



ISSN Print: 2618-060X
 ISSN Online: 2618-0618
 NAAS Rating (2026): 5.20
 IJRA 2026; 9(9): 1277-1282
www.agronomyjournals.com
 Received: 23-06-2026
 Accepted: 05-08-2026
 Published: 28-09-2026

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Assessment of *Zinnia* (*Zinnia elegans* L.) genotypes for growth and flowering attributes

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i9q.6688>

ABSTRACT

The present investigation entitled “Assessment of *Zinnia* (*Zinnia elegans* L.) Genotypes for Growth and Flowering Attributes” was conducted during 2025–26 at the Department of Floriculture and Landscape Architecture, Iruvakk, under Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India, to evaluate the performance of fourteen zinnia genotypes for growth and flowering attributes. The experiment comprising fourteen genotypes was laid out in a Randomized Complete Block Design (RCBD) with three replications. Significant differences were observed among the genotypes for all the characters studied, indicating the presence of considerable genetic variability. Among the growth parameters, *Zinnia* Purple recorded the maximum plant height (43.42 cm at 60 DAT). *Zinnia* Double Zahara Fire recorded the maximum number of leaves per plant (68.22) and primary branches per plant (10.63), indicating superior vegetative growth. *Zinnia* Zesty Purple recorded the maximum leaf length (7.87 cm), while *Zinnia* Zesty Pink recorded the maximum leaf width (4.52 cm), leaf area (1006.23 cm² plant⁻¹) and leaf area index (1.11). *Zinnia* Double Zahara Yellow recorded the maximum plant spread in both east-west (33.20 cm) and north-south (32.84 cm) directions. *Zinnia* Purple recorded the maximum internodal length (7.80 cm), whereas *Zinnia* Zesty Yellow recorded the maximum stem girth (9.68 mm). Among flowering parameters, *Zinnia* Double Zahara Raspberry Ripple recorded the earliest flower bud initiation (11.24 days) and 50 per cent flowering (24.21 days). *Zinnia* Double Zahara Cherry recorded the minimum days for flower opening (5.17 days), while *Zinnia* Double Zahara Yellow recorded the longest flowering duration (67.81 days). Based on the overall performance, *Zinnia* Double Zahara Fire and *Zinnia* Double Zahara Yellow were identified as the most promising genotypes for commercial cultivation owing to their superior performance in growth and flowering performance.

Keywords: *Zinnia*., Performance, Genotypes, Flowering and growth

Introduction

Zinnia (*Zinnia elegans* L.), a popular annual ornamental belonging to the family Asteraceae, is native to Mexico and Central America (Riaz *et al.*, 2014). It is one of the most attractive flowering annuals cultivated worldwide because of its profuse flowering, wide range of flower colours, diverse flower forms and ease of cultivation. The genus was named in honour of the German botanist Johann Gottfried Zinn and comprises about 20–30 species, among which *Zinnia elegans* is the most widely cultivated owing to its adaptability to diverse agro-climatic conditions and superior ornamental value.

The global floriculture industry has expanded rapidly in recent years due to increasing demand for ornamental plants in landscaping, gardening, urban beautification and the cut flower industry. In India, favourable climatic conditions and rich biodiversity have facilitated the commercial cultivation of several ornamental crops, including zinnia. Owing to its attractive blooms, continuous flowering habit and adaptability, zinnia has become an important ornamental crop for flower beds, borders, containers, landscaping and cut flower production (Kumar and Marwein, 2018). The crop also attracts butterflies and other pollinators, thereby enhancing the ecological value of gardens and landscapes. White-flowered zinnia has additionally been reported to possess medicinal importance in the treatment of kidney ailments and body aches.

Zinnia is an herbaceous, seed-propagated annual that performs well under full sunlight in fertile, well-drained soils. The crop is characterized by rapid growth, abundant flowering and tolerance to high summer temperatures, making it suitable for cultivation under tropical and subtropical conditions (Chethankumar *et al.*, 2024). Flowers are available in a wide spectrum of colours, including white, yellow, orange, pink, red, purple and multicoloured shades, with single, semi-double and double flower forms resembling daisies or dahlias (Malakar *et al.*, 2025). Owing to its long flowering period, attractive appearance and good vase life, zinnia is widely preferred for both commercial cultivation and ornamental landscaping.

