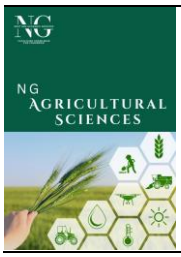

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Evaluation of African marigold (*Tagetes erecta* L.) cultivars for growth and yield under Rayalaseema region of Andhra Pradesh

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HIGHLIGHTS

- "Orange Glory" had the highest flower yield, making it ideal for commercial cultivation.
- "Arka Anamika" showed the earliest flowering and highest Vitamin C content.
- "Tennis Ball Plus" and "Kashi Pragati" exhibited superior growth characteristics.

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ABSTRACT

The study examined different *Tagetes erecta* L. cultivars at the Rayalaseema region of Andhra Pradesh for their crop performance evaluation. The study evaluated growth dynamics together with flowering patterns and yield prospects to find an appropriate plant variety for commercial production in this semi-arid farming area. The experimental design utilized a randomized block design (RBD) to evaluate Pusa Narangi Gainda Pusa Basanti Gainda along with local hybrids as different cultivars. Researchers collected data for plant height and branch numbers and days until 50% flowering and the size of blossoms and the produced flower quantity both per plant and per hectare. The researched cultivars showed major variations in every recorded metric. Tenis ball plus stood out as the best cultivar through its superior vegetative characteristics while Orange glory reached highest flower yield which establishes it as a successful variety for Rayalaseema cultivation. The research data proves that choosing appropriate cultivars will strongly impact marigold crop production within harsh climatic areas. The research establishes a useful framework which will assist floriculturists and farmers to boost marigold production levels in drylands.

1. INTRODUCTION

Tagetes erecta L. or the African marigold exists as an ornamental plant from Asteraceae which attracts cultivation because of its majestic flowers together with its diverse applications. This species has become a popular focus in tropical and subtropical areas of Africa and Asia following its naturalization from its Mexican origin because of its attractive value and commercial potential along with its medicinal benefits. The cultivation of African marigold continues to grow because of mounting requirements in floricultural production together with traditional medication usage and natural dye synthesis as well as

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sustainable pest management through allelopathic properties. The Indian flower industry identifies marigold as one of its primary commercial crops appearing only after rose and chrysanthemum. The Asteraceae family contains Marigold as its member and it originally grew in Mexico and Guatemala. The prime regions where marigold flowers exist today consist of India and Tropical Africa alongside Sri Lanka and Madagascar. The major marigold cultivation areas in India exist within Madhya Pradesh, Karnataka, Gujarat, Andhra Pradesh and West Bengal states. According to NHB (2022) marigold crops cover a total area of 73,150 ha which produces 7,28,530 MT of flower in India while Andhra Pradesh has 6370 ha with a corresponding production of 76,420 MT. Major marigold cultivation areas in Andhra Pradesh can be found in Chittoor (45,684 MT) as well as Ananthapuramu (11,760 MT), Nellore (5,940 MT) and Visakhapatnam district (4,440 MT) according to DOH (2022).

Numerous indigenous genotypes that range in blossom size and form are grown in various regions of India and their yield varies from season to season and region to region. For the production of loose flowers and extraction of pigments, there is an increasing and huge need for cultivars with good flower output that are uniform in size, compact and brightly coloured with a longer shelf life and best quality in the domestic flower market. Cultivar performance varies with geography, season and other growing variables. A cultivar that is promising and doing well in one place may not succeed in another region with different climatic conditions (Naik et al., 2019). Farmers plant local cultivars without considering the output and quality possibilities, even though there are numerous cultivars with great production potential and better-quality metrics, that have been released in various states. Knowledge of how different germplasm accessions perform is crucial for successful cultivation and only the germplasm that performs better in a particular region should be recommended and grown commercially.

Morphological evaluation plays a fundamental role in the characterization and selection of superior genotypes in any plant breeding program. In African marigold, traits such as plant height, number of branches, flower diameter, duration of flowering, and yield parameters are crucial indicators of performance and market value. Assessing morphological variability among genotypes provides insight into the extent of genetic diversity, which is essential for the identification of promising lines for hybrid development and trait improvement. Moreover, understanding the morphological traits enables the formulation of effective selection strategies to enhance specific horticultural attributes such as flower color, size, and longevity.

