were recorded on growth, chlorophyll content and flowering parameters. The data obtained from the experiment were subjected to analysis of variance (ANOVA), and the significance of differences among the varieties was assessed using the critical difference (CD) at the 5 per cent level of significance.

3. Results and discussion

3.1 Vegetative parameters

The Calendula genotypes differed significantly in plant height at different stages of crop growth (Figure 2) (Table 1). Among the evaluated genotypes, Fiesta *Gitana* Orange (*G*₇) recorded the maximum plant height (34.58 cm), whereas the Local genotype (*G*₁₀) recorded the minimum plant height (17.87 cm) at the final stage (60 DAT) of observation. The superior plant height of Fiesta *Gitana* Orange may be attributed to its favourable genetic constitution, efficient nutrient

uptake, and enhanced cell division and elongation. Greater plant height may also contribute to increased photosynthetic surface and biomass accumulation. Similar findings were reported by Baciú *et al.* (2013) [5] in calendula, Beeralingappa (2016) [6] in chrysanthemum, Hegde *et al.* (2022) in dahlia and Swathi *et al.* (2023) [7] in China aster, who also observed significant differences in plant height among different genotypes.

Considerable genotypic variation was observed in plant spread in both East–West (Figure 2) and North–South directions at 60 DAT (Table 1). Touch of Red Yellow (*G*₄) recorded the maximum plant spread in both East–West (30.15 cm) and North–South (29.76 cm) directions, while Touch of Red Buff (*G*₆) recorded the minimum spread (18.40 cm in North–South direction and 18.80 cm in East–West direction)). The wider plant spread in Touch of Red

Yellow may be attributed to its vigorous branching habit, greater internodal development and efficient utilization of nutrients, reflecting its favourable genetic constitution and lateral canopy expansion. Similar findings were reported by Kumar *et al.* (2018) [8] and Kharjana *et al.* (2022) [9] in zinnia, Beeralingappa (2016) [6] in chrysanthemum, Swathi *et al.* (2023) [7] in China aster and Hegde *et al.* (2022) in dahlia.

Internodal length also varied significantly among the Calendula genotypes at 60 DAT (Table 1). The maximum internodal length was recorded in Fiesta *Gitana* Orange (*G*₇) (3.58 cm), whereas the minimum internodal length was observed in Touch of Red Buff (*G*₆) (1.85 cm). The longer internodes in Fiesta *Gitana* Orange may be attributed to its favourable genetic constitution, enhanced cell elongation and vigorous vegetative growth. Longer internodes contribute to better plant architecture and light penetration within the canopy, while shorter internodes favour compact growth suitable for pot culture. Similar observations were reported by Beeralingappa (2016) [6] in chrysanthemum and Swathi *et al.* (2023) [7] in China aster.

The evaluated genotypes exhibited significant variation in the number of branches and leaves per plant (Figure 3) and leaves per plant (Figure 2) at 60 DAT (Table 1). Fiesta *Gitana* Orange (*G*₇) recorded the maximum number of branches (28.33) and leaves (72.40), whereas the Local genotype (*G*₁₀) recorded the minimum number of branches (15.27) and leaves (50.53). This variation may be attributed to differences in genetic constitution, vegetative vigour and nutrient-use efficiency. The superior performance of Fiesta *Gitana* Orange may have promoted greater lateral shoot development and foliage production, increased the photosynthetic area and supported plant growth. Similar findings were reported by Baciú *et al.* (2013) [5] in calendula, Kumar *et al.* (2018) [8] in zinnia, Beeralingappa (2016) [6] and Guddaraddi *et al.* (2021) [10] in chrysanthemum, and Swathi *et al.* (2023) [7] in China aster.