The availability of numerous zinnia genotypes exhibiting considerable variation in vegetative growth, flowering behaviour, flower quality and yield attributes provides excellent opportunities for genetic improvement. However, the performance of these genotypes varies with environmental conditions, and cultivars

adapted to local agro-climatic regions often produce superior flower quality and yield while exhibiting better tolerance to pests, diseases and abiotic stresses (Kumar and Marwein, 2018). Therefore, systematic evaluation of available genotypes is essential for identifying superior cultivars suitable for commercial cultivation as well as for use in breeding programmes.

Genetic variability forms the basis of effective crop improvement and selection. Evaluation of diverse genotypes helps identify desirable parents possessing superior growth, flowering, quality and yield traits, thereby facilitating the development of improved cultivars. Characterization of zinnia germplasm under specific agro-climatic conditions is therefore necessary for recommending suitable genotypes for cultivation and future breeding programmes.

Considering the commercial importance of zinnia and the need to identify superior cultivars under local conditions, the present investigation entitled “Assessment of *Zinnia* Genotypes for Growth and Flowering Attributes” was undertaken with the objectives of evaluating different zinnia genotypes for their growth and flowering performance and identifying promising genotypes suitable for commercial cultivation.

2. Materials and methods

The present investigation entitled “Assessment of *Zinnia* (*Zinnia elegans* L.) Genotypes for Growth and Flowering Attributes” was conducted during the rabi season of 2025–2026 at the Department of Floriculture and Landscaping, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences (KSNUAHS), Iruvaki, Shivamogga, Karnataka, India. The experimental site is located in the Hilly Zone (Zone-9) of Karnataka at 14°25' N latitude, 75°11'59.23" E longitude and an altitude of 650 m above mean sea level.

The experiment was laid out in a Randomized Complete Block Design (RCBD) with 14 zinnia genotypes and three replications. Healthy seeds procured from Indo-American Hybrid Seeds Pvt. Ltd., Bengaluru, Dhandeep Seed Company, Pune, and a Bagalkot local collection were sown separately in pro trays containing cocopeat. Thirty-day-old healthy seedlings were transplanted to the open field at a spacing of 30 × 30 cm in beds measuring 1.8 × 1.8 m, accommodating 36 plants per treatment. Recommended cultural practices, including nutrient management, irrigation, weeding, earthing-up, pinching and plant protection measures, were followed throughout the crop growth period.

Observations were recorded from five randomly selected plants in each treatment for vegetative and flowering parameters. Growth parameters such as plant height, stem girth, internodal length, number of leaves, number of primary branches, leaf length, leaf width, leaf area, leaf area index and plant spread (East–West and North–South) were recorded at 30, 45 and 60 days after transplanting (DAT). Flowering parameters included days to flower bud initiation, days to flower opening, days to 50 per cent flowering and duration of flowering.

3. Results and discussion

The findings of the present investigation were interpreted and are presented in Tables 1 and 2 based on the observations recorded during the study.

3.1 Vegetative parameters

The analysis of variance revealed significant differences among the fourteen *Zinnia* genotypes for all vegetative parameters, indicating the existence of substantial genetic variability.

3.1.1 Plant height

The genotype *Zinnia* Purple recorded the maximum plant height of 43.42 cm, followed by *Zinnia* Zesty Orange (43.12 cm) and *Zinnia* Zesty Scarlet (37.12 cm), while the minimum plant height was observed in *Zinnia* Double Zahara Fire (32.14 cm). These differences in plant height could be attributed to genetic factors and genotype-specific traits, which interact with environmental conditions such as light, temperature and nutrient availability to influence plant growth.

