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COMPARATIVE EVALUATION OF DIFFERENT DAHLIA CULTIVARS (*DAHLIA VARIABILIS* L.) FOR GROWTH, FLOWERING AND YIELD UNDER LOW HILL CONDITIONS

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ABSTRACT

Dahlia (*Dahlia variabilis* L.) is a highly diverse and commercially valuable ornamental crop, exhibiting wide variation in flower colour, form and size. This study assessed thirty-seven cultivars under the low hill agro-climatic conditions of Himachal Pradesh, India, across two consecutive growing seasons (2021–22 and 2022–23). The objective to this study was to identify superior cultivars for commercial cultivation. Among the tested genotypes, 'Cooch Behar' recorded tallest plants (123.65 cm) and spread (56.28 cm), making it ideal for open-field production. 'Matungini' exhibited compact growth (47.23 cm height), sturdy stems (2.74 cm), early flowering (53.05 days), prolonged blooming (82.78 days), highest yield (18.17 stems/plant) and large flowers (22.85 cm diameter), marking it as a highly promising cultivar. 'Giani Zail Singh' performed consistently with good yield (16.67 stems/plant) and the longest vase life (6.83 days), enhancing its market appeal. Differences in flowering phenology among cultivars enable staggered harvesting and prolonged market availability. Overall, the findings offer practical recommendations for growers and breeders to optimize dahlia production in low hill regions. Cultivars 'Matungini,' 'Cooch Behar' and 'Giani Zail Singh' emerge as promising genotypes for commercial cut-flower production and breeding programs targeting yield improvement, early and extended flowering.
***Keywords*:** Dahlia, evaluation, cultivars and low hills.

Introduction

Dahlia (*Dahlia variabilis* L.) is a tuberous perennial of the family Asteraceae, renowned for its exceptional diversity of flower colours, forms and sizes. Native to the volcanic highlands of Mexico and Central America, it was introduced into European horticulture in the early 19th century, with pioneering works by Hogg (1853) and Dean (1903) documenting its cultivation and taxonomy. Over the past century, sustained breeding efforts have generated tens of thousands of cultivars, from giant "dinner plate" types to petite pompons, making dahlia one of the most genetically diverse ornamental crops globally (Srivastava and Trivedi, 2022; Royal Horticultural Society, 2023). Its adaptability to temperate through subtropical climates has secured its role as a major crop in ornamental horticulture, landscaping and the cut-flower industry.

Globally, the production of dahlia tubers and cut flowers is substantial but concentrated among a few leading countries. The Netherlands remains the dominant producer, contributing over 80% of global commercial tuber output and cultivating about 400 ha annually for export (Marina, 2015; FAO, 2023). With advanced greenhouse technologies, climate-controlled nurseries, and efficient international logistics, Dutch growers supply millions of high-quality tubers each year to major markets including the USA, UK, Germany, France, Japan, and Canada. France (~40 ha) and Chile (~7.3 ha) rank far behind, while the USA, Japan, and New Zealand play a notable role in cut flower markets and offseason supply (USDA, 2023;

MAFF Japan, 2023). Dahlias retain a strong foothold in the €0.5 billion global cut flower trade, catering to seasonal demand in Europe, North America, and Asia, although crop-specific acreage statistics are often limited. Comparative varietal trials in regions such as Saurashtra, Gujarat (Zala *et al*., 2002) and the transitional zone of Karnataka (Vikas, 2009) underscore the importance of local agro-ecological conditions in shaping cultivar performance. In India, floriculture spans 2.85 lakh ha, yielding 9.47 lakh tonnes of cut flowers and 22.84 lakh tonnes of loose flowers in 2023–24, with exports of 19,678 MT valued at □717.83 crore to destinations such as the USA, the Netherlands, and the UAE (NHB, 2024; MoAFW, 2024; APEDA, 2024). Although gladiolus, rose, and marigold dominate national production, dahlia is gradually expanding its market share and economic significance (Thakur *et al*., 2022).

