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Agro-Morphological Characterization of Marigold (*Tagetes* spp.) Landraces in Eastern Nepal

Januka Dahal [1]*, Huma Neupane[1], Sanu Krishna Maharjan[1], Punya Aangdembe[2], Sunil Bhandari[1], Anjali Chaudhary[3]

1 Institute of Agriculture and Animal Sciences, Tribhuvan University, Kritipur, Kathmandu, Nepal
2 Ilam Community Agriculture Campus, Ilam, Nepal
3 Nepal Agriculture Research Council, Tarahara, Sunsari, Nepal

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*Corresponding author's email: januka.dahal@gac.tu.edu.np

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ABSTRACT

Marigold (*Tagetes* spp.) is a valuable ornamental crop with aesthetic, commercial, and religious values. It is available in numerous varieties, but its diversity in Nepal has not been recorded to date. In this experiment, marigold landraces from the eastern region of Nepal were collected, and the morphological characteristics were studied to identify the most favored varieties suitable for various agro-climatic zones in Nepal. In this study, 29 marigold landraces were used, as well as one commercial variety as the control. Marigold landraces were collected from four districts (Ilam, Jhapa, Morang, and Sunsari) of Nepal, and research was conducted at two locations: Ilam and Sunsari. The research considered phenotypic variation in plant height, number of branches, flower diameter, petal number, days to flowering, and yield characteristics in various landraces. GGE biplots ranked mean performance and stability for vegetative architecture, floral quality, phenology, and yield. The first principal component explained the majority of G + GE patterns across traits. Thus, the rankings were reliable. Co16866 and Co16868 possessed a stable, good architecture with minimal instability. In flower traits, high and stable diameter and peduncle length entries suited cut-flower markets, and high petal count in combination with medium flower weight suited garland use. Phenology separated very clearly between sites: Ilam was early-flowering and Sunsari was late-flowering. Yield confirmed a multi-trait signal, with Co16872, Co16859, Co16865, Co16884, and Co16871 having high stability, while Co16869 had low stability. The commercial cultivar Co16886, as the control, was above average but less stable than the others. Right-side, near-axis entries are suggested to carry forward for broad release, pairing early-stable lines for Ilam with later-stable, longer-peduncle lines for Sunsari to product goals.

Abbreviations: Average Environment Coordination (AEC), Floriculture Development Centre (FDC), Genotype + Genotype × Environment interaction (GGE), not significant (ns), Principal Component (PC), Randomized Complete Block Design (RCBD)

Introduction

Marigold (*Tagetes* spp. Linn.) is a member of the Asteraceae family and is native to South and Central America, particularly Mexico, where it is used in traditional medicine and ornamentals (Panwar et al., 2013; Mahantesh et al., 2018). In Nepal, marigolds occupy a pivotal position in the ornamental sector due to their cultural significance, environmental adaptability, aesthetic appeal, and cultural significance in major festivals like Tihar (Acharya et al., 2021; Gurung et al., 2020; Regmi and Acharya, 2022). Marigolds can thrive in a wide variety of soils and climates, making them well-suited to the diverse climatic conditions of Nepal, ranging from the lowlands to the hills, emphasizing the potential morphological variation across landraces (Acharya et al., 2021; Gurung et al., 2020).

Despite the increasing popularity and economic potential of marigolds, with an annual market growth of 10-15%, Nepal relies heavily on imported seeds and flowers, fulfilling 80% of the requirement (MoALD, 2022). The lack of improved, well-adapted local cultivars forces Nepalese farmers to rely on costly imported seeds, leading to profit margin compression and threatening native germplasm conservation. These landraces are of high value for future breeding programs, and their replacement causes genetic erosion. Therefore, this study aimed to identify and characterize marigold landraces in Eastern Nepal to support conservation and sustainable cultivation.

As per the above explained scenario, characterization of morphological characteristics of marigold landraces in Nepal is vital for sustainable marigold cultivation and biodiversity conservation. A variety of precise quality marigold is of great significance, as it can receive better premiums in the domestic and export markets. Identifying such local varieties and creating awareness among producers and consumers, both domestically and abroad, would certainly broaden and assure the market for them. Therefore, it is important to identify marigold landraces that possess the immense potential of valuable genes that can be utilized in many breeding programs to produce new varieties with high yield potential and superior quality. Agro-morphological characterization and systematic study of such germplasm are not only important for utilizing the appropriate attribute-based donors but also essential in the present time for protecting the local landraces of Nepal. Thus, there is a need to collect, exploit, and evaluate untapped germplasms.

Thus, the present study was conducted to describe the morphological variation of marigold landraces gathered from Eastern Nepal, an area of emerging floricultural importance. By comparing the performance of these landraces in two different agro-climatic zones namely Sunsari (Terai: Tropical climatic conditions) and Ilam (Mid-hill: Subtropical climatic conditions) this study contributes to varietal development, conservation strategies, and informed commercialization approaches for Nepal's expanding floriculture industry.

Materials and Methods

A total of 29 marigold landraces, along with one commercial variety as the control, were collected from various municipalities and rural municipalities of Ilam, Jhapa, Morang, and Sunsari districts in Nepal (Figs. S1-5). Landrace codes were generated according to the format and serial number of the National Gene Bank, Nepal (Fig. 1). The marigold codes ranged from Co 16859 to Co 16888. Among these, Co 16869 and Co 16872 were French marigolds, and the remaining were African marigolds. The commercial variety was coded as Co16886*, which was Karma-555-Orange. The French types found during the collection were also competent for commercialization; therefore, they were included in the experiment. Although landraces were collected from four districts, field experiments were conducted at two locations, namely, Sunsari and Ilam districts in Nepal (Figs. 2 and 3). Sunsari has a hot and humid climate, representing the subtropical climate of Nepal, whereas Ilam represents the humid temperate climate of Nepal. The research was laid out in a Randomized Complete Block Design (RCBD) with three replications. Seeds were initially sown in plug trays in a commercial peatmoss medium, and seedlings were transplanted into the field after 25 d of sowing at a spacing of 40 × 40 cm. However, in the Sunsari district, the seedlings of the plug tray were transplanted into polybags first and then into the field after 30 d due to excessive rainfall at transplantation time at this location. There were 12 plants in each plot, and the plot size was 1.2 m × 1.2 m. There was a 0.5 m gap between the plots and a 1 m gap between the two replicates. The treatments were randomized using the lottery method. The lottery method of randomization randomly assigns treatments to experimental units by drawing lots, ensuring that each unit has an equal chance of receiving any treatment. As part of cultural work, pinching was carried out after 20 d of transplantation, weeding of the field was carried out as per necessity, and staking was done when the plant started to produce buds to prevent lodging. Thirteen morphological traits were recorded, viz. plant height (cm), plant spread (cm), number of branches, number of nodes, internodal length (cm), days to first flower bud appearance, days to full bloom, flower count per plant, flower diameter (cm), flower weight (g), flower depth (cm), peduncle length (cm), and number of petals per flower from three randomly selected plants per replication. Data were recorded from both field areas 90 d after transplantation. Therefore, the location of cultivation was considered as one factor, whereas landrace was another.

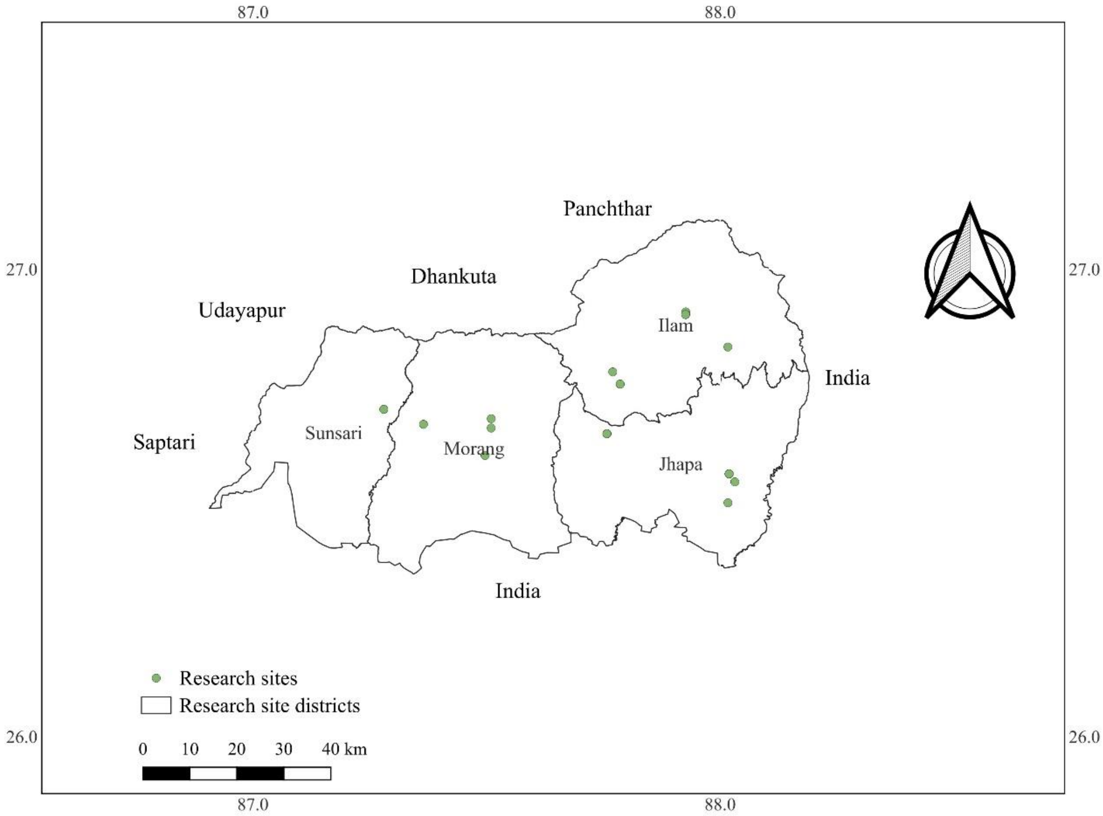


Fig. 1. Distribution map of marigold landraces within four districts of Eastern Nepal.