Despite its growing importance, comprehensive morphological evaluations of African marigold under diverse agro-climatic conditions remain limited. There is a pressing need for systematic studies that examine the phenotypic variation among available genotypes, especially in the context of optimizing performance for commercial cultivation. Such studies not only contribute to the enrichment of germplasm databases but also serve as a scientific foundation for future genetic and molecular research. This study aims to evaluate the morphological characteristics of different African marigold genotypes under uniform environmental conditions to determine the extent of phenotypic variation and identify superior genotypes for further breeding and cultivation purposes. The findings are expected to contribute significantly to the genetic enhancement of Tagetes erecta and support its sustainable development within floricultural systems.

2. MATERIALS AND METHODS

The present experiment entitled "Evaluation of African marigold (*Tagetes erecta* L.) cultivars for growth and yield under Rayalaseema region of Andhra Pradesh" was carried out at Floriculture and Landscape Architecture block, Department of Floriculture and Landscape Architecture, Dr. YSRHU - College of Horticulture, Anantharajupeta, Annamayya district, Andhra Pradesh in kharif season during the year 2022-23. The experiment was laid out in Randomized block design with eleven treatments viz., Pusa Basanti Gainda, Pusa Narangi Gainda, Bidan Marigold 2, Orange Glory, Siri, Tennis Ball Plus, Ashtagandha Plus, Pooja, Dimpal, Mydukur Local and Chitvel Local with three replications. The seedlings and rooted stem cuttings were planted at a spacing of 45 cm x 45 cm from plant to plant and row to row to accommodate twenty-five plants per 4 m2 area and standard cultural practices were followed uniformly for all experimental plots. Five randomly selected plants were tagged for taking observations of both vegetative and yield attributes. Data on vegetative charters were taken at 30, 60 and 90 days after transplanting. Observations were recorded on growth and yield attributing characters and statistical analysis was done using the standard procedure described by Panse and Sukhatme (1967) and treatment means were tested for their significant difference by working out critical difference values at 5% level of significance wherever F statistic was found significant.

3. RESULTS

The data on different morphometric characters are found significant among the treatment and data presented in the table 1. Plant height of different cultivars of African marigold plants varied significantly at various phases of crop growth viz., 30, 60 and 90 DAT. The plant height varied from 20.93 cm to 55.87 cm among the varieties at 30 DAT and it was reported maximum in cultivar Chitvel Local (Yellow) (55.87 cm) followed by variety Pooja (49.07 cm) whereas, minimum plant height was recorded in Dimpal (Yellow) (20.93 cm). The plant height varied from 46.73 cm to 94.87 cm at 60 DAT and 65.40 cm to 104.34 cm at 90 DAT among the varieties and it was recorded maximum in the Tennis Ball Plus (Yellow) (94.87 cm and 104.34 cm) followed by Orange Glory (83.07 cm and 93.03 cm) whereas, minimum plant height was recorded in Dimpal (46.73 cm and 65.40 cm) at 60 and 90 DAT, respectively. Plant height is a crucial varietal characteristic that is determined by genetic makeup. The genetic makeup of each cultivar and the way it has interacted with its environment might be the reason for variations in plant height at 30, 60 and 90 DAT among the cultivars. Plant spread was found highest in Siri (Yellow) variety (31.48 cm) among the cultivars at 30 DAT which was on par with Tennis Ball Plus (30.17 cm), Astagandha Plus (28.45 cm), Chitvel Local (28.25 cm), Bidhan Marigold-2 (28.17 cm) and Pusa Narangi Gainda (28.00 cm). Dimpal recorded the minimum plant spread (12.13 cm) among all cultivars. At 60 and 90 DAT, Plant spread was highest in Tennis Ball Plus (49.70 cm and 56.17 cm) which was on par with Bidhan Marigold-2 (48.50 cm) at 60 DAT and on par with Bidhan Marigold-2 (54.40 cm), Orange Glory (52.30 cm) and Pusa Basanti Gainda (48.54 cm) at 90 DAT. Dimpal (Yellow) recorded minimum plant spread (29.17 cm and 34.57 cm, respectively) among all cultivars at 60 and 90 DAT.