Similar variations in plant height were reported by Pasha *et al.* (2015) in zinnia, Kumar and Marwein (2018) in marigold and Kharjana and Fatmi (2022) in zinnia. (Fig. 1)

3.1.2 Number of leaves per plant

The genotype *Zinnia* Double Zahara Fire recorded the maximum number of leaves per plant (56.30), followed by *Zinnia* Double Zahara Yellow (41.62), *Zinnia* Bagalkot Local Mix (41.28) and *Zinnia* Double Zahara Raspberry Ripple (41.14), while the minimum number of leaves per plant was observed in *Zinnia* Zesty White (31.53). These differences in the number of leaves per plant could be attributed to genetic factors and genotype-specific traits, which interact with environmental conditions to influence vegetative growth. Similar variations in the number of leaves per plant were reported by Malakar *et al.* (2025) in chrysanthemum, Kharjana and Fatmi (2022) in zinnia and Kumar and Marwein (2018) in marigold. (Fig. 1)

3.1.3 Number of primary branches per plant

The genotype *Zinnia* Double Zahara Fire recorded the maximum number of primary branches per plant (10.63), followed by *Zinnia* Zesty Pink (9.84), *Zinnia* Double Zahara Cherry (8.49) and *Zinnia* Zesty Fuchsia (8.18), while the minimum number of primary branches per plant was observed in *Zinnia* Zesty White (7.07). These differences in the number of primary branches per plant could be attributed to genetic factors and genotype-specific traits, which interact with environmental conditions to influence vegetative growth. Similar variations in the number of primary branches per plant were reported by Malakar *et al.* (2025) in chrysanthemum, Kharjana and Fatmi (2022) in zinnia and Kumar and Marwein (2018) in marigold. (Fig. 1)

3.1.4 Internodal length (cm)

The genotype *Zinnia* Purple recorded the maximum internodal length (7.80 cm), followed by *Zinnia* Zesty Yellow (5.20 cm), while the minimum internodal length was observed in *Zinnia* Double Zahara Cherry (3.85 cm). These differences in internodal length could be attributed to genetic factors and genotype-specific traits, which interact with environmental conditions to influence stem elongation and plant growth. Similar variations in internodal length were reported by Riaz *et al.* (2013) in zinnia, Bose *et al.* (2017) in marigold and Malakar *et al.* (2025) in chrysanthemum. (Fig. 1)

3.1.5 Leaf area (cm²/plant)

The genotype *Zinnia* Zesty Pink recorded the maximum leaf area (1006.23 cm²/plant), followed by *Zinnia* Purple (906.20 cm²/plant) and *Zinnia* Zesty Purple (905.27 cm²/plant), while the minimum leaf area was observed in *Zinnia* Double Zahara Cherry (369.63 cm²/plant). These differences in leaf area could be attributed to genetic factors and genotype-specific traits, which interact with environmental conditions to influence leaf expansion and photosynthetic efficiency. Similar variations in leaf area were reported by Sajid *et al.* (2016) in *Chrysanthemum*, Kharjana and Fatmi (2022) in zinnia and Malakar *et al.* (2025) in chrysanthemum.

3.1.6 Leaf area index (LAI)

The genotype *Zinnia* Zesty Pink recorded the maximum leaf area index (1.11), followed by *Zinnia* Zesty Purple (1.00), *Zinnia* Purple (1.00) and *Zinnia* Double Zahara Fire (0.93), while the minimum leaf area index was observed in *Zinnia* Double Zahara Cherry (0.41). These differences in leaf area index could be attributed to genetic factors and genotype-specific traits, which interact with environmental conditions to influence canopy development and light interception. Similar variations in leaf area index were reported by Malakar *et al.* (2025) in chrysanthemum and Kharjana and Fatmi (2022) in zinnia.

3.1.7 Stem girth (mm)

The genotype *Zinnia* Zesty Yellow recorded the maximum stem girth (9.68 mm), followed by *Zinnia* Zesty Scarlet (8.77 mm), *Zinnia* Purple (8.70 mm) and *Zinnia* Zesty Fuchsia (8.56 mm), while the minimum stem girth was observed in *Zinnia* Double Zahara Cherry (5.53 mm). These differences in stem girth could be attributed to

netic factors and genotype-specific traits, which interact with environmental conditions to influence stem development and plant vigour. Similar variations in stem girth were reported by Rathore *et al.* (2018) in marigold, Malakar *et al.* (2025) in chrysanthemum and Kharjana and Fatmi (2022) in zinnia. (Fig. 2)

