The INTERNATIONAL JOURNAL of APPLIED RESEARCH

In Veterinary Medicine

Varietal Evaluation of African Marigold (*Tagetes erecta* L.): A Comprehensive Review

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ISSN: **1542-2666**
NAAS Rating (2025): **5.00**
https://www.jarvm.co/index.html
jarvm.submit@gmail.com
2025; 20-2(Part-A): **39-49**

Received: 22-09-25
Accepted: 21-10-2025
Published: 29-10-2025

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DOI: 10.5281/zenodo.17480657

ABSTRACT

African marigold (Tagetes erecta L.) is an extensively grown ornamental crop of great economic, cultural, and industrial significance. The study aims to explore the varietal evaluation of African marigold (Tagetes erecta L.). Its large-scale application in floriculture and traditional use has necessitated systematic varietal testing to release better performers for various agro-climatic zones. This report sums up evidence on growth characteristics, branching habit, flowering period, yield potential, quality of blooms, and post-harvest qualities of indigenous and exotic cultivars. Multi-location and season-specific studies provided evidence of remarkable variation, with characteristics like optimal plant height, branch formation, early initiation of buds, and flower yield being prominent markers of variety excellence. Notwithstanding this diversity, there are challenges occasioned by limited region-specific trials, the absence of standardised evaluation protocols, and poor appraisal of multi-trait performance. Based on the review, it is concluded that varietal assessment systems need to be strengthened to inform cultivar recommendations, enhance productivity, and facilitate sustainable marigold cultivation expansion. The African marigold is one of the most useful and economically important floricultural crops owing to its flexibility, cultural significance, and numerous industrial uses. The varietal evaluation evidently proves that there is wide diversity among cultivars and hybrids in terms of plant height, branching, flowering duration, flower size, yield, and post-harvest attributes. Strengthening the evaluation systems by conducting multi-location trials, systematic recording of key characters, and the incorporation of stress tolerance and quality characteristics will yield more reliable advice to farmers and the industry.

Keywords: Agro-climatic zone; flowering period; Tagetes erecta; sustainable marigold cultivation; yield potential.

1. INTRODUCTION

African marigold (*Tagetes erecta*) is a widely cultivated ornamental plant that holds significant commercial value among floricultural crops in the family Asteraceae (Mir *et al*., 2019; Zhang *et al*., 2020). African marigold is widely cultivated as a bedding plant, loose plant, an insect and nematode repellent, and a nutrient supplement for poultry feed (Zigene *et al*., 2023; Lahkar *et al*., 2024). It is an erect, profusely branched annual herb that can attain a height of about 1.4 m (Aslam *et al*., 2016; Srinivas & Rajasekharam, 2020). The plant bears large, showy blooms in shades of yellow to orange (Singh, 2023; Singh *et al*., 2019; Zigene *et al*., 2023). Originating from Central and South America, particularly Mexico (Poornachandragowda *et al*., 2016), African marigold is now cultivated extensively across regions such as Europe, the United States, China, India, the Caribbean, Africa, and Oceania (Davidse *et al*., 2018; Khayum *et al*., 2023). African marigold is commonly used as a bedding plant, loose flower, insect and worm deterrent, and nutrient addition for poultry feed (Patel *et al*., 2025). Its growth thrives best in fertile, well-drained sandy loam soils with good moisture-retention capacity, under sunny conditions, and within a soil pH range of 7.0-7.5 (Davidse *et al*., 2018; Priyadarshini *et al*., 2018).

The genus Tagetes comprises approximately 50 species of annual and perennial herbaceous plants, among which *T. erecta*, commonly known as African marigold and locally referred to as "Genda Phul", is the most widely cultivated due to its ornamental and commercial significance (Patel *et al*., 2025). has a somatic chromosome number of 2n = 24 (Hoshi *et al*., 2019). The plants produce large, globular flower heads and typically grow to approximately 90 cm in height. The inflorescences consist of single or double rows of ray florets, with flower colours ranging from lemon yellow and bright yellow to golden yellow and orange, contributing to its high ornamental value (Mahanta, 2017).