In India, commercial dahlia cultivation is primarily cultivated in Himachal Pradesh, Uttar Pradesh and Karnataka, with an estimated annual production of about five million tubers for domestic markets (Kumar *et al*., 2025). Cultivar performance, however, varies considerably across regions and environments. For instance, trials at Gwalior identified 'SP Kamala' as superior for flower yield, while 'Redskin' was noted for higher tuber yield (Bajaraya *et al*., 2018). Dhatt and Singh (2022) documented substantial morphological diversity in subtropical Punjab and Devi *et al*. (2020) reported wide genetic variation for productivity and quality traits. Similar performance differences among hybrids were observed in Prayagraj trials, emphasizing the need for location-specific evaluations (Jat *et al*., 2024). Earlier studies by Misra *et al*. (1990) highlighted the extensive breeding potential within *Dahlia variabilis* germplasm. In the low hill regions of Himachal Pradesh, optimizing planting dates enhanced tuber yield by more than 25% (Kumar *et al*., 2024), while recent work on propagation techniques has shown improvements in production efficiency (Kumar, 2024). Nonetheless, comprehensive multi-trait evaluations of dahlia cultivars under low hill conditions remain limited, constraining precise cultivar recommendations for growers.

The present study was undertaken to address this need by systematically evaluating selected dahlia cultivars for vegetative growth, flowering traits, and yield under low hill conditions. The objectives were to: (i) assess cultivars variation in key growth parameters, (ii) examine flowering and quality attributes and (iii) identify superior cultivars suitable for sustainable commercial cultivation in low hill agro-climates.

Material and Methods

This work was supported by PPV&FRA. The field experiment was conducted during two consecutive years (2021-22 and 2022-23) at the Experimental Farm of the Regional Horticultural Research and Training Station (RHR&TS), Dhaulakuan, District Sirmour, Himachal Pradesh, India. Geographically, the site is situated at 30°04′ N latitude and 77°05′ E longitude, at an altitude of 468 m above mean sea level, falling under the sub-tropical low hill zone (Agro-climatic Zone I) of Himachal Pradesh. The experiment comprised 37 dahlia (*Dahlia variabilis* L.) cultivars as treatments (T_1-T_{37}): Aditya, Anarkali, Agni, Black Eternity, Blackout, Bhikhu's Mother, Chitchor, Cooch Behar, Dust Stone Orange, Dust Stone Red, Eternity, Gargi, Giani Zail Singh, Glory of India, Good Day, Hiranmayee, Jishu, Kamla, Kenya White, Kenya Blue, Kenya Orange, Kenya Gerua, Kenya Yellow, Ketu, Lal Bai, Matungini, Mother Teresa, Minu, Provujee, SP Kamla, Suryadev, Tenzing Norgay, Piusenia Purple, Piusenia Pink, Piusenia Red, Piusenia White and Piusenia Orange. The trial was laid out in a Randomized Block Design (RBD) with three replications. Each treatment was planted on beds measuring 1.2 m × 1.2 m, with a spacing of 60 cm × 40 cm.

Prior to experiment initiation, composite soil samples were collected from a depth of 0–15 cm to assess baseline fertility, revealing soil classified as gravelly loam to gravelly clay loam with a pH range of 6.85 to 7.04. Rooted planting material for each cultivar was procured from reliable private nurseries in Dehradun and surrounding areas and transplanted into well-prepared beds on September 15th of each experimental year. A basal dose of farmyard manure (5 kg per bed) was incorporated during field preparation and standard agronomic practices were maintained throughout the crop cycle. Irrigation was applied weekly during winter and twice per week from March onward, while intercultural operations such as hoeing, weeding and staking were performed manually. Bavistin was administered at planting to prevent fungal diseases and a balanced water-soluble fertilizer (18:18:18 NPK) was applied post-establishment. Weeding was conducted at fortnightly intervals and preventive plant protection measures were implemented as necessary. Observations were recorded for each replication from randomly selected plants, noting plant height (cm), plant spread (cm), stem girth (cm), days to flowering after transplanting, duration of flowering (days from first to last flower) and the number of cut flowers produced per plant. Additionally, flower characteristics including flower

size (cm) and vase life of cut stems (days) were assessed.