3.1.8 Plant spread in N-S and E-W direction (cm)

The genotype *Zinnia* Double Zahara Yellow recorded the maximum plant spread in both the East–West (33.20 cm) and North–South (32.84 cm) directions, followed by *Zinnia* Double Zahara Fire (32.96 cm and 32.62 cm, respectively). The minimum plant spread was recorded in *Zinnia* Zesty Fuchsia (24.39 cm) in the East–West direction and *Zinnia* Zesty White (24.13 cm) in the North–South direction. These variations may be attributed to genetic differences and their interaction with environmental conditions affecting canopy development and plant architecture. Similar findings were reported by Riaz *et al.* (2013), Kharjana and Fatmi (2022) in zinnia and Malakar *et al.* (2025) in chrysanthemum. (Fig. 2)

2. Flowering parameters

The analysis of variance revealed significant differences among the fourteen *Zinnia* genotypes for all flowering parameters, indicating the existence of substantial genetic variability. (Fig. 3)

3.2.1 Days taken for flower bud initiation

The genotype *Zinnia* Double Zahara Raspberry Ripple recorded the minimum number of days taken for flower bud initiation (11.24 days), followed by *Zinnia* Double Zahara Cherry (12.16 days) and *Zinnia* Bagalkot Local Mix (12.93 days), while the maximum number of days was recorded in *Zinnia* Zesty Yellow (21.29 days). These differences in flower bud initiation could be attributed to genetic factors and genotype-specific traits, which interact with environmental conditions to influence flowering behaviour. Similar variations in flower bud initiation were reported by Malakar *et al.* (2025) in chrysanthemum, Kharjana and Fatmi (2022) in zinnia and Naik *et al.* (2019) in marigold.

3.2.2 Days taken for first flower opening

The genotype *Zinnia* Double Zahara Cherry recorded the minimum number of days taken for flower opening (5.17 days), followed by *Zinnia* Double Zahara Orange Bright (5.69 days) and *Zinnia* Double Zahara Raspberry Ripple (6.21 days), while the maximum number of days was recorded in *Zinnia* Zesty Pink (11.24 days). These differences in flower opening could be attributed to genetic factors and genotype-specific traits, which interact with environmental conditions to influence flowering. Similar variations in days taken for flower opening were reported by Singh *et al.* (2021) in marigold, Malakar *et al.* (2025) in chrysanthemum and Kharjana and Fatmi (2022) in zinnia.

3.2.3 Days taken for 50 per cent flowering

The genotype *Zinnia* Double Zahara Raspberry Ripple recorded the minimum number of days taken for 50 per cent flowering (24.21 days), followed by *Zinnia* Zesty Pink (24.75 days) and *Zinnia* Zesty Purple (25.61 days), while the maximum number of days was recorded in *Zinnia* Double Zahara Fire (40.63 days). These differences in days taken for 50 per cent flowering could be attributed to genetic factors and genotype-specific traits, which interact with environmental conditions to influence flowering behaviour. Similar variations in days taken for 50 per cent flowering were reported by Bose *et al.* (2017) in marigold, Kharjana and Fatmi (2022) in zinnia and Malakar *et al.* (2025) in chrysanthemum.