Significant differences were observed among the Calendula genotypes for leaf length (Figure 3) and width at 60 DAT (Table 1). Fiesta *Gitana* Creamy White (*G*₉) recorded the maximum leaf length (19.19 cm), while Touch of Red Orange (*G*₅) recorded the maximum leaf width (4.84 cm). The minimum values were recorded in Local (*G*₁₀) for leaf length (12.75 cm) and Touch of Red Buff (*G*₆) for leaf width (3.41 cm). The variation in leaf dimensions may be attributed to differences in genetic constitution, cell expansion, nutrient utilization and accumulation of photosynthates. Larger leaves provide greater photosynthetic surface area, enhancing light interception and assimilate production, thereby supporting vigorous vegetative growth and flowering. Similar findings were reported by Anand *et al.* (2013) [11] in gerbera, Guddaraddi *et al.* (2021) [10] in chrysanthemum, Swathi *et al.* (2023) [7] in China aster and Hegde *et al.* (2022) in dahlia.

Substantial variation was evident among the Calendula genotypes for leaf area (Figure 1.3) and leaf area index (LAI) at 60 DAT (Table 1). Bon Bon Yellow (*G*₂) recorded the maximum leaf area (27.87 cm²), whereas Fiesta *Gitana* Creamy White (*G*₉) recorded the highest LAI (1.92). The minimum values for both traits were recorded in Touch of Red Buff (*G*₆), with 11.86 cm² leaf area and 0.75 LAI. The variation in leaf area and LAI may be attributed to differences in genetic makeup, leaf expansion and canopy development. Higher leaf area

and LAI enhance light interception and photosynthetic activity, resulting in greater assimilate production and dry matter accumulation, thereby promoting vigorous vegetative growth and flowering. Similar findings were reported by Hegde *et al.* (2022) in dahlia, Anand *et al.*

(2013) [11] in gerbera, Guddaraddi *et al.* (2021) [10] and Beeralingappa (2016) [6] in chrysanthemum, and Swathi *et al.* (2023) [7] in China aster.

Table 1. Performance of Calendula (*Calendula officinalis* L.) genotypes for Growth parameters

Genotypes		Plant height (cm)	Plant spread (cm)		Internodal length (cm)	Number of branches per plant	Number of leaves per plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm ²)	Leaf area index
			E-W	N-S							
G1	Bon Bon Apricot	18.21	26.73	26.21	2.12	21.33	59.60	14.47	3.82	15.29	1.01
G2	Bon Bon yellow	21.67	27.86	27.38	2.51	22.33	59.67	17.45	4.21	27.87	1.85
G3	Bon Bon Orange	20.58	29.25	28.59	2.13	22.80	61.00	13.87	4.11	12.83	0.87
G4	Touch of Red yellow	29.46	30.15	29.76	3.12	27.33	64.20	17.01	4.61	23.55	1.68
G5	Touch of Red Orange	28.29	29.25	29.25	3.03	26.60	65.87	16.94	4.84	25.79	1.89
G6	Touch of Red buff	19.37	18.80	18.40	1.85	19.13	56.67	16.59	3.41	11.86	0.75
G7	Fiesta Gitana Orange	34.58	25.31	24.97	3.58	28.33	72.40	17.01	4.37	18.24	1.47
G8	Fiesta Gitana yellow	24.90	27.15	26.81	2.47	18.00	70.67	18.61	4.05	20.25	1.59
G9	Fiesta Gitana Creamy White	29.58	24.92	24.58	2.61	17.20	68.20	19.19	3.63	25.41	1.92
G10	Local	17.87	26.05	25.69	2.09	15.27	50.53	12.75	3.79	21.37	1.20
S. Em ±		0.86	0.90	0.83	0.13	0.69	2.52	0.71	0.13	0.64	0.06
CD @ 5%		2.55	2.66	2.46	0.39	2.06	7.49	2.12	0.39	1.89	0.16