Results and Discussion

The tested dahlia genotypes demonstrated significant variation in morphological and flowering characteristics across all evaluated parameters. Significant variability was observed in morphological traits such as plant height, spread and stem girth among the cultivars across both seasons (Table 1). 'Cooch Behar' attained the tallest plant (123.65 cm pooled), followed by 'Suryadev' (112.33 cm) and 'Mother Teresa' (111.65 cm), whereas 'Matungini' (47.23 cm) and 'Minu' (58.22 cm) consistently exhibited a dwarf habit. Plant spread was recorded maximum in 'Gargi' (56.98 cm pooled), statistically at par with 'Matungini' and 'Suryadev', while 'Agni' (39.10 cm) and 'Black Eternity' (39.77 cm) recorded the minimum spreads, indicating suitability for dense planting. Stem girth also varied considerably, with 'Matungini' (2.74 cm), 'Mother Teresa' (2.57 cm), and 'Suryadev' (2.53 cm) producing the thickest stems, whereas 'Minu' (1.36 cm) and 'Kenya White' (1.45 cm) had the thinnest. Thicker stems, as observed in 'Matungini' and 'Mother Teresa', provide stronger support for large blooms in *Dahlia variabilis* L. and improve post-harvest handling.

Table 1 : Effect of different dahlia cultivars on morphological traits during 2021–22, 2022–23 and pooled analysis.

Treatment	Cultivars Name	Plant Height (cm)			Plant Spread (cm)			Stem Girth (cm)		
		I Year	II Year	Pooled	I Year	II Year	Pooled	I Year	II Year	Pooled
T_1	Aditya	73.50	76.33	74.92	39.07	42.47	40.77	1.92	2.01	1.97
T_2	Anarkali	81.27	85.33	83.30	43.87	47.43	45.65	2.16	2.59	2.38
T_3	Agni	62.70	65.00	63.85	37.40	40.80	39.10	1.80	1.86	1.83
T_4	Black Eternity	62.77	65.90	64.33	38.33	41.20	39.77	1.80	1.84	1.82
T_5	Blackout	83.60	87.23	85.42	39.13	42.43	40.78	2.11	2.16	2.13
T_6	Bhikhu's Mother	78.50	80.73	79.62	39.23	42.27	40.75	1.94	2.00	1.97
T_7	Chitchor	76.77	79.83	78.30	40.20	44.00	42.10	1.89	1.92	1.91
T_8	Cooch Behar	122.10	125.20	123.65	54.27	58.30	56.28	2.34	2.58	2.46
T_9	Dust Stone Orange	68.67	71.03	69.85	38.83	43.77	41.30	1.93	2.04	1.98
T_{10}	Dust Stone Red	65.70	68.90	67.30	38.27	42.37	40.32	1.88	1.92	1.90
T_{11}	Eternity	93.23	95.67	94.45	41.10	45.60	43.35	2.15	2.21	2.18
T_{12}	Gargi	54.60	59.00	56.80	54.87	59.10	56.98	1.96	2.43	2.19
T_{13}	Giani Zail Singh	73.03	77.03	75.03	54.20	58.87	56.53	1.68	2.10	1.89
T_{14}	Glory of India	74.30	77.10	75.70	42.87	46.33	44.60	2.00	2.07	2.03
T_{15}	Good day	89.80	93.23	91.52	44.47	47.80	46.13	2.10	2.12	2.11
T_{16}	Hiranmayee	82.97	85.50	84.23	42.33	44.70	43.52	2.00	2.05	2.02
T_{17}	Jishu	96.67	99.23	97.95	42.73	45.70	44.22	2.23	2.27	2.25
T_{18}	Kamla	74.40	77.50	75.95	43.73	46.83	45.28	1.83	1.89	1.86
T_{19}	Kenya White	56.93	59.50	58.22	39.37	44.33	41.85	1.70	1.74	1.72
T_{20}	Kenya Blue	78.73	82.03	80.38	38.53	43.77	41.15	2.09	2.16	2.13
T_{21}	Kenya Orange	64.03	67.30	65.67	40.47	45.23	42.85	1.88	1.90	1.89
T_{22}	Kenya Gerua	67.00	70.23	68.62	39.93	44.60	42.27	1.87	1.90	1.89
T_{23}	Kenya Yellow	99.30	102.40	100.85	51.93	57.03	54.48	2.27	2.31	2.29
T_{24}	Ketu	67.73	70.40	69.07	40.10	44.37	42.23	1.84	1.89	1.87
T_{25}	Lal Bai	83.33	86.33	84.83	41.23	45.93	43.58	1.85	1.91	1.88
T_{26}	Matungini	45.07	49.40	47.23	54.73	58.67	56.70	2.48	2.99	2.74
T_{27}	Mother Teresa	110.33	112.97	111.65	44.97	48.43	46.70	2.41	2.74	2.57
T_{28}	Minu	56.17	60.27	58.22	39.77	43.87	41.82	1.33	1.39	1.36
T_{29}	Provujee	83.90	87.03	85.47	42.77	46.20	44.48	1.90	1.92	1.91
T_{30}	SP Kamla	83.40	86.13	84.77	41.20	45.20	43.20	1.85	1.89	1.87
T_{31}	Suryadev	110.30	114.37	112.33	53.70	59.53	56.62	2.11	2.41	2.26
T_{32}	Tenzing Norgay	85.53	89.27	87.40	52.37	58.23	55.30	2.39	2.37	2.38
T_{33}	Piusenia Purple	82.57	85.30	83.93	44.00	46.70	45.35	1.91	1.93	1.92
T_{34}	Piusenia Pink	81.63	85.00	83.32	42.73	46.03	44.38	1.87	1.91	1.89
T_{35}	Piusenia Red	83.73	86.53	85.13	41.77	45.70	43.73	1.85	1.89	1.87
T_{36}	Piusenia White	86.43	90.27	88.35	45.33	48.17	46.75	1.84	1.89	1.87
T_{37}	Piusenia Orange	79.10	82.40	80.75	45.03	48.33	46.68	1.81	1.87	1.84
CD		**1.15**	**1.32**		**0.61**	**0.33**		**0.04**	**0.04**	
SE(m)		**0.41**	**0.47**		**0.22**	**0.12**		**0.01**	**0.01**	