Fig. 2. Field of Sunsari.

Fig. 3. Field of Ilam.

Statistical analysis

Statistical analyses were performed using R software version 4.5.1. The experimental data of the two locations relating to each parameter were pooled and statistically analyzed using analysis of variance with a randomized block design. Mean vs. stability was plotted in GGE biplot using mean values of each parameter. Mean separation was performed using Tukey's test at a 0.05% level of significance. Data including the interaction effect are presented in the supplementary table wherever the effect is significant.

Results

The analysis of variance of vegetative, reproductive, and floral traits (Table 1) revealed that almost all parameters observed were significantly influenced ($P < 0.05$) by growing conditions, landrace type, and the interaction between them ($P < 0.05$). However, an exception lies in the number of nodes, internodal length, days to maturity, and floral depth, where the interaction effect of climate and landraces did not significantly affect the number of nodes. Likewise, internodal length was statistically similar according to the landraces studied, and floral depth was not significantly different according to the landraces used and the interaction between growing conditions and landraces. In addition, days to maturity was not significantly influenced by the growing location.

Table 1. Analysis of variance to evaluate the effect of location and landraces on different parameters of marigold.

Parameters	Location	Landraces	Location × Landrace
Plant height (cm)	< 2.2e-16***	3.643e-11***	0.001528**
Plant spread (cm)	< 2.2e-16***	0.0001279***	1.445e-08***
Number of branches	< 2.2e-16***	0.0006577***	0.0112310*
Number of nodes	6.67e-06***	0.002088**	0.154067
Internodal length (cm)	< 2.2e-16***	0.0557239	0.0006143***
Days to bud formation	< 2.2e-16***	< 2.2e-16***	1.582e-06***
Days to maturity	0.193625	< 2.2e-16***	0.002501**
Flower diameter (cm)	< 2.2e-16***	1.090e-12***	1.184e-07***
Floral depth (cm)	< 2.2e-16***	0.1490	0.1753
Peduncle length (cm)	1.544e-05***	3.370e-09***	5.030e-06***
Number of petals	0.9032	< 2.2e-16***	2.653e-05***
Weight of flower (g)	5.121e-07***	< 2.2e-16***	< 2.2e-16***
Number of flowers	9.334e-10***	< 2.2e-16***	< 2.2e-16***

ns, *, **, ***: non-significance and significance at 5, 1 and 0.01% level, respectively.

Vegetative traits (GGE mean vs. stability biplots)

The GGE biplots (Fig. 4) of plant height, plant spread, number of branches, number of nodes, and internodal length summarizes genotype means (on the Average Environment Coordination, AEC) and stability (distance from the AEC). In plant height, the first two PCs accounted for most of the G+GE pattern, indicating a stable ranking. Genotypes Co16866, Co16864, and Co16868 fell below the AEC abscissa, reflecting over-average height in environments, while Co16861 and Co16863 were close to the AEC ordinate, reflecting greater stability. The control variety Co16886 had an intermediate mean but a larger projection off the AEC, characteristic of location-specific response.

PC1 and PC2 together explained the majority of variation of plant spread. Mean spread was higher in genotypes Co16880 (Fig. S1), Co16877, and Co16866, while Co16868 and Co16881 were relatively stable in Sunsari and Ilam. Co16886 showed moderate mean with less stability, indicating greater adaptability at a single location.

Regarding the number of branches, all the variation that is useful is plotted on PC1, so AEC ranking is reliable. Co16870, Co16869, and Co16878 genotypes were superior for mean branching, while Co16866 and Co16861 were among the most stable. The control variety Co16886 was below the grand mean and thus reported to be moderately stable.

For node count, the two initial PCs accounted for a high proportion of variation together. The genotypes Co16866, Co16868, and Co16872 possessed combined higher means and good stability; Co16886 was clustered near the origin, which indicates average performance and medium stability.

For internodal length, the biplot separated mean and stability noticeably. Genotypes Co16870, Co16863, and Co16860 had longer internodes on average while Co16868 and Co16864 were most stable at sites. The control variety Co16886 remained intermediate with moderate stability.

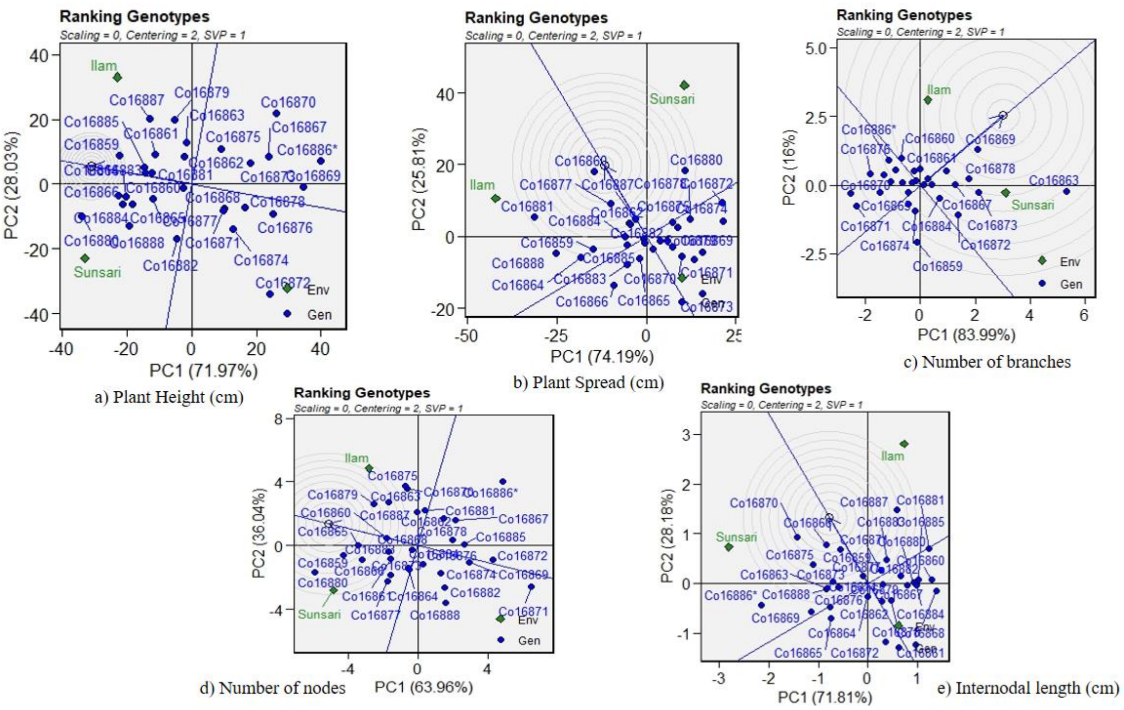


Fig. 4. GGE biplots representing mean vs. stability of traits (**a**) plant height (cm); (**b**) plant spread (cm); (**c**) number of branches; (**d**) number of nodes; (**e**) intermodal length (cm) at two locations.