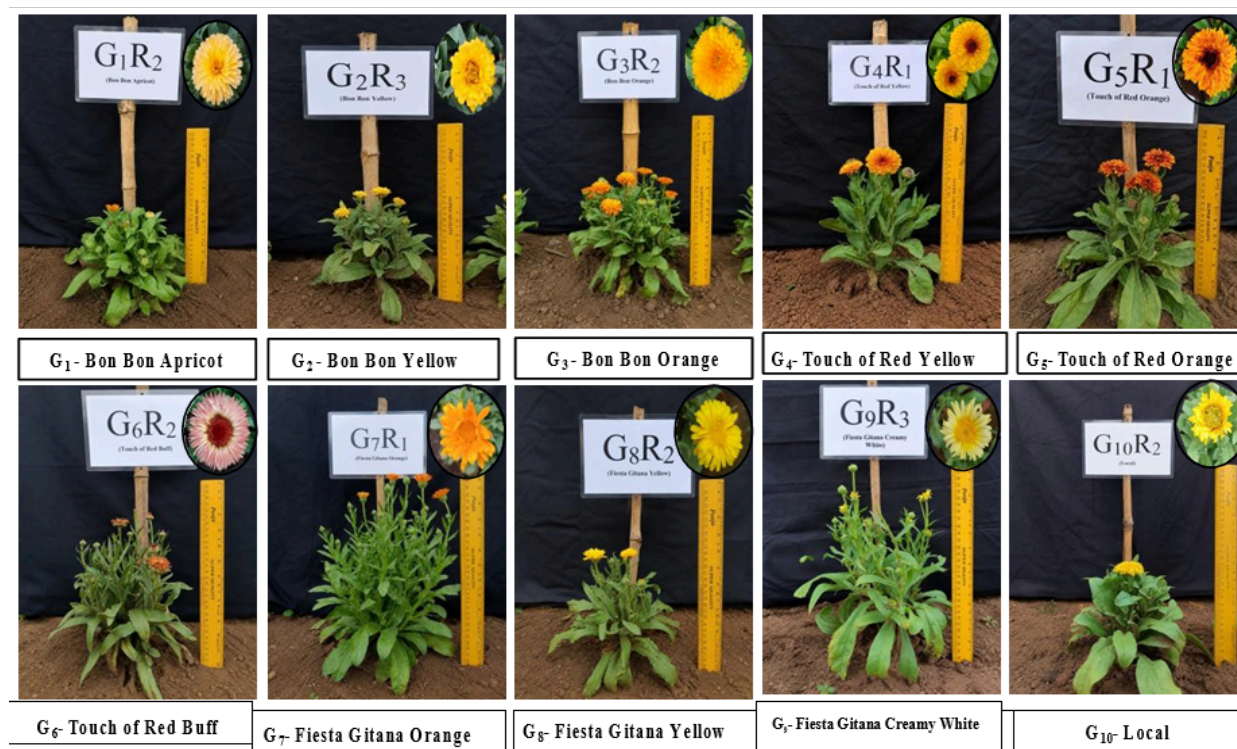


Figure 1. Field view of the representative plant of Calendula (*Calendula officinalis* L.) genotypes