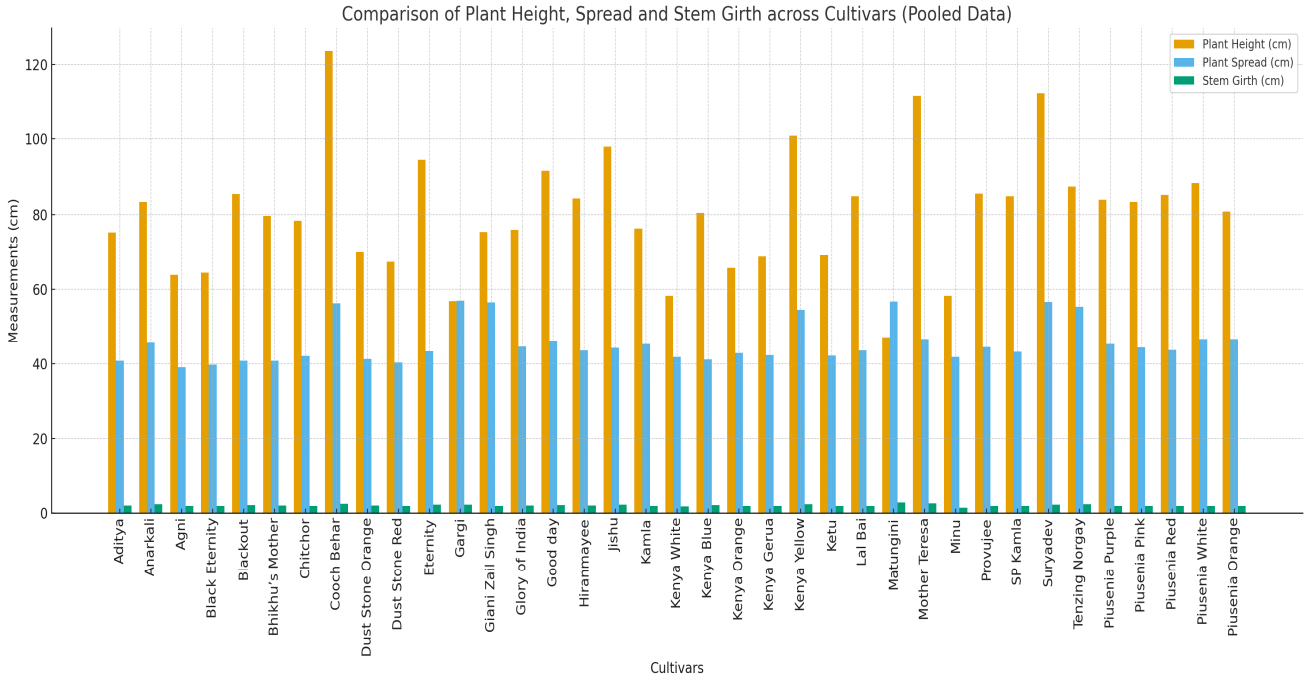

Fig. 1: Comparison of plant height, spread and stem girth across cultivers (pooled data)