Floral characteristics (GGE mean Vs. stability biplots)

Five GGE biplots (Fig. 5) rank genotypes for flower size, flower depth, flower weight, peduncle length, and petal number in Ilam and Sunsari. In each panel, movement along the AEC abscissa represents the mean for the trait (right = larger), and displacement from the AEC axis represents instability (far = less stable). PC1 captures most of the exploitable pattern in all traits (73-85%), i.e., the AEC ranking is consistent. The status of selected floral characteristics are as below:

a) Head diameter of inflorescence head: PC1 and PC2 account for about 72.8 and 27.2% of the G+GE pattern. The genotypes to the right of the diagonal have larger heads on average; entries close to the AEC axis are more uniform at different locations. Test environments on the left, therefore, and right-side entries are suitable for large, well-adapted capitula.

b) Floral depth: Depth is well-organized in order by the AEC with about 77.9% on PC1. Most genotypes cluster near the axis, indicating good to moderate stability; genotypes on right side provide more complete flowers without compromising reliability.

c) Head weight: The first principal component of the GGE biplot captures about 72.5% of the pattern in G + GE for head weight. The environment indicators diverge sharply: Sunsari to the right, Ilam to the left, indicating heavier heads are achieved in Sunsari while in Ilam tends to be lighter. Select right-and-near-axis genotypes for higher, uniform flower weight; reject points far from the axis (unstable over sites).

d) Peduncle length. The first principal component of the GGE biplot captures about 81.2% of peduncle length. The genotypes in right-hand entries have longer stalks (more suitable for bunching/cut-flower production). The genotypes of Sunsari are at right position, suggesting the place favors longer peduncles; while those of Ilam takes the left position. The genotypes at right and near axis ones can be commercially adapted, marketable stem length.

e) Petal number: The first principal component of the GGE biplot captures about 84.7% of petal number indicating ranking of AEC being strong. Some genotypes extend very far to the right (large petal numbers), but the majority group toward the origin (mean). The genotypes at right side and near axis lines can be preferred for full heads with consistent expression at locations.

Phenology traits (GGE mean: stability biplots)

Figure 6 shows GGE mean stability biplots for (a) number of days to bud formation and (b) number of days to maturity in Ilam and Sunsari. Points to the right of the AEC axis represent greater number of days (later), and points on the left represent fewer number of days (earlier). Distance from the axis represents instability across environments.

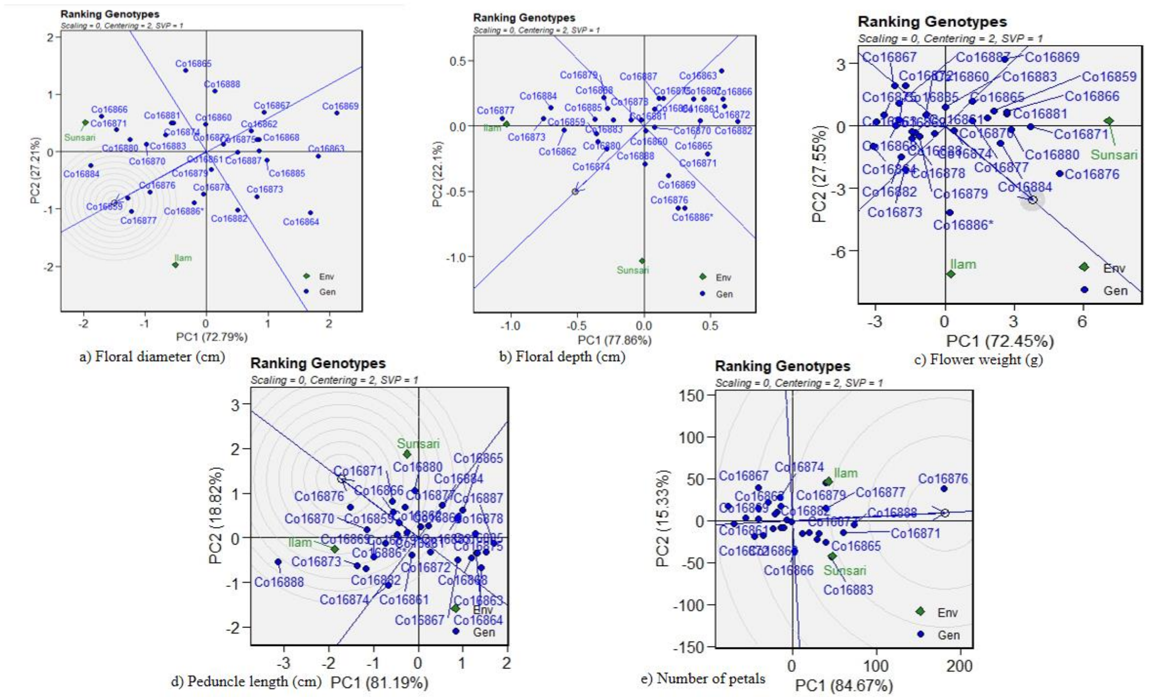
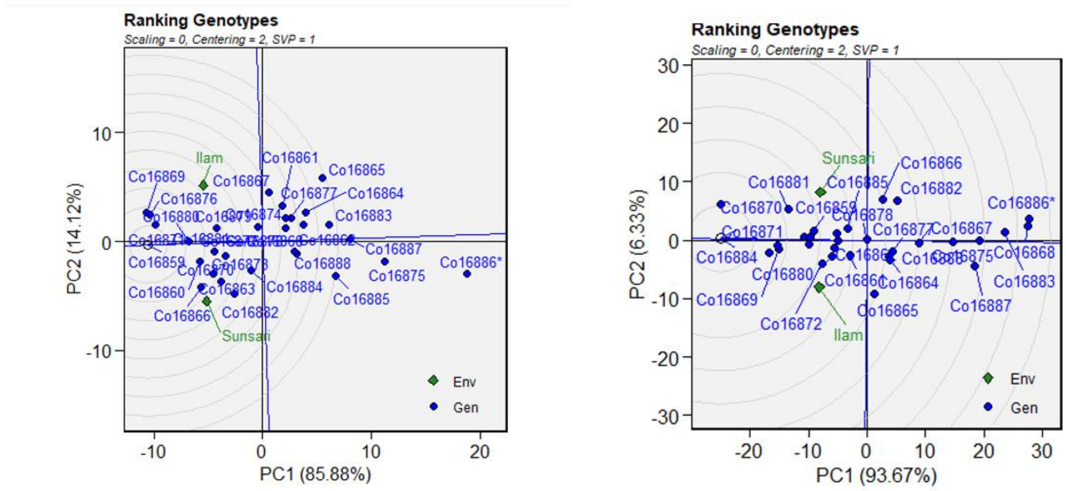


Fig. 5. GGE biplots representing mean vs. stability of traits (**a**) floral diameter (cm); (**b**) floral depth (cm); (**c**) flower weight (g); (**d**) peduncle length (cm); (**e**) number of petals at two locations.



a) Days to bud formation

b) Days to maturity

Fig. 6. GGE biplots representing mean vs. stability of traits (**a**) days to bud formation; (**b**) days to maturity at two locations.

a) Days to bud formation: PC1 explains 85.88% of the pattern (PC2 14.12%), and AEC ranking may be relied on. Most genotypes cluster near the origin, indicating mid-level earliness with moderate stability. Entries well to the left are earlier and some near the axis (early-stable); entries well to the right are late, the control genotype Co16886* one of the very late but still very stable (minuscule projection from the axis). Both Sunsari and Ilam are located on the left side of the AEC, which means that, relative

to the “average environment,” bud initiation will occur earlier at both places.
b) Maturity days: PC1 accounts for 93.67% (PC2 6.33%), suggesting strong ranking. Left column genotypes mature earliest and some are close to the axis (early stable group). Right set genotypes are later, and the control variety Co16886 again is one of the latest and very stable. Environment markers bifurcate: Ilam on the left (later trend for maturity), and Sunsari on the right (earlier trend for maturity).
Typically, for short-season or risk-averse planting, genotypes left from center, near to axis genotypes in both panels (stable and early) can be selected. To produce seed or stagger harvest, cross an early stable line (optimized for Ilam) with a late stable line (well covered in Sunsari). This pattern follows standard AEC "mean vs stability" and "ideal genotype" selection logic used for GGE biplots.

Overall output trait (GGE mean: stability biplot)

Figure 7 shows GGE "ranking genotypes" biplot for the main output trait (e.g., marketable flower yield per plant). Genotypes at the right of the Average Environment Coordination (AEC) have higher in mean, and distance from the AEC axis indicates reduced stability among sites.

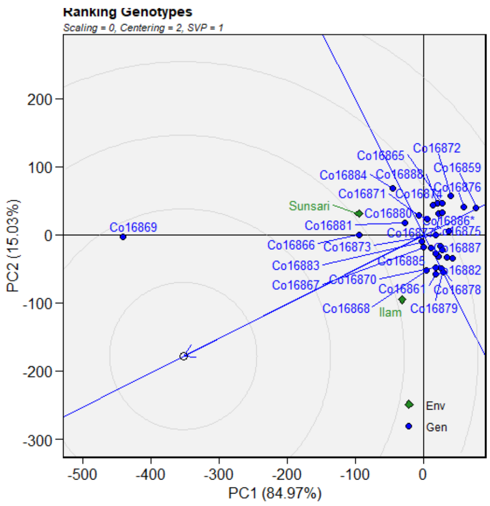


Fig. 7. GGE biplots representing mean vs. stability of number of flowers at two locations.