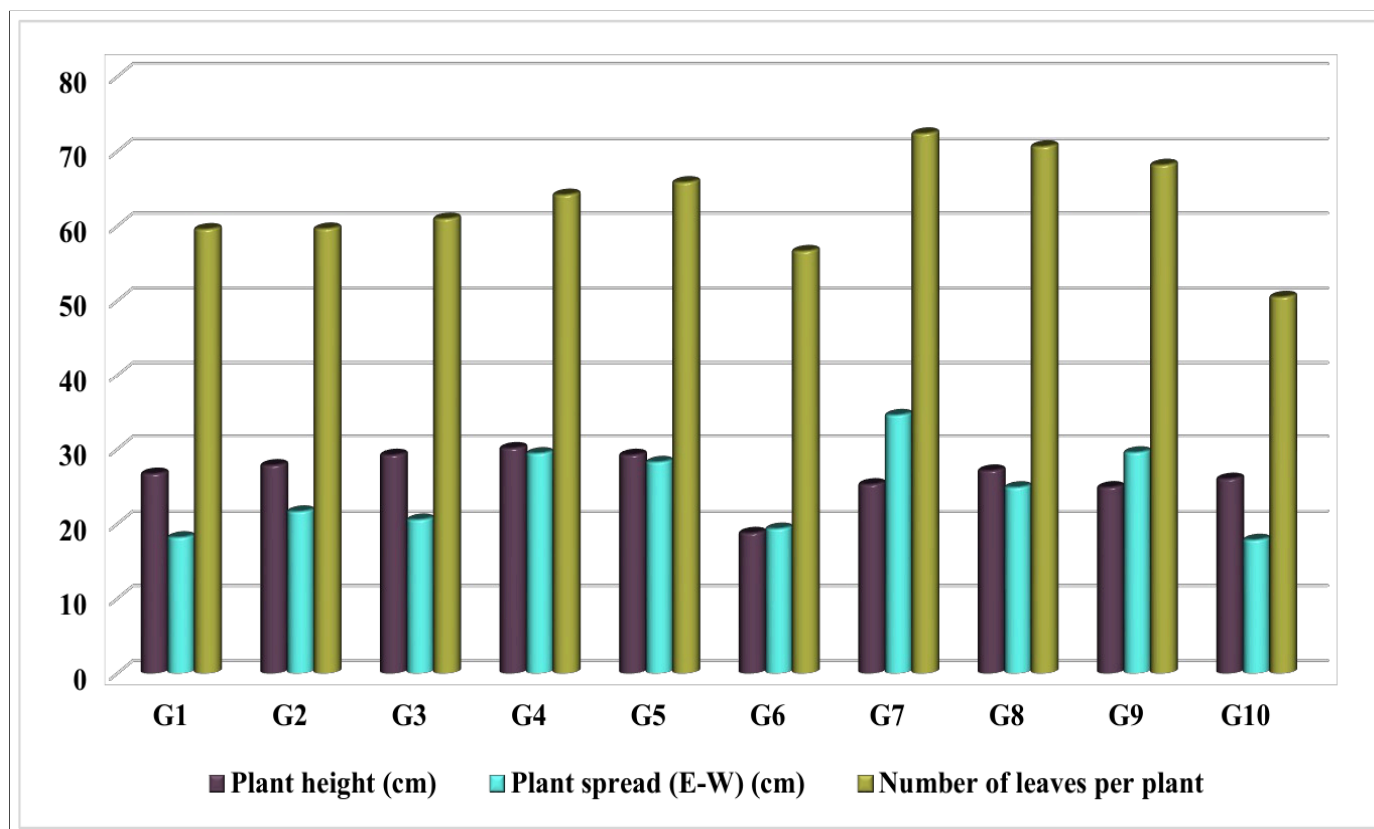


Figure 2. Performance of Calendula (*Calendula officinalis* L.) genotypes for plant height, plant spread (E-W) and Number of leaves at 60 days after transplanting.