3.2.4 Flower duration (days)

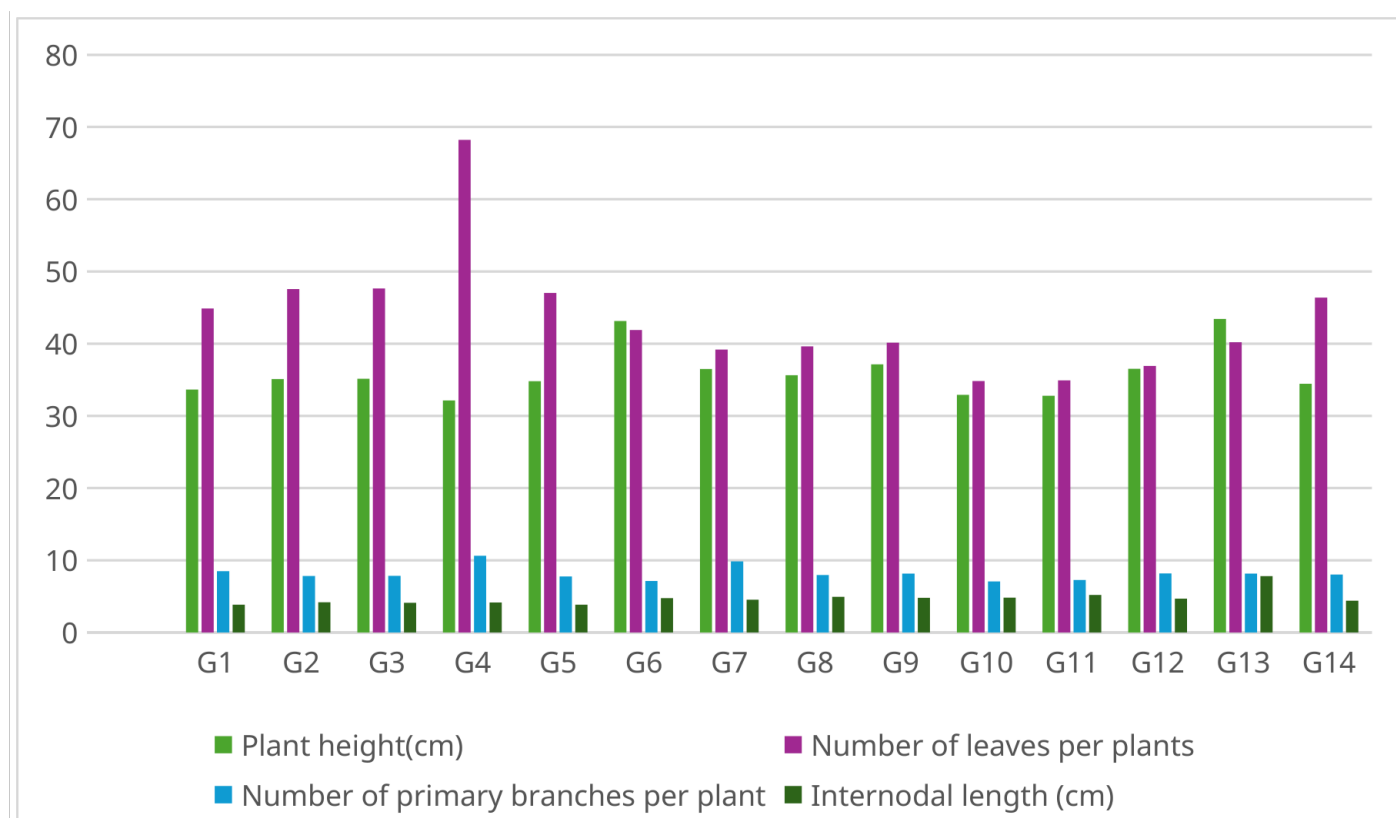
The genotype *Zinnia* Double Zahara Yellow recorded the maximum flower duration (67.81 days), followed by *Zinnia* Double Zahara Orange Bright (65.34 days) and *Zinnia* Double Zahara Cherry (64.69 days), while the minimum flower duration was observed in *Zinnia* Zesty Fuchsia (44.32 days). These differences in flower duration could be attributed to genetic factors and genotype-specific traits, which interact with environmental conditions to influence flowering and flower longevity. Similar variations in flower duration were reported by Riaz *et al.* (2013) in zinnia, Malakar *et al.* (2025) in chrysanthemum and Kumar *et al.* (2019) in marigold.

Table 1. Performance of *Zinnia* genotypes for vegetative parameters under Hill Zone of Karnataka