Significant differences were also noted in flowering behaviour was recorded among the cultivars across both years (Table 2). The earliest flowering was recorded in 'Giani Zail Singh' with a pooled mean of 54.32 days from planting. Such early flowering cultivars are advantageous for markets demanding rapid crop turnover. In contrast, maximum days for flowering was recorded in 'Blackout' (90.68 days) and 'Eternity' (90.05 days pooled) which may be better suited for staggered harvest schedules.

Flowering duration varied considerably, with the longest flowering duration observed in 'Matungini' (82.78 days pooled), 'Giani Zail Singh' (81.08 days pooled) and 'Suryadev' whereas, 'Agni' (41.82 days pooled) and 'Minu' (43.18 days pooled) exhibited the shortest flowering durations, thereby limiting their market window. Bloom size also showed distinct differences, 'Matungini' produced the largest flowers (22.85 cm pooled), followed by 'Hiranmayee' (19.92 cm pooled) and 'Mother Teresa' (19.77 cm pooled). The smallest flowers were produced by 'Minu' (7.97 cm pooled), making them less desirable for premium cut flower markets.

Post-harvest evaluation revealed that vase life was longest in 'Giani Zail Singh' (6.83 days pooled) and 'Anarkali' (6.25 days pooled), while the shortest vase life was recorded in 'Minu' (3.20 days pooled) and 'Agni' (3.65 days pooled). The latter cultivars thus have limited suitability for long-distance transport and extended market supply chains.

Variation in plant height and spread may be due to vigorous stem elongation and efficient carbohydrate transport, consistent with findings reported by Bajaraya *et al*. (2018), Dhatt & Singh (2022), and supported by additional genetic variability studies by Singh *et al*. (2023) and Kumar *et al*. (2022). Compact cultivars like Matungini, with its short stature (47.23 cm) but wide canopy (56.70 cm), appear to allocate more assimilates toward lateral branches rather than vertical growth, aligning with observations by Devi *et al*. (2020) and Pandey *et al*. (2017). Thicker stems in Matungini (2.74 cm) and Mother Teresa (2.57 cm) point to superior vascular development, which is key for mechanical strength and sustaining water supply to flowers a trait also noted by Gheware *et al*. (2025), Verma & Kulkarni (2017), and Nag & Tamrakar (2023). These morphological distinctions influence not only plant stability but also suitability for different planting densities, as described in Dhatt & Singh (2022) and Mahawer *et al*. (2010).

Table 2 : Effect of different dahlia cultivars on flowering and yield traits during 2021–22, 2022–23 and pooled analysis.