1.1 Scientific Classification of *Tagetes erecta*

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Asterales
Family: Asteraceae
Genus: *Tagetes*
Species: *erecta*

T erecta is most commonly cultivated cut flower that holds cultural significance, which is being extensively used in religious ceremonies, social functions, and for the preparation of garlands (Raihandhany and Kurniawan 2023; Khayum *et al.,* 2025). It is considered the most popular loose flower as well as a potted ornamental plant. Prominent cultivars of *T. erecta* include Giant Double African Orange, Giant Double African Yellow, Cracker Jack, Climax, Dubloon, Golden Age, Chrysanthemum Charm, Crown of Gold, and Spun Gold (Bhatt *et al*., 2016). The crop is indigenous to Central and South America, particularly Mexico, and was introduced to other parts of the world in the early 16th century (Kaplan, 1960; Grissell, 2020; Estrada *et al*., 2025). In India, marigold was brought by the Portuguese, where they quickly gained popularity due to their adaptability to diverse soil and climatic conditions (De, 2017). Presently, the total area under flower cultivation in India is 255.02 lakh ha, with loose flower production estimated at 1754.49 MT (NHB, 2014; Sheikh et al., 2015). A major portion of this area is devoted to traditional flower crops, especially those cultivated under open-field conditions. Nearly 80% of the total cultivated area is occupied by marigolds, tuberose, and jasmine. In Andhra Pradesh, flower crops are grown in an area of about 20,370 ha, primarily by small and marginal farmers in peri-urban areas around major cities. However, 80-90% of the state's flower demand is met through imports from neighbouring regions such as Karnataka. Specifically, marigold occupies around 55,890 ha across India with a production of 515.56 MT, while in Andhra Pradesh it is grown commercially on about 3,290 ha,

yielding 24,640 MT during 2013-14 (NHB database, 2013-14).

Given its adaptability, high aesthetic appeal, and socio-economic significance, *T. erecta* is one of the most economically profitable floricultural crops in the world. In addition to its ornamental value, it plays a crucial role in traditional practices, religious ceremonies, and the floral trade, while also offering potential in natural dye extraction, medicinal uses, and pest management. The large-scale cultivation of *T. erecta* in India and globally indicates the need for a thorough assessment of its varieties to identify those with superior traits such as higher yield, enhanced flower quality, wider adaptability, and better resistance to biotic and abiotic stresses. Therefore, a comprehensive review of varietal performance, growth attributes, and economic potential is crucial to strengthen its cultivation prospects and to provide knowledge for future crop improvement programs.

2. MULTIFACETED IMPORTANCE OF *T erecta*

T erecta plays a significant role in floriculture globally due to its versatility, aesthetic appeal, and multifaceted utility. Its importance can be broadly categorised into ornamental, cultural, economic, industrial, medicinal, and ecological aspects (Fig. 1).

2.1 Economic and Industrial Value

T erecta is one of the most commercially important floricultural crops worldwide. Its flowers are a primary source of natural carotenoids, particularly lutein, which is extracted and used as a colouring agent in the food industry, in poultry and aquaculture feed for pigmentation, and in nutraceutical formulations for eye health (Sowbhagya *et al*., 2004). *T. erecta* also brings significant revenue to small and medium-scale farmers, as demonstrated by Indian cultivars such as Pusa Narangi Gainda that yield high flowers and good cost–benefit ratios under sustainable production conditions (Idan *et al*., 2014; Mohapatra *et al*., 2020).