Genotype	Plant height	Number of leaves per plants	Number of primary branches per plant	Internodal length (cm)	Leaf area (cm ² /plant)	Leaf area index (LAI)	Stem girth (mm)	Plant spread (N-S) (cm)	Plant spread (E-W) (cm)
G ₁	33.64	44.86	8.49	3.85	369.63	0.41	5.53	25.45	25.72
G ₂	35.08	47.55	7.83	4.17	426.92	0.47	6.93	26.53	26.82
G ₃	35.12	47.64	7.85	4.13	409.17	0.45	6.80	32.84	33.20
G ₄	32.14	68.22	10.63	4.15	841.15	0.93	6.48	32.62	32.96
G ₅	34.80	47.03	7.77	3.85	404.19	0.44	6.26	26.32	26.61
G ₆	43.12	41.89	7.13	4.75	760.18	0.84	7.39	27.62	24.57
G ₇	36.49	39.17	9.84	4.52	1006.23	1.11	7.94	26.57	26.85
G ₈	35.62	39.61	7.97	4.93	905.27	1.00	7.40	26.94	27.23
G ₉	37.12	40.12	8.16	4.80	721.89	0.80	8.77	27.57	27.87
G ₁₀	32.91	34.81	7.07	4.83	642.18	0.71	8.39	24.31	27.92
G ₁₁	32.77	34.90	7.28	5.20	642.74	0.71	9.68	24.79	25.06
G ₁₂	36.51	36.90	8.18	4.70	666.96	0.74	8.56	24.13	24.39
G ₁₃	43.42	40.20	8.17	7.80	906.20	1.00	8.70	27.60	27.90
G ₁₄	34.44	46.36	8.02	4.40	432.43	0.48	6.76	26.05	26.33
Mean	35.94	43.52	8.17	4.72	652.51	0.72	7.06	27.10	27.39
S. Em ±	2.27	3.46	0.52	0.22	44.98	0.05	0.48	1.75	1.77
CD @ 5%	6.61	10.06	1.50	0.65	130.74	0.14	1.40	5.10	5.15

Table 2. Performance of *Zinnia* genotypes for vegetative parameters under Hill Zone of Karnataka

Genotype	Days taken for flower bud initiation (days)	Days taken for first flower opening (days)	Days taken for 50 per cent flowering (days)	Flower duration (days)
G ₁	12.16	5.17	37.47	64.69
G ₂	14.81	5.69	31.68	65.34
G ₃	13.46	6.38	31.29	67.81
G ₄	13.05	6.42	40.63	61.31
G ₅	11.24	6.21	24.21	60.78
G ₆	14.01	7.19	37.60	55.74
G ₇	17.65	11.24	24.75	52.89
G ₈	16.62	7.58	25.61	53.08
G ₉	18.32	8.21	27.49	46.76
G ₁₀	19.14	9.17	33.63	49.80
G ₁₁	21.29	10.41	28.54	47.50
G ₁₂	18.93	10.15	29.68	44.32
G ₁₃	14.73	10.17	34.58	45.56
G ₁₄	12.93	7.77	31.82	60.96
Mean	15.60	7.43	31.36	55.47
S. Em ±	0.88	0.46	1.25	2.24
CD @ 5%	2.57	1.35	3.62	6.52