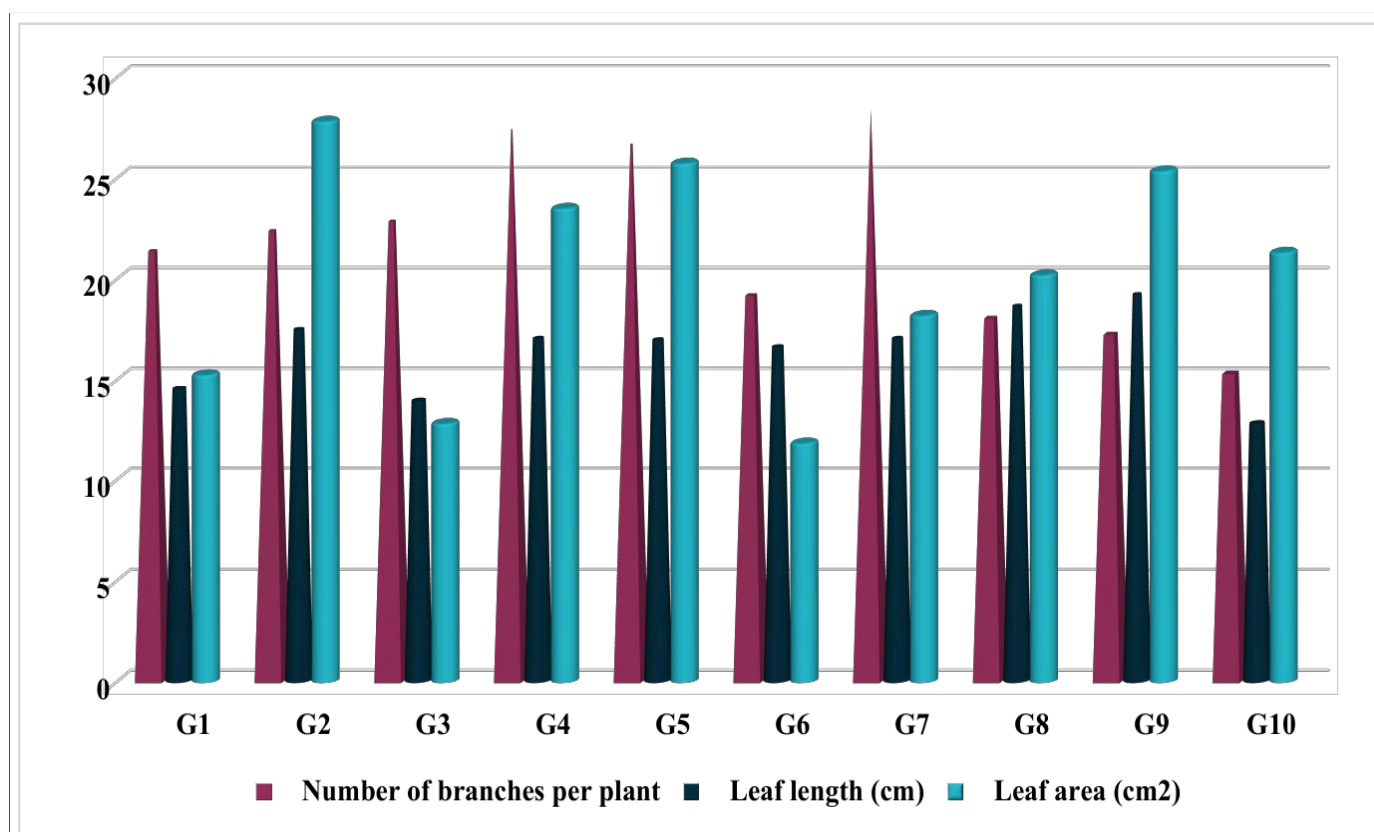


Figure 3. Performance of Calendula (*Calendula officinalis* L.) genotypes for number of branches per plant, leaf length and leaf area at 60 days after transplanting.

3.2 Chlorophyll analysis (mg g^{-1} fresh weight)

Significant variation was observed among the *Calendula officinalis* genotypes for chlorophyll content (Table 2). Fiesta Gitana Orange recorded the maximum chlorophyll a (1.94 mg g^{-1} fresh weight), chlorophyll b (0.69 mg g^{-1} fresh weight) and total chlorophyll content

(2.63 mg g^{-1} fresh weight), which were statistically on par with Touch of Red Orange (1.81 , 0.61 and 2.41 mg g^{-1} fresh weight, respectively). The minimum chlorophyll a, chlorophyll b and total chlorophyll contents were recorded in Bon Bon Yellow (1.19 , 0.42 and 1.61 mg g^{-1} fresh weight, respectively). The variation in chlorophyll

content among the genotypes may be attributed to their genetic makeup, chlorophyll synthesis capacity and physiological efficiency. The present findings are in conformity with the reports of

Beeralingappa (2016) [6] in chrysanthemum, Hallikeri (2018) [12] in China aster, Hegde *et al.* (2022) in dahlia and Chethankumar *et al.* (2024) in zinnia.

Table 2. Performance of Calendula (*Calendula officinalis* L.) genotypes for chlorophyll content

Genotypes		Chlorophyll a (mg/g of fresh weight)	Chlorophyll b (mg/g of fresh weight)	Total chlorophyll content (mg/g of fresh weight)
G1	Bon Bon Apricot	1.25	0.46	1.72
G2	Bon Bon Yellow	1.19	0.42	1.61
G3	Bon Bon Orange	1.34	0.50	1.85
G4	Touch of Red Yellow	1.70	0.58	2.28
G5	Touch of Red Orange	1.81	0.61	2.41
G6	Touch of Red Buff	1.70	0.58	2.28
G7	Fiesta <i>Gitana</i> Orange	1.94	0.69	2.63
G8	Fiesta <i>Gitana</i> Yellow	1.54	0.56	2.11
G9	Fiesta <i>Gitana</i> Creamy White	1.48	0.51	1.99
G10	Local	1.28	0.49	1.77
	S. Em ±	0.14	0.04	0.18
	CD @ 5%	0.41	0.12	0.53