PC1 explains about 85% of the pattern (PC2 explains about 15%), so the AEC ranking is good. Most of the entries are clustered in the right hand quadrant near the AEC axis, indicating that several genotypes combine above-average yields with acceptable stability. Specifically, Co16872, Co16859, Co16865, Co16884, and Co16871 are to the right and near the axis and hence are promising lines for broad recommendation. The commercial variety, Co16886*, as the control, is also to the right with a short perpendicular projection, indicating above-mean yield with moderate stability. In contrast, Co16869 is far to the left and close to the axis, marking it as a low-yielding line with stable performance instead of an unstable one.
The environment markers are reasonably distant from each other, suggesting some site discrimination but with no site dominating the ranking. For general release, prioritize genotypes closest to the bullseye (high mean, low instability) on the right—e.g., Co16872/Co16859/Co16865 and only consider site-specific testing for entries with larger perpendicular projections.

Discussion

Marigold (*Tagetes* spp.), part of the Asteraceae family, is a popular ornamental plant. It has economic and cultural significance in developing countries, being used for decoration, gardening, religious offerings, cosmetics, food preservatives, and pharmaceuticals. Its success in the market comes from its hardiness, easy cultivation, and ability to adapt to different climates (Singh et al., 2017). Important traits like plant height, number of nodes, internodal distance, flower size, color, and yield affect its commercial value and profitability, especially for hybrid and cut-flower production (Sai et al., 2020; Haque et al., 2013). This study looked at the growth and yield traits of thirty marigold genotypes in two locations to understand how genotype and environment affect them.
Market demand affects preferences for plant height. Taller varieties are preferred for cut flowers, while shorter types are better for bedding and pots. Plant height varied by location, supporting findings from Sharma et al. (2019) that show environmental conditions greatly affect growth. Genotypic

differences also contributed to variations in plant height, aligning with the work of Singh et al. (2014) and Thakur and Kaur (2023). Additionally, plant spread and branching habits influence overall yield and the visual quality of the crop. Dense and well-branched plants typically produce more marketable flowers (Sonklien et al., 2020). Both location and genotype played a role in plant spread, confirming earlier observations by Kumar et al. (2014), Singh and Mishra (2008), and Choudhary et al. (2014). The number of branches was higher in Ilam, likely due to cooler temperatures that reduce apical dominance and improve light availability (Schoellhorn et al., 1996). This trait also showed variation based on genotype, as noted by Bharathi and Jawaharlal (2014) and Bhusaraddi et al. (2022).

Node number and internodal distance are important for flower density. More nodes and shorter internodes usually improve flower production. Differences among genotypes reflect inherent genetic variations (Kumar et al., 2014; Majumder et al., 2018). Variations in internodal length may relate to genetic factors, as seen in maize (Ku et al., 2015) and winter squash (Almeida et al., 2020).

The timing and development of flowering after transplanting are key indicators of commercial potential, affecting both early growth and how resources are used. Budding time, flower diameter, and yield per plant are crucial for economic returns (Burlec et al., 2021). African and French marigolds have different flowering times, with African varieties taking 80 to 90 d and French varieties 30 to 55 d (Zhang et al., 2022). Floral traits like flower diameter, depth, peduncle length, weight, and number of flowers per plant changed with location, confirming the findings of Patel et al. (2020), Kumar et al. (2014), and Singh and Mishra (2008). The double transplanting in Sunsari delayed bud formation, showing the impact of environmental conditions (Abbas, 2019).

Flower diameter, peduncle length, and petal number showed notable differences based on genotype. A larger flower diameter generally correlates with better overall performance, making specific genotypes more appealing for breeding (Singh et al., 2014; Singh et al., 2008). Peduncle length is mainly controlled by genetics, as seen in cowpea and sorghum (Rocha et al., 2009; Dansena et al., 2022). Variations in flower weight and number per plant reflect the genetic diversity within marigold populations (Patel et al., 2020; Sharma et al., 2019; Dhatt, 2014). While genetic differences control how traits express, environmental elements like temperature, humidity, and soil moisture significantly influence how plants perform. This underscores the importance of understanding how genotype interacts with the environment.

GGE mean-stability biplots offer a visual tool for assessing performance and stability of traits. Moving to the right on the AEC abscissa indicates higher average trait means, while deviation from the axis shows instability. Selecting genotypes close to the ideal target rings can improve adaptability (Yan and Kang, 2002; Yan and Tinker, 2006; Yan, 2001). For cut flowers, the best traits include a larger flower diameter, suitable peduncle length, and moderate flower weight for commercial standards. In contrast, garlands or loose-flower uses prefer a greater number of petals and floral depth (Flowers Canada Growers, 1996). Relationships among plant height, branching, flower size, peduncle traits, and flower yield can guide breeding and selection choices.

The climate differences between the locations affected plant performance. The hot and humid conditions in Sunsari, followed by dry periods, showed varying levels of tolerance among landraces. Some exhibited traits like better plant spread, more nodes, greater flower depth, and longer peduncle lengths under stress (Kumar et al., 2022; Cicevan et al., 2016). The cooler, temperate climate in Ilam encouraged better branching and height, as it reduced competition and improved the ability to adapt (Griffin-Nolan et al., 2025; Siefert et al., 2015; Lajoie and Vellend, 2015). Marigold landraces showed variations in growth traits based on their unique genetics and their interactions with local soil and climate conditions. This aligns with findings from Tomasi et al. (2024), Mohammadi et al. (2017), and Yousefi and Aghdaei (2018). Environmental factors such as light, shade, soil quality, temperature, and moisture directly impacted growth patterns and trait expression (Nuraga et al., 2020).

Overall, this study confirms that both genotype and environment strongly shape the morphological traits and yield of marigolds. The genetic diversity among genotypes provides various traits for selection, while environmental conditions influence how these traits express, highlighting the need to consider the interaction between genotype and environment when choosing plants for different climates.

Conclusion

Across Ilam and Sunsari, the GGE biplots recognize few high-yielding and stable genotypes. Co16866 and Co16868 are stable “architecture” lines, while Co16872, Co16859, Co16865, Co16884, and Co16871 are outstanding for overall production. Site effects are clear: Sunsari favors longer peduncles and larger heads (cut flowers), while Ilam favors earlier development and more compact canopies (garlands and early harvests). In general, we recommend advancing the right-side/near-axis entries to wide release, pairing early-stable lines for Ilam with later-stable lines for Sunsari when a broader window or seed production is needed. Co16869 is consistently low-quality and can be dropped from further consideration.

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Author Contributions
Conceptualization, Methodology, Field work setup, Data curation, Writing, Review and Editing, JD; Conceptualization, Methodology, Data curation, Writing, Review and Editing, HN; Methodology, Review and Editing, SKM; Methodology and Data curation, PA; Methodology, Writing and Review and Editing, SB; Methodology, AC.

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Conflict of Interest
The authors indicate no conflict of interest in this work.

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Supplementary Materials

Figure S1. Co16880 in the field representing tall nature.

Table S1. Information on the collection sites of each marigold landrace with color.

Varietal code	Address	Latitude	Longitude	Altitude	Color
Co16859	Ilam-9, Ilam	26.90277° N	87.9259° E	989	Gold
Co16860	Kamal-4, Jhapa	26.6478° N	87.7577° E	250	Orange
Co16861	Haldibari-3, Jhapa	26.5448° N	88.0314° E	94	Orange
Co16862	Sundarharaicha -8, Morang	26.6679° N	87.3649° E	320	Gold
Co16863	Kanepokhari-7, Morang	26.6013° N	87.49689° E	114	Orange
Co16864	Itahari-20, Sunsari	26.7° N	87.28° W	110	Orange
Co16865	Ilam-9, Ilam	26.90277° N	87.9259° E	991	Orange
Co16866	Haldibari-3, Jhapa	26°30′N	88°01′E	103	Orange
Co16867	Haldibari-3, Jhapa	26.50°N	88.01°E	96	Gold
Co16868	Haldibari-3, Jhapa	26.56199°N	88.01911°E	98	Orange
Co16869	Ilam-5, Ilam	26.91039° N	87.923675° E	1,205.58	Red
Co16870	Kanepokhari-7, Morang	26.6599° N	87.51° E	169	Orange
Co16871	Ilam-5, Ilam	26.91039° N	87.923675° E	1,207	Gold
Co16872	Ilam-5, Ilam	26.945° N	87.453° E	1210	Orange
Co16873	Kamal- 4 ,kerkha	26.78° N	87.77° E	150	Orange
Co16874	Ilam-5, Ilam	26.91039° N	87.923675° E	1,207	Gold

Co16875	Sundarharaicha -8, Morang	26.68° N	87.51° E	330	Orange
Co16876	Ilam-9, Ilam	26.277° N	87.259° E	993	Orange
Co16877	Ilam-9, Ilam	26.754° N	87.786° E	991	Orange
Co16878	Haldibari-3, Jhapa	26.56199°N	88.01911°E	99	Orange
Co16879	Kamal-4, Jhapa	26.6478° N	87.7577° E	154	Gold
Co16880	Ilam 5, Ilam	26.91039° N	87.923675° E	1,210	Yellow
Co16881	Ilam-9, Ilam	26°54′30″N	87°55′35″E	991	Gold
Co16882	Kamal 4, Jhapa	26.6478° N	87.7577° E	336	Orange
Co16883	Kamal 4, Jhapa	26.6479° N	87.7575° E	334	Gold
Co16884	Ilam-9, Ilam	26.90277° N	87.9259° E	1001	Yellow
Co16885	Haldibari-3, Jhapa	26.56199°N	88.01911°E	98	Yellow
Co16886**	Commercial variety (Karma-555-Orange)				Orange
Co16887	Itahari-20, Sunsari	26.7° N	87.28° W	112	Orange
Co16888	Ilam-9, Ilam	26.90277° N	87.9259° E	998	Orange

Table S2. Interaction effect of growing location and marigold landraces on different growth traits.