**Figure 1.** The variation in vegetative traits of 14 *Zinnia* genotypes under study

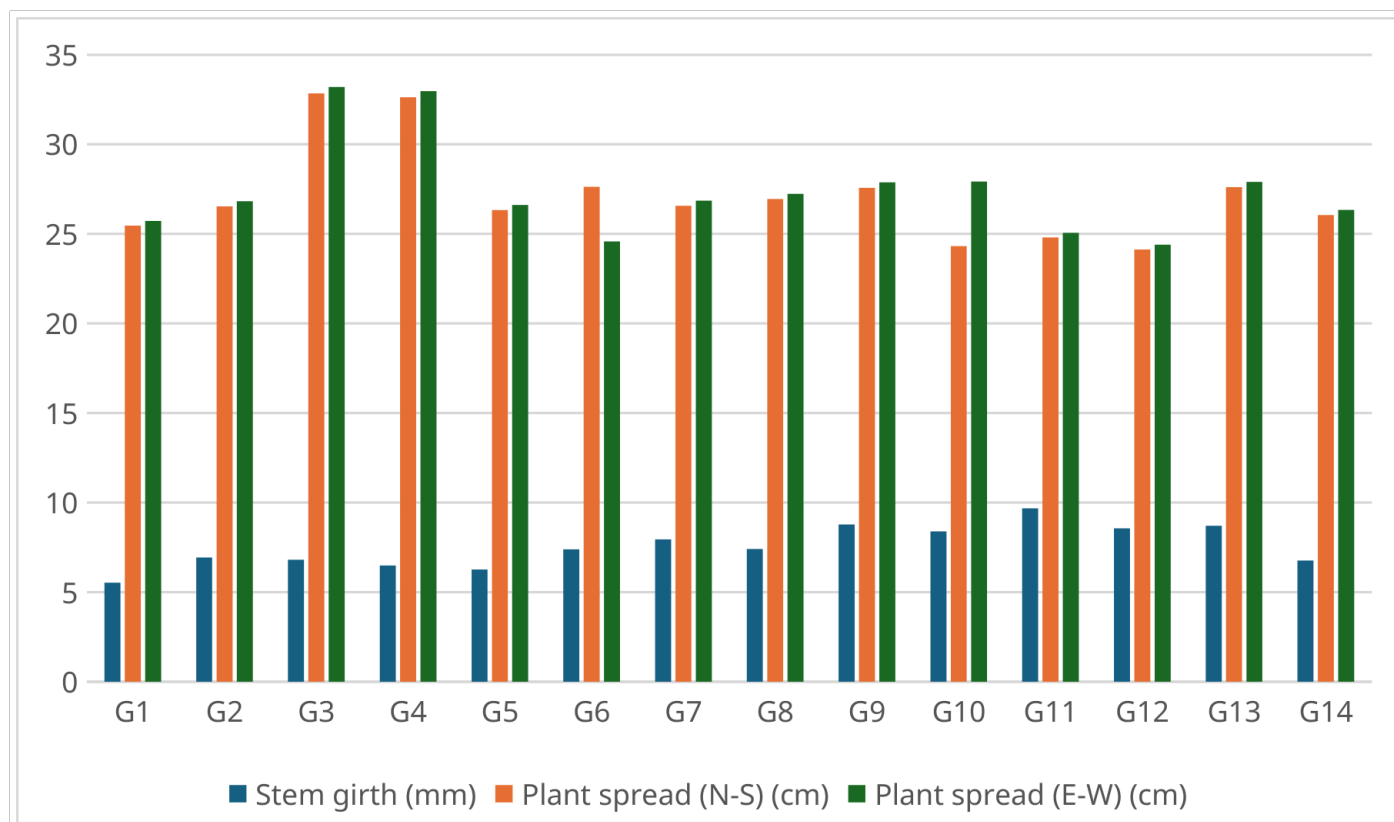


Figure 2. The variation in vegetative traits of 14 *Zinnia* genotypes under study