3.3 Flowering parameters

Significant differences were observed among the *Calendula* genotypes for flowering parameters (Table 3) (Figure 4). Bon Bon Orange (G₃) recorded the earliest flower bud initiation (26.33 days), followed by Local (G₁₀) (31.53 days), whereas Bon Bon Apricot (G₁) took the maximum days for bud initiation (43.20 days). Similarly, Bon Bon Orange recorded the earliest first flowering (33.00 days), followed by Local (38.67 days), while Bon Bon Apricot took maximum days (49.93 days). For 50 per cent flowering, Bon Bon Orange was earliest (48.40 days), followed by Local (53.93 days), whereas Bon Bon Apricot took maximum days for 50% flowering (66.13 days). The variation among the genotypes may be attributed to inherent genetic differences, endogenous hormonal balance and differential assimilate partitioning, which influence the transition from vegetative to repro-

ductive growth. Similar findings were reported by Dharmendra *et al.* (2019) [13] in China aster, Roopa *et al.* (2018) in chrysanthemum, Rathava *et al.* (2021) [14] in *Gomphrena globosa*, Kharjana *et al.* (2022) [9] in zinnia and Sharma *et al.* (2024) [15] in chrysanthemum.

The longest flowering duration was recorded in Bon Bon Orange (48.20 days), followed by Touch of Red Yellow (43.40 days), while Fiesta *Gitana* Yellow recorded the shortest duration (28.07 days). The variation in flowering duration among the genotypes may be attributed to differences in genetic makeup, flowering behaviour, assimilate production and environmental adaptability. Similar observations were reported by Roopa *et al.* (2018) in chrysanthemum, Pasha *et al.* (2015) [16] in zinnia, Kharjana *et al.* (2022) [9] in zinnia, Swathi *et al.* (2023) [7] in China aster and Beeralingappa (2016) [6] in chrysanthemum.

Table 3. Performance of Calendula (*Calendula officinalis* L.) genotypes for Flowering parameters.

Genotypes		Days to flower bud initiation	Days taken for first flowering	Days taken for 50% flowering	Duration of flowering(days)
G1	Bon Bon Apricot	43.20	49.93	66.13	28.47
G2	Bon Bon Yellow	39.27	45.80	61.27	32.80
G3	Bon Bon Orange	26.33	33.00	48.40	48.20
G4	Touch of Red Yellow	34.13	40.93	56.73	43.40
G5	Touch of Red Orange	33.40	40.40	55.47	39.87
G6	Touch of Red Buff	39.33	46.47	62.33	31.73
G7	Fiesta <i>Gitana</i> Orange	35.13	41.73	58.33	41.40
G8	Fiesta <i>Gitana</i> Yellow	42.27	49.07	65.20	28.07
G9	Fiesta <i>Gitana</i> Creamy White	37.40	44.27	59.47	34.87
G10	Local	31.53	38.67	53.93	37.07
	S. Em ±	1.34	1.34	2.41	1.88
	CD @ 5%	3.97	3.99	7.16	5.59