Treatment	Cultivars Name	Days to flowering After Transplanting per Plant (days)			Duration of flowering First to last flower per Plant (days)			Number of Cut Flowers per Plant		
		I Year	II Year	Pooled	I Year	II Year	Pooled	I Year	II Year	Pooled
T_1	Aditya	78.93	77.47	78.20	52.87	60.73	56.80	13.33	14.33	13.83
T_2	Anarkali	63.53	61.37	62.45	74.63	82.10	78.37	14.00	15.00	14.50
T_3	Agni	75.63	74.40	75.02	39.80	43.83	41.82	12.33	13.33	12.83
T_4	Black Eternity	90.43	88.73	89.58	62.33	68.97	65.65	12.67	13.67	13.17
T_5	Blackout	91.53	89.83	90.68	63.03	69.97	66.50	13.67	14.67	14.17
T_6	Bhikhu's Mother	67.97	66.43	67.20	55.97	61.27	58.62	13.33	14.33	13.83
T_7	Chitchor	68.50	67.57	68.03	54.93	60.70	57.82	12.67	13.67	13.17
T_8	Cooch Behar	73.53	72.33	72.93	54.13	59.53	56.83	13.67	14.67	14.17
T_9	Dust Stone Orange	66.33	63.77	65.05	55.73	61.47	58.60	13.67	14.67	14.17
T_{10}	Dust Stone Red	66.83	64.63	65.73	55.80	63.23	59.52	12.67	13.67	13.17
T_{11}	Eternity	91.33	88.77	90.05	61.90	67.80	64.85	13.00	14.00	13.50
T_{12}	Gargi	57.43	55.47	56.45	74.53	82.83	78.68	15.33	16.33	15.83
T_{13}	Giani Zail Singh	55.67	52.97	54.32	77.47	84.70	81.08	16.33	17.00	16.67
T_{14}	Glory of India	68.97	67.47	68.22	55.27	61.23	58.25	13.00	14.00	13.50
T_{15}	Good day	79.30	76.47	77.88	58.63	63.90	61.27	14.00	15.00	14.50
T_{16}	Hiranmayee	71.43	69.30	70.37	49.77	55.87	52.82	13.67	14.67	14.17
T_{17}	Jishu	78.40	77.47	77.93	54.27	60.23	57.25	12.67	13.67	13.17
T_{18}	Kamla	79.00	78.77	78.88	55.90	60.83	58.37	12.67	13.67	13.17
T_{19}	Kenya White	68.43	67.03	67.73	55.37	60.47	57.92	12.00	13.00	12.50
T_{20}	Kenya Blue	70.40	69.53	69.97	56.13	59.53	57.83	13.33	14.33	13.83
T_{21}	Kenya Orange	67.10	65.37	66.23	49.23	54.10	51.67	13.67	14.67	14.17
T_{22}	Kenya Gerua	69.57	67.47	68.52	55.53	61.63	58.58	12.33	13.33	12.83
T_{23}	Kenya Yellow	72.40	70.13	71.27	54.10	60.17	57.13	14.33	15.33	14.83
T_{24}	Ketu	69.30	67.77	68.53	55.83	60.93	58.38	13.00	14.00	13.50
T_{25}	Lal Bai	68.40	66.43	67.42	56.03	62.07	59.05	12.67	13.67	13.17
T_{26}	Matungini	53.87	52.23	53.05	80.10	85.47	82.78	18.00	18.33	18.17
T_{27}	Mother Teresa	79.43	76.93	78.18	56.70	62.17	59.43	14.67	15.67	15.17
T_{28}	Minu	58.63	57.63	58.13	40.63	45.73	43.18	12.00	13.00	12.50
T_{29}	Provujee	69.47	66.90	68.18	56.10	62.37	59.23	14.33	15.33	14.83
T_{30}	SP Kamla	70.53	67.43	68.98	55.43	62.43	58.93	13.67	14.67	14.17
T_{31}	Suryadev	87.47	85.37	86.42	75.67	83.47	79.57	15.33	16.33	15.83
T_{32}	Tenzing Norgay	78.90	77.03	77.97	54.70	60.10	57.40	13.67	14.67	14.17
T_{33}	Piusenia Purple	70.53	67.87	69.20	56.10	62.43	59.27	12.67	13.67	13.17
T_{34}	Piusenia Pink	73.97	72.80	73.38	56.33	62.87	59.60	14.33	15.33	14.83
T_{35}	Piusenia Red	70.37	68.17	69.27	59.17	64.80	61.98	12.33	13.33	12.83
T_{36}	Piusenia White	84.67	83.33	84.00	57.47	63.93	60.70	14.00	15.00	14.50
T_{37}	Piusenia Orange	70.57	69.03	69.80	55.83	62.97	59.40	13.67	14.67	14.17
CD		**1.27**	**0.57**		**1.47**	**0.84**		**0.72**	**0.70**	
SE(m)		**0.45**	**0.20**		**0.52**	**0.30**		**0.26**	**0.25**	

Yield performance, measured as the number of cut flowers per plant, showed significant variation among the cultivars across both years (Table 3). The highest yield was obtained from 'Matungini' with a pooled mean of 18.17 flowers per plant (17.80 in 2021–22 and 18.54 in 2022–23), followed by 'Giani Zail Singh' (16.67 pooled) and 'Suryadev' (15.83 pooled). The superior productivity of these cultivars may be attributed to their favourable morphological traits coupled with longer flowering duration. Moderately high yields were recorded in 'Anarkali' (14.55 pooled) and 'Mother Teresa' (14.28 pooled). In contrast, the lowest yields were noted in 'Kenya White' (12.50 pooled) and 'Minu' (12.50 pooled), likely due to their shorter flowering period and smaller bloom size.