Location	Landraces	Plant Height (cm)	Plant Spread (cm)	Number of branches	Internodal Length (cm)
Ilam	Co16859	$151.11 \pm 2.62^{abcdefghi}$	83.27 ± 7.92^{abcde}	3.11 ± 0.58^{m}	$4.82 \pm 0.59^{efghijklmn}$
Ilam	Co16860	$141.11 \pm 3.72^{abcdefghi}$	88.27 ± 3.31^{abc}	$6.11 \pm 0.44^{defghijklm}$	$4.69 \pm 0.39^{fghijklmn}$
Ilam	Co16861	$145.22 \pm 4.40^{abcdefghi}$	62.00 ± 3.17^{bcdefgh}	$5.77 \pm 0.96^{efghijklm}$	3.34 ± 0.34^{n}
Ilam	Co16862	$139.55 \pm 12.20^{abcdefghi}$	75.16 ± 4.97^{abcdefg}	5.44 ± 0.40^{fghijklm}	4.02 ± 0.27^{jklmn}
Ilam	Co16863	$142.77 \pm 10.80^{abcdefghi}$	67.00 ± 7.00^{bcdefgh}	5.44 ± 0.67^{fghijklm}	3.99 ± 0.75^{jklmn}
Ilam	Co16864	$139.55 \pm 3.65^{abcdefghi}$	86.11 ± 9.38^{abcd}	5.22 ± 0.67^{ghijklm}	4.04 ± 1.01^{jklmn}
Ilam	Co16865	$136.55 \pm 11.3^{abcdefghij}$	$69.88 \pm 4.73^{abcdefgh}$	4.44 ± 0.96^{klm}	3.43 ± 0.68^{mn}
Ilam	Co16866	$141.33 \pm 3.86^{abcdefghi}$	75.16 ± 3.34^{abcdefg}	5.22 ± 0.67^{ghijklm}	$4.84 \pm 0.78^{efghijklmn}$
Ilam	Co16867	$124.66 \pm 4.94^{cdefghij}$	$69.66 \pm 6.55^{abcdefgh}$	5.33 ± 0.50^{ghijklm}	4.45 ± 0.22^{ghijklmn}

Ilam	Co16868	119.33±9.19^{defghij}	63.72±5.54^{bcdefgh}	4.88±0.55^{hijklm}	4.50±0.39^{ghijklmn}
Ilam	Co16869	110.88±4.94^{ij}	53.38±3.36^{defgh}	6.66±1.07^{cdefghijklm}	3.45±0.56^{mn}
Ilam	Co16870	134.33±7.04^{bcdefghij}	58.61±7.10^{cdefgh}	4.66±0.19^{jklm}	4.84±0.31^{efghijklmn}
Ilam	Co16871	119.00±6.55^{defghij}	55.05±8.87^{cdefgh}	4.22±0.40^{lm}	4.62±0.31^{fghijklmn}
Ilam	Co16872	89.666±20.40^{j}	51.55±5.59^{efgh}	4.22±0.29^{lm}	3.24±0.39^{n}
Ilam	Co16873	126.22±15.70^{bcdefghij}	50.66±2.81^{efgh}	5.11±0.55^{ghijklm}	4.15±0.49^{ijklmn}
Ilam	Co16874	112.66±7.89^{hij}	49.88±1.39^{efgh}	4.22±0.58^{lm}	4.06±0.52^{ijklmn}
Ilam	Co16875	135.00±10.50^{bcdefghij}	63.66±6.80^{bcdefgh}	4.77±0.44^{ijklm}	4.38±0.47^{hijklmn}
Ilam	Co16876	109.44±5.80^{ij}	65.55±1.97^{bcdefgh}	5.44±0.90^{fghijklm}	3.65±0.36^{lmn}
Ilam	Co16877	134.44±6.18^{bcdefghij}	81.66±4.17^{abcdef}	5.66±1.07^{efghijklm}	4.41±0.26^{ghijklmn}
Ilam	Co16878	116.22±3.65^{efghij}	58.88±2.09^{bcdefgh}	5.55±1.09^{fghijklm}	4.08±0.49^{ijklmn}
Ilam	Co16879	150.55±11.20^{abcdefghi}	61.83±7.56^{bcdefgh}	5.44±1.30^{fghijklm}	4.35±0.46^{hijklmn}
Ilam	Co16880	142.44±4.65^{abcdefghi}	63.61±4.20^{bcdefgh}	5.22±1.05^{ghijklm}	4.54±0.44f^{ghijklmn}
Ilam	Co16881	131.88±7.90^{bcdefghij}	**101.3±6.00^{a}**	5.33±0.66^{ghijklm}	5.28±0.57^{defghijklmn}
Ilam	Co16882	119.88±9.03^{defghij}	74.94±9.05^{abcdefg}	5.66±0.69^{efghijklm}	4.6±0.44^{fghijklmn}
Ilam	Co16883	142.33±8.59^{abcdefghi}	73.11±4.95^{abcdefg}	5.77±0.48^{efghijklm}	4.86±0.47^{efghijklmn}
Ilam	Co16884	138.44±6.54^{abcdefghij}	75.44±5.58^{abcdefg}	4.77±0.48^{ijklm}	4.50±0.37^{ghijklmn}
Ilam	Co16885	143.88±2.05^{abcdefghi}	74.38±6.41^{abcdefg}	5.22±0.58^{ghijklm}	4.62±0.31^{fghijklmn}
Ilam	Co16886*	114.33±0.88^{ghij}	70.27±1.21^{abcdefgh}	6.00±0.57^{defghijklm}	3.32±0.14^{n}
Ilam	Co16887	155.22±0.77^{abcdefghi}	73.94±5.69^{abcdefg}	5.26±0.49^{ghijklm}	5.88±1.08^{cdefghijklmn}
Ilam	Co16888	131.55±8.50^{bcdefghij}	93.11±7.94^{ab}	5.22±0.40^{ghijklm}	3.96±0.21^{klmn}
Sunsari	Co16859	165.88±6.79^{abcde}	46.88±2.05^{gh}	9.62±0.51^{bcdefghi}	8.56±0.52^{abc}
Sunsari	Co16860	160.88±5.11^{abcdefgh}	68.05±9.12^{abcdefgh}	8.79±0.33^{bcdefghijkl}	6.63±0.66^{abcdefghijklm}
Sunsari	Co16861	156.66±4.40^{abcdefghi}	53.05±4.72^{defgh}	10.40±1.29^{abcde}	6.62±1.07^{abcdefghijklm}