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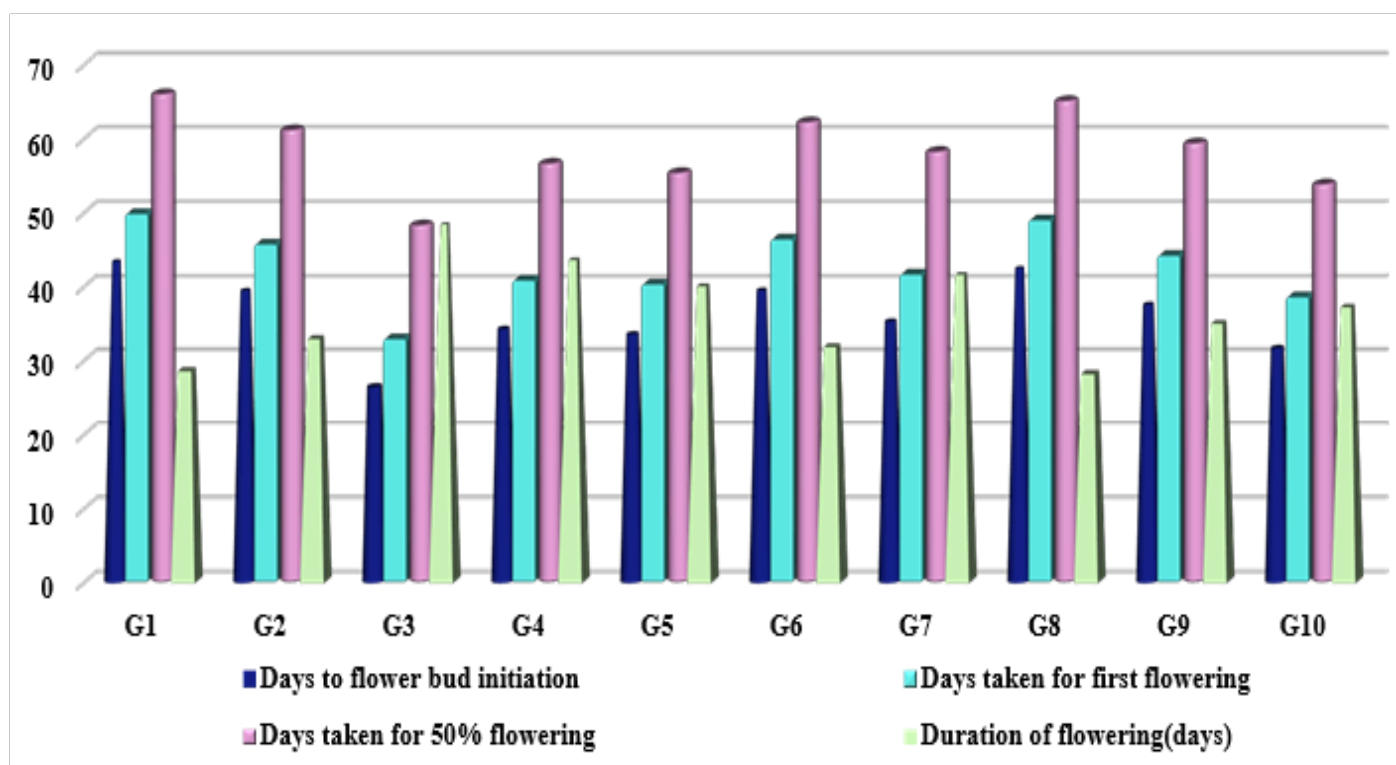


Figure 4. Performance of *Calendula* (*Calendula officinalis* L.) genotypes for flowering parameters

4. Conclusion

The results of the experiment clearly revealed significant variation among the *Calendula officinalis* genotypes for vegetative growth, photosynthetic pigments and flowering parameters. Among the evaluated genotypes, Fiesta Gitana Orange (G₇) exhibited superior vegetative growth, recording maximum plant height, internodal length, number of branches and leaves per plant, along with the highest chlorophyll a, chlorophyll b and total chlorophyll content. Touch of Red Yellow (G₄) recorded the maximum plant spread in both East–West and

North–South directions, indicating its vigorous and wider canopy development, while Bon Bon Yellow (G₂) recorded the highest leaf area. Fiesta Gitana Creamy White (G₉) recorded the highest leaf area index and maximum leaf length, whereas Touch of Red Orange (G₅) recorded the maximum leaf width. With regard to flowering, Bon Bon Orange (G₃) was found to be superior for earliness, recording the earliest flower bud initiation, first flowering and 50 per cent flowering, besides exhibiting the longest flowering duration. Hence, Fiesta Gitana Orange, Touch of Red Yellow, Bon Bon Yellow, Fiesta Gitana Creamy White, Touch of Red Orange and Bon Bon Orange were identified as promising genotypes for their respective desirable traits and may be utilized in further breeding programmes and for commercial cultivation, landscaping and production of quality *Calendula* flowers.

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