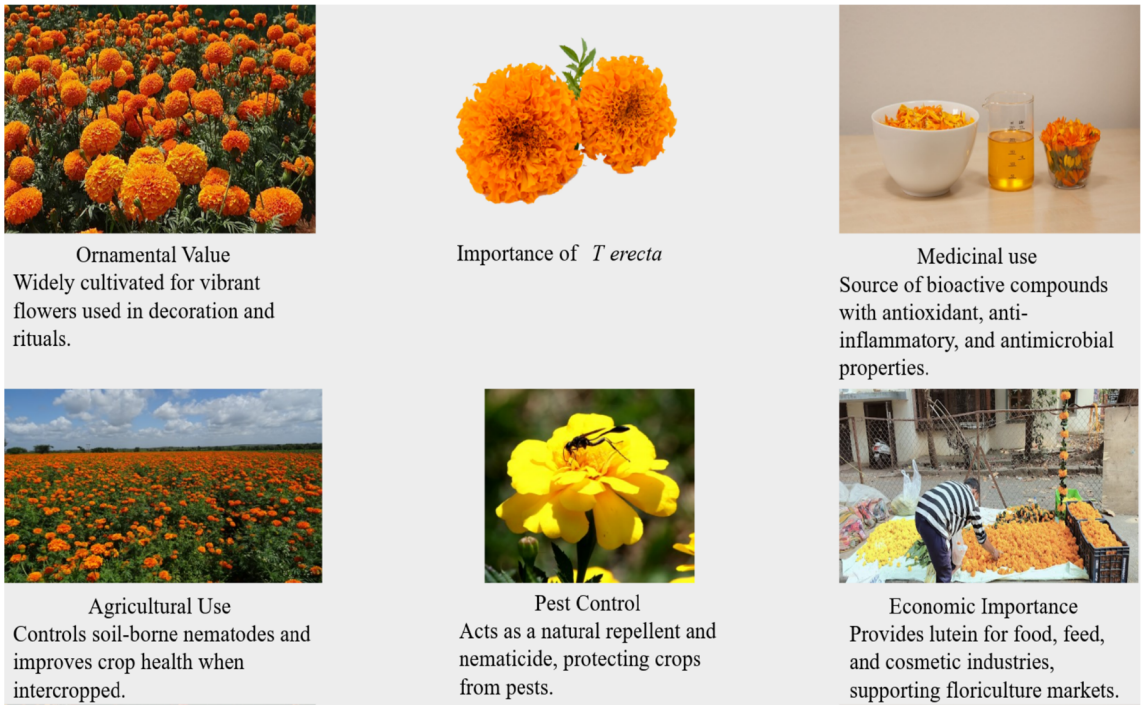

Fig. 1. Importance of *Tagetes erecta*, highlighting its roles in various fields

2.2 Ethnomedicinal Uses

Different parts of *T. erecta*, including the flowers, leaves, and roots, are traditionally used in folk medicine to treat a variety of ailments. The leaves are employed as an antiseptic and are used to relieve kidney disorders, muscular pain, piles, boils, and carbuncles (Singh *et al.*, 2020; Sachin and Homraj, 2021). The flowers are applied in cases of fever, epileptic fits (Ayurveda), scabies, liver complaints, and eye disorders (Chaudhari *et al.*, 2024). They are considered blood-purifying, and the flower juice is also administered as a remedy for bleeding piles. Additionally, the flowers are used in managing rheumatism, colds, and bronchitis. Various species of Tagetes exhibit antimicrobial, anti-inflammatory, hepatoprotective, wound-healing, insecticidal, and analgesic activities. The pharmacological potential of *T. erecta* is attributed to its diverse secondary metabolites, primarily terpenes, essential oils, flavonoids, carotenoids, and polyphenols.

2.3 Ornamental and Cultural Value

Marigold occupies a significant position in ornamental horticulture because of their bright, durable flowers and tolerance to various agro-climatic conditions. In India and Southeast Asia, *T. erecta* is used on a mass scale in religious practices, social events, garland decoration, and garden ornamentation (Raihandhany & Kurniawan, 2023). In Mexico, the species popularly known as cempasúchil carries deep cultural symbolism during the Day of the Dead (Estrada *et al.*, 2025), where its flowers are utilised to adorn altars and procession ways as an emblem of life and death (Boncompagni & Monzali, 2021). The fact that it is used as both a decoration and a culturally symbolic flower adds further to its social relevance throughout the world.

2.4 Agricultural and Environmental Contributions

Tagetes erecta yields secondary metabolites like α-terthienyl and other thiophenes, which exhibit nematicidal, insecticidal, and antifungal activities (Salehi *et al.*, 2018). Therefore, marigold is used widely in integrated pest management systems in which it acts as a biological control agent against soil-borne nematodes and insect pests (Parihar *et al.*, 2025). Intercropping of marigolds with vegetables and cereals has been found to enhance the health and productivity of crops by naturally decreasing the incidence of pests. Also, its residues can be made into silage, which is valuable forage for animals.

2.5 Source of Value-Added Bioproducts

Undergoing research emphasises the underutilised potential of marigold leaves and non-flower biomass. Both plant components are high in phenolic acids and flavonoids like quercetin, chlorogenic acid, and caffeic acid, which have antioxidant and antimicrobial properties (Youssef *et al.,* 2020). These compounds can be harnessed in the food, pharmaceutical, and cosmetic industries, contributing to a circular bioeconomy by utilising what was once considered agricultural waste (Chauhan *et al.*, 2022).