Sunsari	Co16862	$149.55\pm8.37^{abcdefghi}$	56.5 ± 6.36^{cdefgh}	9.82 ± 0.17^{bcdefg}	7.49 ± 0.43^{abcdefgh}
Sunsari	Co16863	$146.66\pm12.00^{abcdefghi}$	51.11 ± 3.91^{efgh}	14.8 ± 0.11^{a}	8.62 ± 0.43^{abc}
Sunsari	Co16864	171.44 ± 3.08^{abc}	43.77 ± 1.62^{gh}	$8.91\pm0.81^{bcdefghijkl}$	7.8 ± 0.18^{abcdef}
Sunsari	Co16865	171.22 ± 2.11^{abc}	47.56 ± 0.55^{fgh}	9.18 ± 1.75^{bcdefghijk}	8.40 ± 0.31^{abcd}
Sunsari	Co16866	173.44 ± 16.80^{abc}	38.66 ± 1.10^{h}	9.69 ± 1.66^{bcdefgh}	8.87 ± 0.61^{abc}
Sunsari	Co16867	$128.33\pm2.54^{bcdefghij}$	52.33 ± 6.79^{defgh}	10.80 ± 1.21^{abcd}	$7.07\pm0.36^{abcdefghijk}$
Sunsari	Co16868	$148.88\pm7.34^{abcdefghi}$	54.16 ± 2.60^{cdefgh}	9.15 ± 0.45^{bcdefghijk}	$6.48\pm0.43^{bcdefghijklmn}$
Sunsari	Co16869	125.00 ± 8.38^{cdefghij}	53.66 ± 6.27^{defgh}	11.50 ± 1.56^{abc}	8.82 ± 0.56^{abc}
Sunsari	Co16870	118.66 ± 17.00^{defghij}	51.00 ± 4.58^{efgh}	$7.08\pm0.36^{bcdefghijklm}$	9.48 ± 0.74^{ab}
Sunsari	Co16871	$149.44\pm14.90^{abcdefghi}$	51.11 ± 7.80^{efgh}	$7.33\pm0.91^{bcdefghijklm}$	7.67 ± 0.18^{abcdefg}
Sunsari	Co16872	$152.22\pm6.40^{abcdefghi}$	68.33 ± 8.03^{abcdefgh}	11.00 ± 1.73^{abc}	$7.21\pm0.34^{abcdefghijk}$
Sunsari	Co16873	$134.00\pm0.66^{bcdefghij}$	42.38 ± 6.78^{gh}	11.70 ± 1.07^{ab}	8.55 ± 0.53^{abc}
Sunsari	Co16874	$150.22\pm8.86^{abcdefghi}$	63.38 ± 11.9^{bcdefgh}	9.45 ± 1.00^{bcdefghij}	8.41 ± 0.91^{abcd}
Sunsari	Co16875	$138.88\pm13.60^{abcdefghij}$	59.66 ± 6.83^{bcdefgh}	$8.13\pm0.83^{bcdefghijkl}$	9.02 ± 0.6^{abc}
Sunsari	Co16876	$137.33\pm11.3^{abcdefghij}$	53.94 ± 5.21^{defgh}	$7.73\pm0.66^{bcdefghijklm}$	8.47 ± 0.79^{abcd}
Sunsari	Co16877	165.11 ± 7.71^{abcdef}	60.33 ± 3.42^{bcdefgh}	$8.62\pm0.55^{bcdefghijkl}$	7.99 ± 0.61^{abcde}
Sunsari	Co16878	$143.33\pm4.61^{abcdefghi}$	61.77 ± 1.25^{bcdefgh}	11.30 ± 1.37^{abc}	7.32 ± 0.8^{abcdefghi}
Sunsari	Co16879	$145.55\pm12.80^{abcdefghi}$	58.61 ± 7.27^{cdefgh}	$8.21\pm0.40^{bcdefghijkl}$	7.56 ± 0.43^{abcdefgh}
Sunsari	Co16880	186.11 ± 2.00^{a}	74.50 ± 4.15^{abcdefg}	$8.92\pm1.10^{bcdefghijkl}$	$6.96\pm0.69^{abcdefghijk}$
Sunsari	Co16881	$155.44\pm7.26^{abcdefghi}$	51.61 ± 7.67^{efgh}	9.41 ± 0.83^{bcdefghij}	$6.84\pm0.82^{abcdefghijkl}$
Sunsari	Co16882	166.11 ± 10.50^{abcd}	56.22 ± 4.39^{cdefgh}	9.30 ± 1.16^{bcdefghijk}	7.25 ± 0.35^{abcdefghij}
Sunsari	Co16883	162.44 ± 5.02^{abcdefg}	45.16 ± 0.75^{gh}	9.48 ± 0.28^{bcdefghij}	7.60 ± 0.52^{abcdefgh}
Sunsari	Co16884	173.66 ± 8.54^{abc}	52.66 ± 10.1^{defgh}	10.20 ± 0.73^{abcdef}	$6.89\pm0.15^{abcdefghijkl}$
Sunsari	Co16885	161.55 ± 2.83^{abcdefgh}	50.55 ± 2.22^{efgh}	9.96 ± 0.86^{bcdefg}	$6.88\pm0.43^{abcdefghijkl}$

Sunsari	Co16886*	116.00±3.78^{fghij}	53.09±2.29^{defgh}	8.33±0.42^{bcdefghijkl}	**9.83±0.87^{a}**
Sunsari	Co16887	151.88±5.16^{abcdefghi}	58.05±7.01^{cdefgh}	9.27±0.48^{bcdefghijk}	7.66±0.34^{abcdefg}
Sunsari	Co16888	175.88±6.45^{ab}	43.38±4.78^{gh}	8.49±0.58^{bcdefghijkl}	8.64±0.47^{abc}

Table S3. Interaction effect of growing location and marigold landraces on different reproductive traits.

Location	Landrace	Days to bud formation	Days to maturity
Ilam	Co16859	63.00±1.53^{abcdefghij}	96.00±4.17^{bcdefgh}
Ilam	Co16860	63.00±2.09^{abcdefghij}	93.67±0.34^{bcdefghijk}
Ilam	Co16861	61.00±0.58^{defghijkl}	94.67±2.61^{bcdefghijk}
Ilam	Co16862	58.34±0.89^{hijklm}	90.00±2.09^{cdefghijklmn}
Ilam	Co16863	60.34±0.34^{efghijkl}	98.00±4.51^{bcdefg}
Ilam	Co16864	59.00±3.79^{ghijklm}	90.34±5.37^{bcdefghijklmn}
Ilam	Co16865	60.00±2.89^{efghijkl}	96.34±1.21^{bcdefgh}
Ilam	Co16866	61.34±2.41^{cdefghijkl}	84.00±2.65^{ghijklmnop}
Ilam	Co16867	62.67±1.46^{bcdefghijk}	84.67±1.46^{fghijklmnop}
Ilam	Co16868	57.34±1.46^{ijklm}	69.34±2.34^{q}
Ilam	Co16869	69.67±1.46^{abcd}	102.67±1.77^{abcd}
Ilam	Co16870	61.34±1.86^{cdefghijkl}	104.34±3.39^{abc}
Ilam	Co16871	68.34±1.86^{abcde}	102.34±4.92^{abcd}
Ilam	Co16872	61.34±1.21^{cdefghijkl}	99.00±2.89^{abcdef}
Ilam	Co16873	61.67±0.34^{bcdefghijkl}	98.34±3.39^{bcdefg}
Ilam	Co16874	60.00±0.00^{efghijkl}	95.67±2.19^{bcdefgh}
Ilam	Co16875	50.67±2.34^{mn}	77.00±1.16^{mnopq}
Ilam	Co16876	69.34±2.34^{abcd}	94.34±0.34^{bcdefghijk}
Ilam	Co16877	59.67±0.89^{efghijkl}	89.00±5.57^{defghijklmno}
Ilam	Co16878	59.34±0.67^{fghijklm}	90.67±0.67^{bcdefghijklm}
Ilam	Co16879	64.00±2.09^{abcdefghi}	97.34±2.97^{bcdefg}
Ilam	Co16880	65.00±2.89^{abcdefghi}	97.00±1.53^{bcdefg}
Ilam	Co16881	62.67±1.46^{bcdefghijk}	96.67±2.73^{bcdefgh}
Ilam	Co16882	58.67±1.21^{ghijklm}	82.34±2.85^{hijklmnopq}
Ilam	Co16883	56.67±0.89^{ijklm}	73.00±3.47^{pq}
Ilam	Co16884	59.00±1.00^{ghijklm}	104.34±3.93^{abc}
Ilam	Co16885	53.00±1.74^{lmn}	91.67±2.34^{bcdefghijkl}
Ilam	Co16886*	44.34±0.67^{n}	68.34±3.39^{q}

Ilam	Co16887	54.34±2.34 [jklm]	80.67±3.93 [jklmnopq]
Ilam	Co16888	57.00±2.09 [ijklm]	80.34±2.41 [klmnopq]
Sunsari	Co16859	70.00±0.00 [abc]	99.00±0.58 [abcdef]
Sunsari	Co16860	70.00±0.00 [abc]	96.00±1.53 [bcdefgh]
Sunsari	Co16861	61.00±1.00 [defghijkl]	91.67±0.34 [bcdefghijkl]
Sunsari	Co16862	61.00±1.00 [defghijkl]	87.00±1.16 [efghijklmnop]
Sunsari	Co16863	70.00±0.00 [abc]	101.67±2.73 [abcd]
Sunsari	Co16864	60.00±0.00 [efghijkl]	86.34±0.67 [fghijklmnop]
Sunsari	Co16865	56.67±0.89 [ijklm]	84.00±2.09 [ghijklmnop]
Sunsari	Co16866	71.67±1.67 [a]	94.67±2.61 [bcdefghijk]
Sunsari	Co16867	61.00±1.00 [defghijkl]	85.00±0.58 [fghijklmnop]
Sunsari	Co16868	63.34±1.67 [abcdefghi]	74.00±1.53 [pq]
Sunsari	Co16869	70.00±0.00 [abc]	101.00±2.09 [abcde]
Sunsari	Co16870	70.00±0.00 [abc]	113.34±1.21 [a]
Sunsari	Co16871	70.34±0.34 [ab]	101.67±0.89 [abcd]
Sunsari	Co16872	64.00±1.00 [abcdefghi]	94.00±0.58 [bcdefghijk]
Sunsari	Co16873	68.00±1.00 [abcdef]	98±0.58 [bcdefg]
Sunsari	Co16874	61.67±1.67 [bcdefghijkl]	94.34±0.67 [bcdefghijk]
Sunsari	Co16875	58.34±0.67 [hijklm]	78.00±1.16 [lmnopq]
Sunsari	Co16876	70.00±0.00 [abc]	95.00±1.53 [bcdefghij]
Sunsari	Co16877	61.34±1.34 [cdefghijkl]	87.00±1.53 [efghijklmnop]
Sunsari	Co16878	62.34±1.21 [bcdefghijk]	91.67±1.46 [bcdefghijkl]
Sunsari	Co16879	66.67±3.34 [abcdefgh]	98.67±0.89 [bcdef]
Sunsari	Co16880	69.34±0.67 [abcd]	93.67±2.97 [bcdefghijk]
Sunsari	Co16881	68.34±1.67 [abcde]	104.67±2.91 [ab]
Sunsari	Co16882	70.00±0.00 [abc]	92.67±1.46 [bcdefghijk]
Sunsari	Co16883	59.34±0.67 [fghijklm]	76.00±1.16 [nopq]
Sunsari	Co16884	67.34±1.46 [abcdefg]	101.67±1.67 [abcd]
Sunsari	Co16885	62.34±1.46 [bcdefghijk]	95.34±1.77 [bcdefghi]
Sunsari	Co16886*	54.00±0.58 [klm]	74.67±2.41 [opq]
Sunsari	Co16887	59.00±1.00 [ghijklm]	75.34±0.34 [opq]
Sunsari	Co16888	63.34±1.67 [abcdefghi]	81.00±2.09 [ijklmnopq]