Table 1. Evaluation of African Marigold cultivars for vegetative characters

Cultivar	**Plant height** (cm)			**Plant spread** (cm)		
	30 DAT	**60 DAT**	**90 DAT**	**30 DAT**	**60 DAT**	**90 DAT**
T1 - Pusa Basanti Gainda	34.09^{e}	68.00^{e}	84.00^{cd}	24.58^{bc}	42.76^{cd}	48.54^{ab}
T2 - Pusa Narangi Gainda	36.91^{e}	65.20^{e}	80.42^{cd}	28.00^{ab}	42.27^{cd}	47.99^{b}
T3 - Bidhan Marigold - 2	25.17^{f}	62.13^{e}	78.24^{d}	28.17^{ab}	48.50^{ab}	54.40^{ab}
T4 - Orange Glory	40.67^{d}	83.07^{b}	93.03^{b}	24.50^{bc}	45.10^{bc}	52.30^{ab}
T5 – Siri	43.37^{cd}	78.23^{bc}	87.61^{bc}	31.48^{a}	40.67^{de}	47.33^{b}
T6 - Tennis Ball Plus	45.40^{bc}	94.87^{a}	104.34^{a}	30.17^{a}	49.70^{a}	56.17^{a}
T7 - Astagandha Plus	45.77^{bc}	75.60^{cd}	87.69^{bc}	28.45^{ab}	38.47^{ef}	47.01^{b}
T8 – Pooja	49.07^{b}	66.33^{e}	75.95^{de}	22.82^{c}	35.59^{fg}	42.97^{b}
T9 – Dimpal	20.93^{g}	46.73^{f}	65.40^{f}	12.13^{d}	29.17^{h}	34.57^{c}
T10 - Mydukur Local	21.87^{fg}	48.93^{f}	68.86^{ef}	15.73^{d}	33.36^{g}	37.26^{c}
T11 - Chitvel Local	55.87^{a}	68.73^{de}	76.86^{de}	28.25^{ab}	38.03^{ef}	43.50^{b}
Mean	**38.10**	**68.89**	**82.04**	**24.93**	**40.33**	**46.54**
S. Em±	1.57	2.43	2.99	1.74	1.25	2.61
CD (*p=0.05*)	4.64	7.16	8.83	5.15	3.67	7.71

It was observed in Table 2 that at 30 DAT, a greater number of primary branches per plant in Bidhan Marigold - 2 (7.67) which was on par with Astagandha Plus (7.13) and Tennis Ball Plus (7.00) and lowest number of primary branches were observed in Dimpal (3.10). Orange Glory (14.83 and 19.03) recorded maximum number of primary branches among the cultivars at 60 and 90 DAT which was on par with Tennis Ball Plus (14.10), Astagandha Plus (13.93) and Bidhan Marigold- 2 (13.00) at 60 DAT and on par with Tennis Ball Plus (17.70) at 90 DAT. The lowest was observed in Dimpal (5.60 and 8.90, respectively) at 60 and 90 DAT. The highest number of secondary branches per plant was in the Bidhan Marigold - 2 (8.60) followed by the Siri (6.13). The lowest number of secondary branches per plant was observed in Dimpal (1.00) at 30 DAT. At 60 DAT and 90 DAT, the highest number of secondary branches per plant was found in Orange Glory (36.00 and 45.92) which was on par with Tennis Ball Plus (32.67 and 41.43). Whereas, the lowest was observed in Dimpal (9.27 and 14.40, respectively).

The cultivars showed significant variation in the number of days taken for the first bud to appear.

Table 3 provide information regarding the number of days taken for the first bud to appear. The days, cultivars taken for the first flower bud to appear ranged from 31.93 days to 43.47 days. The minimum days taken for the first flower bud appearance was observed in Mydukur Local (31.93 days) which was on par with Chitvel Local (32.47 days) and the maximum days taken for the first flower bud appearance was observed in Pusa Basanti Gainda (43.47 days).

Table 2. Evaluation of African Marigold cultivars for vegetative characters

Cultivar	Number of primary branches per plant			Number of secondary branches per plant		
	30 DAT	**60 DAT**	**90 DAT**	**30 DAT**	**60 DAT**	**90 DAT**
T1 - Pusa Basanti Gainda	5.87^{de}	9.46^{cd}	11.96^{cd}	1.50^{f}	18.33^{c}	25.66^{cd}
T2 - Pusa Narangi Gainda	5.27^{e}	10.27^{c}	12.87^{c}	3.27^{cde}	15.13^{cd}	22.14^{de}
T3 - Bidhan Marigold - 2	7.67^{a}	13.00^{ab}	16.60^{b}	8.60^{a}	24.33^{b}	32.26^{b}
T4 - Orange Glory	6.13^{cd}	14.83^{a}	19.03^{a}	3.93^{c}	36.00^{a}	45.92^{a}
T5 – Siri	6.67^{bc}	12.87^{b}	16.47^{b}	6.13^{b}	17.53^{c}	29.23^{bc}
T6 - Tennis Ball Plus	7.00^{ab}	14.10^{ab}	17.70^{ab}	3.30^{cd}	32.67^{a}	41.43^{a}
T7 - Astagandha Plus	7.13^{ab}	13.93^{ab}	16.73^{b}	2.60^{e}	25.00^{b}	34.80^{b}
T8 – Pooja	4.20^{f}	7.60^{de}	10.50^{de}	2.93^{de}	16.73^{c}	23.25^{cde}
T9 – Dimpal	3.10^{g}	5.60^{f}	8.90^{e}	1.00^{f}	9.27^{e}	14.40^{f}
T10 - Mydukur Local	3.80^{fg}	6.40^{ef}	9.70^{e}	1.47^{f}	12.00^{de}	17.60^{ef}
T11 - Chitvel Local	5.33^{e}	8.23^{de}	10.93^{cde}	1.57^{f}	14.87^{cd}	21.05^{de}
Mean	**5.65**	**10.57**	**13.76**	**3.30**	**20.17**	**27.98**
S. Em±	0.26	0.66	0.73	0.23	1.28	2.08
CD (*p=0.05*)	0.77	1.96	2.17	0.68	3.76	6.13