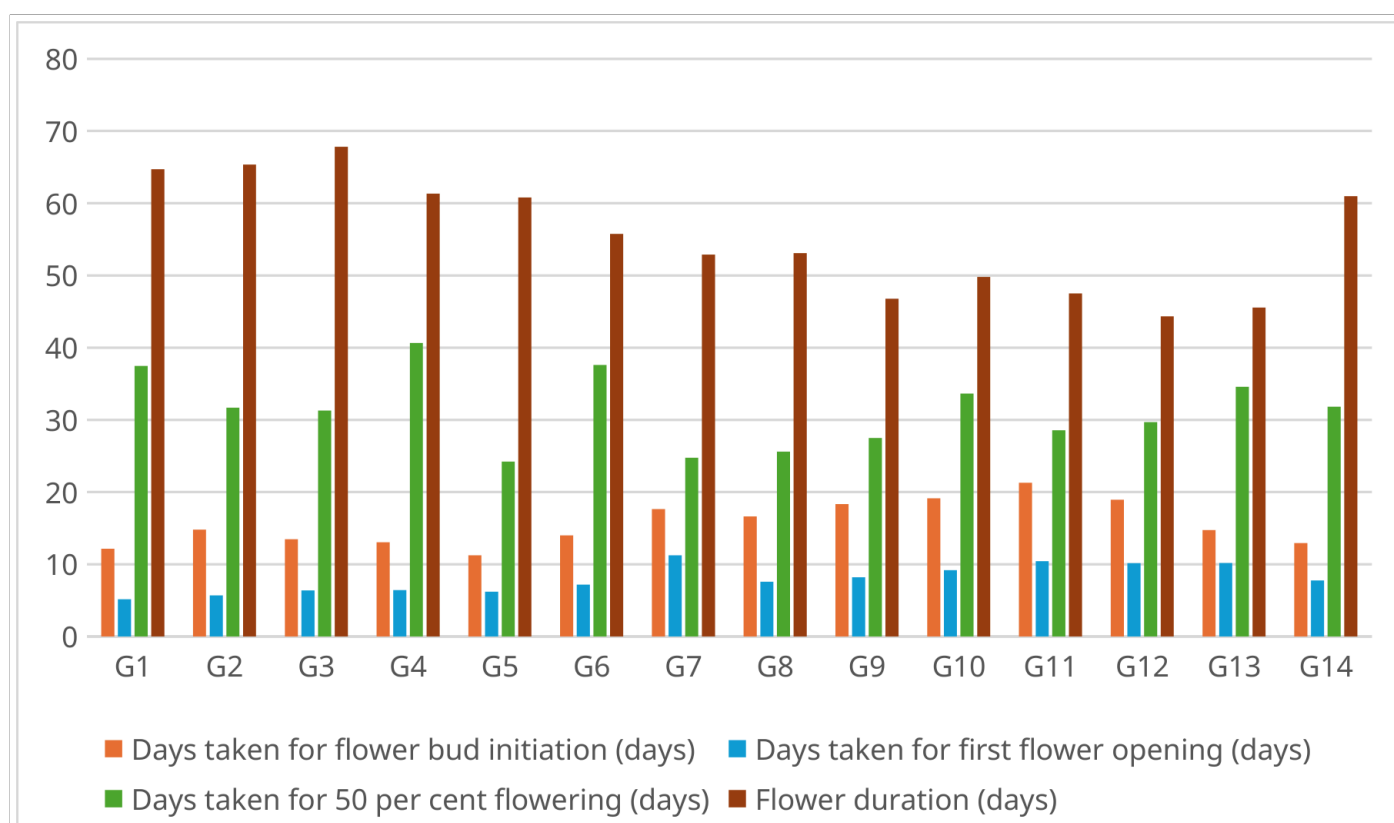


Figure 3. The variation in flowering traits of 14 *Zinnia* genotypes under study

Conclusion

The present investigation revealed significant genetic variability among the fourteen zinnia genotypes for growth and flowering parameters. Among the evaluated genotypes, *Zinnia* Double Zahara Fire exhibited superior vegetative growth, producing the maximum number of leaves and primary branches per plant. *Zinnia* Purple recorded the maximum plant height and internodal length, while *Zinnia* Zesty

Pink recorded the highest leaf area and leaf area index. *Zinnia* Zesty Yellow was superior for stem girth, whereas *Zinnia* Double Zahara Yellow recorded the maximum plant spread in both East–West and North–South directions. *Zinnia* Double Zahara Raspberry Ripple was the earliest flowering genotype, recording the minimum days to flower bud initiation and 50 per cent flowering, while *Zinnia* Double Zahara Cherry recorded the minimum days to first flower opening. *Zinnia* Double Zahara Yellow recorded the longest flower duration,

followed by *Zinnia* Double Zahara Orange Bright and *Zinnia* Double Zahara Cherry. Overall, *Zinnia* Double Zahara Fire and *Zinnia* Double Zahara Yellow were identified as promising genotypes for commercial cultivation owing to their superior performance in growth and flowering characteristics.

Future prospect

The promising genotypes, particularly *Zinnia* Double Zahara Fire, *Zinnia* Double Zahara Yellow, *Zinnia* Zesty Pink, *Zinnia* Purple and *Zinnia* Double Zahara Raspberry Ripple, may be evaluated under different agro-climatic conditions to assess their stability and adaptability. These genotypes can be utilized in hybridization and crop improvement programmes for developing cultivars with improved growth, early flowering, superior flower quality and prolonged flowering duration. Further studies on molecular characterization, nutrient management, plant growth regulators and postharvest performance may be undertaken to exploit their commercial potential and suitability for landscaping and commercial cultivation.

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How to cite this article: Bhoomika R, Srinivasulu G, Latha S, Nandini C, Jayaprakash R. Assessment of *Zinnia* (*Zinnia elegans* L.) genotypes for growth and flowering attributes. *International Journal of Research in Agronomy.* 2026;9(9):1277-1282. doi: <https://www.doi.org/10.33545/2618060X.2026.v9.i9q.6688>