3. VARIETAL DIVERSITY IN AFRICAN MARIGOLD (*Tagetes erecta*)

T erecta exhibits wide varietal diversity, which has been shaped by its long history of domestication, adaptation to diverse agro-climatic conditions, and continuous efforts in crop improvement (Barbas *et al.,* 2025). The availability of numerous varieties and hybrids with distinct morphological and agronomic attributes underlines its significance in commercial floriculture (Mahanta, 2017). This diversity is expressed in terms of plant stature, branching habit, flowering duration, bloom size, flower form, colour range, yield potential, and resistance to stresses, making it one of the most versatile ornamental crops for farmers, landscapers, and the floriculture industry (Thakur and Dhiman, 2022).

3.1 Indian Varieties

Tagetes erecta is found to have significant varietal variation in India, where it is grown

widely as one of the major loose flowers (Himaja *et al*.,2025). Public-sector breeding programs, especially the Indian Agricultural Research Institute (IARI), are meeting the various requirements of growers and consumers. Pusa Narangi Gainda is a tall-median variety with abundant branching and dense, bright orange flowers with excellent garland preparation value because of their bright colour and uniform flowering (Singh, 2017). Its sister variety, Pusa Basanti Gainda, has good keeping quality, lemon-yellow flowers and is particularly sought-after during festivals (Mahanta, 2017). Pusa Arpita, another IARI line, is characterised by its dwarf plant type, medium-to-large flowers, and greater yield potential and is ideal for commercial cultivation (Mamatha *et al*., 2025). Tall-growing varieties like Calcutta Orange and Calcutta Giant in eastern India are favoured for their large, deep-orange flowers and ease of cultivation on a commercial scale for flower markets Mahanta *et al*., 2020). Besides, locally popular varieties like Siracole and Jaipur Orange are valued for their heavy flowering and versatility and hence are well suited for garland and ornamental use (Ghosh & Pal, 2008). The broad diversity of these varieties accentuates the phenotypic richness of African marigolds in India, with flexibility regarding flower size, colour, and seasonality, coupled with meeting cultural, visual, and market requirements.

3.2 Hybrid Varieties

Hybrid breeding of African marigold (*Tagetes erecta* L.) has become a valuable means to increase flower production, enhance uniformity, and satisfy the floriculture industry's quality standards. A field assessment in South Gujarat of 34 exotic hybrids showed significant diversity in growth and flowering characteristics, thus highlighting the commercial cultivation potential of hybrids (Patel *et al*., 2025). Among the genotypes tested, Yellow #0068 was better with the highest flower production (638.30 g per plant), greater bloom diameter (5.75 cm), and the highest number of flowers per plant (96). Some other hybrids, such as Marigold #074, Marigold #078, Yellow #0065, and Marvel Yellow, were also showing promising performance for important horticultural traits. Together, these results identify the contribution of F_1 hybrids to increasing productivity, maintaining consistency in floral characteristics, and satisfying varied market demands for garlands, loose flowers, and ornamental landscaping.

3.3 Internationally Documented Varietal Diversity of *T erecta*

African marigolds have been heavily bred not just in India but also throughout North America, Europe, and East Asia. Various internationally accepted cultivars and series of hybrids have resulted, each possessing distinct characteristics that suit various climatic zones and systems of production. Recorded tests point to wide diversity in growth habit, flowering habit, potential yield, pigment content, and post-harvest attributes (Table 1).

Table 1. Internationally recognised cultivars and hybrids of *T erecta* and their notable traits

Cultivar / Series	Origin / Breeder	Notable Traits	Source
Inca II™ (Deep Orange, Gold, Yellow, Mix)	Syngenta Flowers, USA/International hybrid series	Early flowering, medium height, branched plants, large double flowers, less day-length sensitive, tolerant under hot tropical weather and in container production.	Poudel *et al*., (2017)
Inca Orange	Likely India / Introduced line derived from *Inca* germplasm	Among the shortest to first flower opening (≈ 51 days) in West Bengal trials; exhibited early flowering and compact growth habit.	Lohar *et al*., (2018)
Crackerjack Mix / Crackerjack	Commercial hybrid lines (USA / India)	Moderate plant number of flowers per plant with good ornamental value; but lower carotenoid content in biochemical	Patokar *et al*., (2018)

		studies; yield variable depending on location.	
NAM-2	Indian trial selection (Nagpur)	Maximum number of flowers per plant (~62.7), maximum flower yield per plant (642 g) and per hectare (23.24 t/ha), big flower diameters (~7.1 cm), maximum petal number and high consumer acceptability in Nagpur Kharif trials.	Patokar *et al*., (2018)
African Giant Double	Indian / commercial improved line	Characterized by longer shelf life (4.07 days) and good flower quality, but flower yield counts fluctuated; improved post-harvest endurance was a major characteristic.	Patokar *et al*., (2018)