Table 3. Evaluation of African Marigold cultivars for vegetative characters

Cultivar	Days to first flower bud appearance	Days to first flower opening	Days to 50% flowering	Number of flowers per plant	Flower yield per plant (g)
T1 - Pusa Basanti Gainda	43.47^{a}	54.93^{b}	61.00^{a}	39.50^{def}	369.91^{ef}
T2 - Pusa Narangi Gainda	41.73^{ab}	51.40^{a}	63.00^{a}	36.46^{ef}	324.14^{fg}
T3 - Bidhan Marigold - 2	41.80^{ab}	49.80^{bcd}	57.33^{b}	44.63^{cd}	377.44^{e}
T4 - Orange Glory	36.07^{d}	47.40^{ef}	53.00^{cd}	83.20^{a}	741.09^{a}
T5 – Siri	37.93^{cd}	50.73^{bc}	54.33^{bc}	42.81^{cde}	567.88^{c}
T6 - Tennis Ball Plus	39.07^{bcd}	49.86^{bcd}	55.33^{bc}	73.25^{b}	670.87^{b}
T7 - Astagandha Plus	39.07^{bcd}	49.00^{cde}	56.00^{bc}	47.54^{c}	478.03^{d}
T8 – Pooja	37.73^{cd}	48.66^{def}	63.33^{a}	34.98^{fg}	306.73^{g}
T9 – Dimpal	39.80^{bc}	49.26^{cd}	56.66^{b}	29.39^{g}	161.63^{h}
T10 - Mydukur Local	31.93^{e}	45.00^{g}	50.33^{d}	29.99^{g}	183.59^{h}
T11 - Chitvel Local	32.47^{e}	47.06^{f}	50.67^{d}	29.91^{g}	295.89^{g}
Mean	38.28	49.38	56.45	44.70	407.02
S. Em±	1.05	0.59	1.08	2.19	16.09
CD (*p=0.05*)	3.10	1.74	3.17	6.45	47.47

Days taken for the first flower to open ranged from 45.00 days to 54.93 days. Lowest number of days taken for the first flower to open was observed in Mydukur Local (45.00 days) which was on par with Chitvel Local (47.06 days) and Orange Glory (47.40 days). The maximum number of days for first flower to open was reported in Pusa Basanti Gainda (54.93 days). The range for days to 50% flowering was

observed between 50.33 and 63.33 days. The minimum number of days taken for 50% flowering was noted in the Mydukur Local (50.33 days) cultivar which was on par with Chitvel Local (50.67 days) and Orange Glory (53.00 days). The maximum number of days taken for 50% flowering was observed in Pooja (63.33 days). The data indicated that Orange Glory had the highest number of flowers per plant (83.20) followed by Tennis Ball Plus (73.25) and Dimpal had the fewest number of flowers per plant (29.39). The observations presented in table 3 revealed a significant difference among the data on flower yield per plant. Orange Glory had recorded the highest flower production (741.09 g) significantly surpassing the yield of the other cultivars. However, Dimpal exhibited the lowest flower production per plant (161.63 g).

4. DISCUSSION

African marigold cultivars demonstrated important differences in their plant height development from 30 DAT through to 90 DAT because of their genetic constitution combined with environmental effects. The plants belonging to the cultivar Chitvel Local reached their maximum plant height at 30 Days After Transplanting whereas Tennis Ball Plus achieved its peak plant height at both 60 and 90 Days After Transplanting. Certain African marigold cultivars possess genetic traits to reach maximum height at particular growth stages because their development depends on the combined factors of cell division and expansion together with water consumption and nutrient access. The extensive plant growth was observed in Siri at Day 30 after sowing but Tennis Ball Plus achieved maximum spread on Days 60 and 90. The different cultivars manifest varying plant spread patterns because their genetic characteristics determine how they distribute their growth resources into lateral development. Genetic characteristics of marigold cultivars control their growth patterns according to Mehta (2022) and Bhusal et al. (2023). The cultivars such as the Chitvel Local reach maximum height during the early growing stages possibly due to a vigorous initial vertical growth phase, whereas the Tennis Ball Plus shows peak plant height later, indicating a longer vegetative period or continuous growth habits (Anwarzai et al., 2020).