Table S4. Interaction effect of growing location and marigold landraces on different floral traits.

Location	Landraces	Flower Diameter (cm)	Peduncle Length (cm)	Number of Petals	Flower Weight (g)	Flower Number
Ilam	Co16859	5.48±0.93^{abcdefghi}	4.77±0.74^{bcde}	158.34±6.00^{cdefghijklmn}	3.83±0.05^{hijklm}	14.34±2.27^{pq}
Ilam	Co16860	3.91±0.74^{fghij}	4.12±0.45^{bcde}	121.12±14.0^{hijklmn}	3.90±0.96^{ghijklm}	88.12±2.15^{efghijklmn}
Ilam	Co16861	4.25±0.76^{defghij}	4.58±1.10^{bcde}	105.62±13.30^{lmn}	4.74±0.66^{defghijklm}	126.34±22.28^{cdef}
Ilam	Co16862	3.84±0.36^{fghij}	4.30±0.53^{bcde}	147.45±8.99^{cdefghijklmn}	4.69±0.38^{defghijklm}	97.23±3.53^{defghijk}
Ilam	Co16863	3.99±0.70^{efghij}	3.15±0.25^{bcde}	152.23±7.97^{cdefghijklmn}	4.19±1.14^{fghijklm}	100.45±1.42^{defghijk}
Ilam	Co16864	4.98±0.71^{abcdefghij}	3.07±0.31^{cde}	158±12.51^{cdefghijklmn}	5.36±0.92^{cdefghijkl}	95.23±5.97^{defghijkl}
Ilam	Co16865	3.09±0.48^{j}	3.32±0.68^{bcde}	162.78±18.90^{cdefghijklmn}	3.35±0.59^{jklm}	23.78±6.17^{nopq}
Ilam	Co16866	4.20±0.56^{defghij}	4.87±0.95^{bcde}	130.00±10.34^{fghijklmn}	3.89±0.35^{hijklm}	105.78±9.37^{defghij}
Ilam	Co16867	3.47±0.46^{ghij}	3.57±0.3^{bcde}	157.56±3.79^{cdefghijklmn}	2.48±0.37^{klm}	94.00±7.69^{efghijkl}
Ilam	Co16868	3.95±0.32^{fghij}	3.26±0.38^{bcde}	118.67±7.20^{hijklmn}	4.38±1.09^{fghijklm}	125.00±8.68^{cdefg}
Ilam	Co16869	3.19±0.28^{ij}	5.44±0.23^{abcd}	116.89±16.60^{hijklmn}	1.36±0.11^{m}	216.89±32.10^{b}
Ilam	Co16870	4.49±0.66^{cdefghij}	5.50±0.35^{abcd}	150.67±18.93^{cdefghijklmn}	4.14±0.73^{fghijklm}	116.12±9.94^{defghi}
Ilam	Co16871	4.36±0.46^{cdefghij}	4.85±0.48^{bcde}	185.73±2.73^{cdefghij}	4.64±0.46^{defghijklm}	51.45±16.39^{ijklmnopq}
Ilam	Co16872	4.18±0.44d^{efghij}	4.16±0.44^{bcde}	111.23±3.66^{jklmn}	2.49±0.29^{klm}	10.12±3.38^{q}
Ilam	Co16873	4.92±0.57^{abcdefghij}	5.82±0.89^{ab}	165.39±34.7^{cdefghijklm}	6.52±1.03^{bcdefghij}	71.12±2.49^{efghijklmnopq}
Ilam	Co16874	4.02±0.71^{efghij}	5.19±0.71^{abcde}	166.56±12.60^{cdefghijklm}	4.74±0.67^{defghijklm}	31.00±6.16^{lmnopq}
Ilam	Co16875	3.97±0.40^{fghij}	3.12±0.21^{cde}	141.89±10.30^{defghijklmn}	3.87±0.91^{hijklm}	59.67±8.45^{ghijklmnopq}
Ilam	Co16876	5.29±0.73^{abcdefghij}	5.80±0.94^{ab}	304.00±29.33^{a}	6.94±1.23^{abcdefghi}	19.56±5.76^{opq}
Ilam	Co16877	5.69±0.26^{abcdefg}	4.59±0.63^{bcde}	193.00±8.84^{bcdefgh}	4.29±0.47^{fghijklm}	40.34±3.43^{jklmnopq}
Ilam	Co16878	5.10±0.39^{abcdefghij}	3.10±0.66^{cde}	153.89±7.86^{cdefghijklmn}	5.00±0.86^{defghijkl}	115.67±6.17^{defghi}
Ilam	Co16879	4.65±0.11^{bcdefghij}	4.84±0.06^{bcde}	215.28±16.4^{bcd}	4.96±0.70^{defghijkl}	119.89±9.18^{cdefgh}
Ilam	Co16880	4.47±0.66^{cdefghij}	4.33±1.05^{bcde}	139.34±13.00^{defghijklmn}	4.75±0.88^{defghijklm}	53.12±7.29^{ijklmnopq}
Ilam	Co16881	4.02±0.48^{efghij}	4.62±0.47^{bcde}	139.67±8.27^{defghijklmn}	4.00±0.39^{ghijklm}	68.56±4.46^{efghijklmnopq}