4. CRITERIA FOR VARIETAL EVALUATION IN *Tagetes erecta*

Varietal screening in *T. erecta* is a comprehensive analysis of morphological, physiological, and economic characters that define a variety's adaptability, productivity, and marketability. These assessments are imperative for the identification of better genotypes qualified for mass production, floricultural trade, and varied agro-climatic zones. The major parameters taken into consideration under performance trials are growth characters, flowering habits, yield and quality characters, and biotic stress resistance.

1. Growth Parameters

Growth traits provide the basic framework for establishing the vigour, versatility, and stability of a marigold variety under diverse environmental conditions. These factors affect not just the plant's total biomass but also its flowering potential and resistance to lodging.

Plant Height: Planting date has been reported as a critical factor influencing plant height in ornamental crops. Lakshmi *et al*., (2014) reported in African marigold (*Tagetes erecta*) cv. Pusa Narangi Gainda that 1st October planting gave the highest plants (71.70 cm) among four dates of planting (1st September, 1st October, 1st November, and 1st December). Sharma *et al*., (2015) also found that Gaillardia (*Gaillardia pulchella*) cv. Double Yellow reached optimum height (75.45 cm) when sown on 1st October, as opposed to 1st September and 1st November sowings. Conversely, Yadram *et al*., (2015) found the maximum plant height (57.75 cm) of African marigold cv. Pusa Narangi Gainda, when sown on 15th September, as opposed to subsequent October and November sowings. These results together indicate that early-to-mid October planting tends to be beneficial for maximum vegetative growth in ornamental plants, with certain responses based on species and climatic conditions at the place of growing. African marigold cultivars themselves display a great deal of inherent variation in plant height, varying between 40 cm for dwarf types and 120-140 cm tall hybrids. Taller crops generally carry more flowers per plant because of higher availability of nodes; but where there is too much height, this causes lodging under field conditions, especially where there is strong wind or excessive rain, and varieties should therefore be chosen that suit the target environment.

Leaf Size and Foliage Density: Leaf morphology impacts photosynthetic efficiency, light capture, and plant vigour. Densely foliated varieties can accommodate greater biomass accumulation, although too much vegetative growth might postpone flowering (Patel *et al.,* 2025).

Branching Pattern: Branching determines the canopy structure, flower distribution, and total yield of African marigold (*Tagetes erecta*). Early-mid October planting usually favours better branching. Smita *et al*., (2012) found the highest number of primary branches (19.54) in October-planted cv. African Double Orange, and Lakshmi

et al. (2014) found 16.89 primary branches in the 1st October planting of cv. Pusa Narangi Gainda. Yadram *et al*., (2015) counted 18.79 primary branches at 15th October planting, while Mohanty *et al*., (2015) reported the highest primary (16.61) and secondary (52.37) branches for cv. Sirakole at November planting. Kaur and Sidhu (2004) also observed a higher number of secondary branches in early plantings. These results suggest that early planting is conducive to better branching, although varietal and climatic conditions can bring about variations.

2. Flowering Behaviour

Flowering traits are key determinants of marketability and economic returns in ornamental crops.

Bud initiation: Bud initiation, or the time from transplanting to the first visible bud, indicates earliness and suitability for specific market windows. In African marigold (*Tagetes erecta*) cv. Sierra Orange, Sreekanth *et al*., (2006) reported early bud initiation (57.04 days) in December planting. In cv. Pusa Narangi Gainda, Pratibha *et al*., (2014) observed the earliest bud initiation (42.33 days) in 16th October planting among eight planting dates, while Sharma *et al*., (2015) recorded early bud initiation (53.86 days) in 1st October planting of Gaillardia (Gaillardia pulchella) cv. Double Yellow.