Different marigold cultivars demonstrated notable differences in their production of primary and secondary plant branches. At 30 DAT Bidhan Marigold-2 displayed the greatest number of primary branches followed by Orange Glory reaching its maximum at both 60 and 90 DAT. At 60 and 90 days after planting the most secondary branches occurred in the cultivar Orange Glory. Different cultivars demonstrate superior subterminal branching abilities likely because of their natural genetic capacity to divide cells and maintain hormonal equilibrium. Overall plant vitality together with environmental factors like light exposure and temperature stand to influence the development of plant branches. Cell division and expansion, water uptake and storage, nutrition availability, hormonal balance and environmental conditions including light intensity and temperature were the primary factors contributing to stem girth growth in plants. These elements worked together to influence the overall growth of the plant. Similar results were also observed by Mahantesh et al. (2018), Dahal et al. (2021) and Shilpa et al. (2022). Plant height, number of leaves, and stem diameter are not merely physical attributes but critical morphological determinants that integratively reflect a plant's physiological status, photosynthetic capacity, and overall health, offering a comprehensive assessment of its growth trajectory and adaptive responses to both intrinsic genetic programming and extrinsic environmental cues (Kalaji et al., 2016).

Different cultivars show diverse times required for budding and flowering to commence which demonstrates that flowering time represents a genetic feature. Bud appearance and flower opening occurred initially in Mydukur Local and Chitvel Local cultivars but Pusa Basanti Gainda required the longest period for these events. The cultivars express different genetic responses to environmental cues for photoperiod and temperature which causes their flowering time variations. Plant vigor, primary and secondary branches produced by an individual plant during the crop season might had a significant influence on the number of flowers produced per plant. A greater number of primary branches in a genotype brought about more secondary branches, leading to an increased number of flowers in that plant. It's possible that the variation was brought on by the cultivar's inherited traits. There could have been more or fewer branches, which would have explained the variance. The phenotypic efficiency of the plant might have been responsible because it aided in increasing food accumulation, which promoted plant development and increased flower production. These findings are in line with Samantray (2018), Srinivas and Rajasekharam (2020), Bhusaraddi et al. (2022) and Bhusal et al. (2023). The more flowers that bloom on a plant, and the more clusters that each plant produces, the greater the yield of fruits per plant (Vaghasia & Polara, 2016).

The number of flowers per plant reached maximum levels in Orange Glory with Tennis Ball Plus placing second but Dimpal produced the smallest number. The floral output exhibited diverse

quantification because the number of main and supplementary shoot branches functioned together to generate extra flower origination points. Each cultivar's natural potential to produce flowers together with factors including soil nutrient levels and hormonal equilibrium strongly influences the number of flowers that appear on each plant. Hence the wide variation between cultivars regarding their flower yield per plant demonstrates that cultivars with high yield potential remain essential for commercial marigold cultivation given the successful performance of Orange Glory while Dimpal recorded the lowest yield. The final flower yield variables can be understood through their collective influence between flower weights and total flower numbers on each plant. Previous research results similar to these findings demonstrate that marigold cultivars produce distinct amounts of flowers (Kumar et al., 2015; Nilima et al., 2017; Patokar et al., 2018). Flower production differences underscore the significance of genotype selection for desired output levels (Narute et al., 2020).

5. CONCLUSIONS

The evaluation of African marigold (*Tagetes erecta* L.) for growth and yield revealed significant variability among different cultivars or treatments. Key growth parameters such as plant height, number of branches, leaf area, and days to flowering showed a strong correlation with overall flower yield. Optimal environmental conditions, appropriate nutrient management, and effective spacing played a crucial role in enhancing both vegetative growth and flower production. Among the evaluated varieties orange glory demonstrated superior performance in terms of overall growth and yield, making it the most suitable for commercial cultivation. These findings highlight the potential of African marigold not only as an ornamental crop but also for economic returns when proper agronomic practices are followed. Further research could focus on optimizing irrigation, pest management, and exploring post-harvest handling techniques to improve the marketability and shelf life of the flowers.

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