Ilam	Co16882	5.23 ± 0.39^{abcdefghij}	5.64 ± 0.82^{abc}	$159.12\pm17.1^{cdefghijklmn}$	5.88 ± 0.69^{bcdefghijk}	97.34 ± 4.05^{defghijk}
Ilam	Co16883	4.25 ± 0.15^{defghij}	3.45 ± 0.16^{bcde}	$153.78\pm7.83^{cdefghijklmn}$	3.58 ± 0.29^{ijklm}	$87.12\pm7.03^{efghijklmn}$
Ilam	Co16884	5.07 ± 0.36^{abcdefghij}	3.75 ± 0.52^{bcde}	$151.56\pm9.90^{cdefghijklmn}$	5.39 ± 0.43^{cdefghijkl}	26.12 ± 1.55^{mnopq}
Ilam	Co16885	4.27 ± 0.26^{defghij}	2.93 ± 0.13^{de}	$133.34\pm12.50^{fghijklmn}$	4.12 ± 0.68^{ghijklm}	91.23 ± 2.52^{efghijklm}
Ilam	Co16886*	5.28 ± 0.16^{abcdefghij}	5.13 ± 0.44^{abcde}	$152.00\pm3.52^{cdefghijklmn}$	8.63 ± 0.38^{abc}	37.23 ± 8.48^{klmnopq}
Ilam	Co16887	4.15 ± 0.04^{defghij}	2.73 ± 0.32^{e}	$129.78\pm18.2^{fghijklmn}$	3.30 ± 0.02^{jklm}	$84.34\pm8.69^{efghijklmno}$
Ilam	Co16888	3.32 ± 0.49^{hij}	7.56 ± 1.01^{a}	200.78 ± 23.90^{bcdefg}	4.84 ± 0.84^{defghijklm}	26.00 ± 3.87^{mnopq}
Sunsari	Co16859	6.45 ± 0.2^{abcd}	4.25 ± 0.05^{bcde}	$179.34\pm9.57^{cdefghijkl}$	7.45 ± 0.45^{abcdefg}	35.12 ± 1.82^{klmnopq}
Sunsari	Co16860	5.55 ± 0.28^{abcdefgh}	4.09 ± 0.23^{bcde}	112.34 ± 15.60^{jklmn}	4.50 ± 0.29^{efghijklm}	$62.56\pm7.10^{efghijklmnopq}$
Sunsari	Co16861	4.92 ± 0.12^{abcdefghij}	3.50 ± 0.15^{bcde}	106.67 ± 1.21^{klmn}	4.00 ± 0.29^{ghijklm}	$60.67\pm8.52^{fghijklmnopq}$
Sunsari	Co16862	4.8 ± 0.35^{bcdefghij}	4.09 ± 0.23^{bcde}	$135.67\pm7.76^{efghijklmn}$	3.84 ± 0.45^{hijklm}	$69.89\pm7.14^{efghijklmnopq}$
Sunsari	Co16863	3.63 ± 0.20^{ghij}	3.34 ± 0.23^{bcde}	119.34 ± 11.32^{hijklmn}	2.34 ± 0.34^{klm}	$65.23\pm4.90^{efghijklmnopq}$
Sunsari	Co16864	3.50 ± 0.13^{ghij}	3.00 ± 0.00^{cde}	192.67 ± 15.00^{bcdefgh}	2.17 ± 0.17^{lm}	44.45 ± 3.9^{jklmnopq}
Sunsari	Co16865	6.09 ± 0.55^{abcdef}	4.34 ± 0.17^{bcde}	203 ± 10.97^{bcdef}	6.50 ± 1.05^{bcdefghij}	$84.34\pm11.52^{efghijklmno}$
Sunsari	Co16866	7.21 ± 0.44^{a}	4.50 ± 0.29^{bcde}	$182.00\pm7.94^{cdefghijk}$	8.00 ± 0.58^{abcde}	185.78 ± 22.48^{bc}
Sunsari	Co16867	4.67 ± 0.31^{bcdefghij}	3.25 ± 0.25^{bcde}	99.67 ± 2.85^{mn}	3.17 ± 0.45^{jklm}	$90.00\pm17.07^{efghijklm}$
Sunsari	Co16868	4.63 ± 0.37^{bcdefghij}	3.25 ± 0.15^{bcde}	$142.00\pm3.52^{defghijklmn}$	3.17 ± 0.17^{jklm}	$75.67\pm3.10^{efghijklmnopq}$
Sunsari	Co16869	3.53 ± 0.06^{ghij}	3.56 ± 0.06^{bcde}	87.34 ± 4.81^{n}	8.00 ± 0.58^{abcde}	513.34 ± 35.56^{a}
Sunsari	Co16870	6.39 ± 0.12^{abcd}	4.20 ± 0.11^{bcde}	$134.67\pm3.93^{efghijklmn}$	$7.17\pm0.17a^{bcdefgh}$	$64.45\pm5.3^{efghijklmnopq}$
Sunsari	Co16871	6.92 ± 0.12^{ab}	4.75 ± 0.00^{bcde}	210.34 ± 3.85^{bcde}	9.00 ± 0.50^{ab}	111.67 ± 19.75^{defghi}
Sunsari	Co16872	5.17 ± 0.09^{abcdefghij}	3.50 ± 0.15^{bcde}	$134.34\pm5.82^{efghijklmn}$	3.67 ± 0.34^{hijklm}	$75.34\pm1.65^{efghijklmnopq}$
Sunsari	Co16873	4.42 ± 0.16^{cdefghij}	3.42 ± 0.09^{bcde}	189.67 ± 11.4^{bcdefghi}	3.50 ± 0.29^{ijklm}	$78.23\pm7.96^{efghijklmnop}$
Sunsari	Co16874	6.06 ± 0.08^{abcdef}	2.89 ± 0.48^{de}	126.34 ± 2.73^{ghijklmn}	$5.67\pm0.00^{bcdefghijkl}$	95.56 ± 7.10^{defghijkl}
Sunsari	Co16875	4.67 ± 0.31^{bcdefghij}	3.34 ± 0.17^{bcde}	$153.67\pm8.46^{cdefghijklmn}$	2.67 ± 0.17^{klm}	$62.89\pm2.81^{efghijklmnopq}$
Sunsari	Co16876	6.13 ± 0.13^{abcdef}	4.75 ± 0.15^{bcde}	264.34 ± 1.77^{ab}	10.17 ± 0.45^{a}	52.00 ± 7.58^{ijklmnopq}

Sunsari	Co16877	6.34±0.17[abcde]	4.59±0.42[bcde]	175.67±17.8[cdefghijklm]	6.50±0.50[bcdefghij]	84.23±8.90[efghijklmno]
Sunsari	Co16878	5.27±0.18[abcdefghij]	3.78±0.15[bcde]	155.67±5.93[cdefghijklmn]	3.84±0.45[hijklm]	55.12±6.67[hijklmnopq]
Sunsari	Co16879	5.25±0.44[abcdefghij]	4.00±0.00[bcde]	154.67±10.00[cdefghijklmn]	4.17±0.17[fghijklm]	51.45±3.07[ijklmnopq]
Sunsari	Co16880	6.67±0.30[abc]	4.92±0.23[abcde]	116±11.27[ijklmn]	8.17±0.61[abcd]	97.00±13.12[defghijkl]
Sunsari	Co16881	6.09±0.33[abcdef]	4.00±0.00[bcde]	150.67±8.3[cdefghijklmn]	8.00±0.58[abcde]	126.89±13.01[cde]
Sunsari	Co16882	4.67±0.17[bcdefghij]	3.34±0.17[bcde]	134.34±5.49[efghijklmn]	3.34±0.67[jklm]	52.67±3.18[ijklmnopq]
Sunsari	Co16883	6.13±0.51[abcdef]	4.17±0.45[bcde]	219.34±19.30[bc]	5.34±0.67[cdefghijkl]	94.78±17.01[defghijkl]
Sunsari	Co16884	7.17±0.23[a]	4.5±0.29[bcde]	149.34±3.85[cdefghijklmn]	7.67±0.17[abcdef]	160.34±28.48[bcd]
Sunsari	Co16885	4.42±0.31[cdefghij]	3.34±0.17[bcde]	145.00±4.73[cdefghijklmn]	3.34±0.34[jklm]	79.34±6.18[efghijklmnop]
Sunsari	Co16886*	5.39±0.08[abcdefghij]	3.84±0.17[bcde]	174.67±30.77[cdefghijklm]	5.34±0.89[cdefghijkl]	80.34±11.87[efghijklmnop]
Sunsari	Co16887	4.59±0.40[bcdefghij]	3.50±0.25[bcde]	124.67±4.34[ghijklmn]	3.34±0.89[jklm]	67.78±9.25[efghijklmnopq]
Sunsari	Co16888	5.55±0.30[abcdefgh]	3.75±0.15[bcde]	214.34±15.3[bcd]	4.84±0.61[defghijklm]	91±7.26[efghijklm]

Table S5. Vegetative traits of marigold landraces at different locations of Eastern Nepal.

Location	Number of nodes	Flower depth
Ilam	22.25±0.36[b]	2.04±0.03[b]
Sunsari	24.49±0.39[a]	3.31±0.09[a]
LSD	0.94***	0.15***
Landraces		
Co16859	26.17±2.41[a]	2.89±0.43
Co16860	24.67±0.90[ab]	2.69±0.38
Co16861	24.28±0.92[ab]	2.39±0.39
Co16862	22.67±1.67[ab]	3.00±0.43
Co16863	25.00±1.84[ab]	2.18±0.36
Co16864	23.44±2.12[ab]	2.58±0.50
Co16865	25.73±1.69[a]	2.44±0.23
Co16866	25.39±0.73[ab]	2.28±0.39
Co16867	22.17±1.30[ab]	2.35±0.34
Co16868	23.56±1.20[a]	2.73±0.41
Co16869	21.17±0.64[ab]	2.77±0.19
Co16870	24.44±1.63[ab]	2.64±0.35
Co16871	18.44±0.62[b]	2.54±0.35
Co16872	20.28±1.38[ab]	2.30±0.25
Co16873	24.11±0.48[ab]	3.03±0.48
Co16874	22.17±1.41[ab]	2.91±0.33
Co16875	24.56±1.91[ab]	2.50±0.41
Co16876	22.94±0.79[ab]	2.86±0.32
Co16877	24.17±0.69[ab]	3.19±0.54
Co16878	22.06±1.57[ab]	2.71±0.35
Co16879	25.56±1.25[ab]	2.75±0.39
Co16880	27.11±0.98[a]	2.91±0.42
Co16881	23.50±1.51[ab]	2.67±0.34
Co16882	21.83±1.34[ab]	2.31±0.31
Co16883	24.44±1.29[ab]	2.77±0.35
Co16884	23.50±1.32[ab]	2.96±0.47
Co16885	21.56±1.52[ab]	2.84±0.39
Co16886*	20.79±2.20[ab]	2.83±0.27
Co16887	23.78±1.74[ab]	2.52±0.39
Co16888	21.61±1.17[ab]	2.82±0.29
Mean	23.36	2.6
LSD	7.07**	1.2[ns]
CV(%)	13.63	20.23
Lox×races	ns	ns

**Means per column with different letters are significant via Tukey's tests ($P > 0.05$); [ns] = not significant.