Flower yield: Flower yield, an important economic trait, is influenced by planting date and flowering span. Lakshmi *et al*., (2014) reported maximum flower yield per hectare (25.90 t) in the 1st October planting of African marigold cv. Pusa Narangi Gainda. Similarly, Rajyalakshmi and Rajasekhar (2014) found the highest yield (6.5 t/ha) in September planting, while Mohanty *et al*. (2015) recorded the maximum yield (20.08 t/ha) in November planting of cv. Sirakole. These studies indicate that early-to-mid October plantings generally favour timely bud initiation and higher flower yield, though varietal differences and local climate conditions influence optimal performance.

3. Yield and Quality Attributes

Yield and quality attributes are key varietal evaluation parameters in *Tagetes erecta* since they directly influence economic rewards and marketable quality.

Flowers per plant: These are a major productivity indicator that differs markedly with genotype and date of planting. Ghosh and Pal (2008) indicated that 12th October planting resulted in the highest number of flowers in cv. Sirakole in West Bengal conditions. Likewise, Smita *et al*., (2012) noticed maximum flower yield (348.6 g per plant) in October-sown cv. African Double Orange, whereas Lakshmi *et al*., (2014) noticed 50.10 flowers per plant in the 1st October planting of cv. Pusa Narangi Gainda. Sharma *et al*., (2015) noticed 179.69 flowers per plant in the 1st October planting of Gaillardia (*Gaillardia pulchella*) cv. Double Yellow. Rajyalakshmi and Rajasekhar (2014) and Anil et al., (2015) similarly highlighted that early-to-mid planting favoured higher flower numbers across varieties. These findings indicate that optimal planting dates are critical for maximising floral productivity.

Flower weight and size: Flower weight and size significantly influence market value, with larger, uniformly shaped, and brightly colored flowers preferred in cut flower and garland markets. Singh *et al*., (2019) stated that superior African marigold lines have flower weights of 5-15 g. In field conditions, Samantary *et al*., (1999) noticed the highest flower weight in September-sown cv. African Yellow, and Sreekanth *et al*., (2006) noticed the highest flower weight in October-sown cv. Sierra Orange. Sharma *et al*., (2015) also documented the highest flower weight of 43.62 g per 10 flowers in the 1st October planting of Gaillardia cv. Double Yellow.

Shelf life and post-harvest quality are necessary for commercial purposes, with hybrids such as African Giant Double showing a maximum of four days of freshness under ambient conditions (Patokar *et al*., 2018). Furthermore, the intensity and evenness of colours play a significant role in ornamental value, where vivid yellow and rich orange blooms are greatly preferred for decoration and

religious ceremonies (Davidse *et al*., 2018). Overall, these studies together highlight that high-quality planting times and selections are essential for high yield and high-quality production in African marigolds.

5. CONSTRAINTS AND RESEARCH GAPS

Despite the commercial significance of African marigolds, varietal improvement and systematic evaluation still face several limitations:

Limited zone-specific evaluation: While a large number of varieties and hybrids are present, their performance has not been consistently evaluated across diverse agro-climatic conditions. A majority of studies are restricted to some experimental stations, so it is hard to find varieties suitable for various regional markets (Khayum *et al*., 2018).

Requirement of standardised performance trials: Modern varietal testing tends to vary in methodology, characteristics considered, and trial length, which causes uneven results. Inadequate standard protocols for recording growth, yield, and quality characteristics limit the potential for comparative analysis and meta-assessment (Khayum *et al*., 2023).

Lack of improved varieties with multiple desirable traits: Although some varieties have a high yield, there are others that do well regarding flower size, storage life, or resistance against diseases. Nevertheless, such varieties that possess all these characteristics together at the same time are very rare, thus restricting their full-scale commercial use. Apart from that, carotenoid-rich varieties for industrial extraction are underutilised (Davidse *et al*., 2018).

6. CONCLUSION

The African marigold is one of the most useful and economically important floricultural crops owing to its flexibility, cultural significance, and numerous industrial uses. The varietal evaluation evidently proves that there is wide diversity among cultivars and hybrids in terms of plant height, branching, flowering duration, flower size, yield, and post-harvest attributes. Such heterogeneity presents enormous opportunities for farmers to choose varieties most appropriate to local conditions and consumer demands. Yet varietal improvement is still hampered by region-specific trials, lack of standardised procedures, and limited consideration of economic and quality factors. Strengthening the evaluation systems by conducting multi-location trials, systematic recording of key characters, and the incorporation of stress tolerance and quality characteristics will yield more reliable advice to farmers and the industry. Systematic varietal evaluation is ultimately the basis for improving productivity, sustainability, and releasing the full economic potential of African marigolds.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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