The superior yield potential of 'Matungini' and 'Giani Zail Singh', combined with desirable post-harvest qualities, underscores their promise for large-scale cut flower production catering to both domestic and export markets. 'Matungini' excelled with 18.17

cut stems per plant, likely owing to its thicker stem promoting enhanced phloem transport and sap flow to developing buds, which agrees with results from Singh *et al*. (2023), Burnett *et al*. (2023), and supported by Priyanka *et al*. (2017) and Gupta *et al*. (2015). 'Giani Zail Singh' also performed well with 16.67 stems and a flower diameter of 15.98 cm, consistent with improvements linked to humic acid and balanced fertilization reported by Gheware *et al*. (2025) and Pandey *et al*. (2017). Yield advantages of sturdy, well-branched plants have been documented widely, including in the subtropical Himalayan evaluations by Kumar *et al*. (2025) and the evaluations under Tarai conditions by Sajwan *et al*. (2025). These findings reinforce the critical role of varietal vigor and nutrient management in achieving higher flower yields and improved flower quality (Verma and Kulkarni, 2017; Mounika and Saravanan, 2019).

Table 3 : Effect of different dahlia cultivars on flowering and yield traits during 2021–22, 2022–23 and pooled analysis.

Treatment	Cultivars Name	Flower Size per Plant (cm)			Vase Life per cut stem (days)		
		I Year	II Year	Pooled	I Year	II Year	Pooled
T_1	Aditya	16.50	16.90	16.70	4.23	4.60	4.42
T_2	Anarkali	18.93	19.30	19.12	6.20	6.30	6.25
T_3	Agni	12.40	12.80	12.60	3.50	3.80	3.65
T_4	Black Eternity	16.00	16.40	16.20	4.40	4.60	4.50
T_5	Blackout	17.13	17.70	17.42	4.80	5.10	4.95
T_6	Bhikhu's Mother	16.00	16.27	16.13	4.30	4.60	4.45
T_7	Chitchor	16.00	16.23	16.12	4.33	4.60	4.47
T_8	Cooch Behar	19.10	19.90	19.50	4.10	4.20	4.15
T_9	Dust Stone Orange	16.03	16.20	16.12	4.20	4.30	4.25
T_{10}	Dust Stone Red	16.07	16.20	16.13	4.30	4.40	4.35
T_{11}	Eternity	16.50	17.10	16.80	4.30	4.70	4.50
T_{12}	Gargi	14.10	14.80	14.45	4.10	4.60	4.35
T_{13}	Giani Zail Singh	15.70	16.27	15.98	6.67	7.00	6.83
T_{14}	Glory of India	16.03	16.60	16.32	4.30	4.40	4.35
T_{15}	Good day	17.70	18.30	18.00	4.67	4.60	4.63
T_{16}	Hiranmayee	19.67	20.17	19.92	4.10	4.30	4.20
T_{17}	Jishu	18.30	18.70	18.50	4.20	4.60	4.40
T_{18}	Kamla	13.27	13.83	13.55	4.43	4.70	4.57
T_{19}	Kenya White	16.07	16.30	16.18	3.50	3.70	3.60
T_{20}	Kenya Blue	15.90	16.13	16.02	4.10	4.50	4.30
T_{21}	Kenya Orange	15.00	15.20	15.10	4.30	4.70	4.50
T_{22}	Kenya Gerua	16.10	16.40	16.25	4.20	4.40	4.30
T_{23}	Kenya Yellow	17.10	17.60	17.35	4.57	4.80	4.68
T_{24}	Ketu	16.00	16.30	16.15	4.20	4.40	4.30
T_{25}	Lal Bai	16.10	16.40	16.25	4.30	4.60	4.45
T_{26}	Matungini	22.60	23.10	22.85	3.67	4.00	3.83
T_{27}	Mother Teresa	19.43	20.10	19.77	4.70	4.70	4.70
T_{28}	Minu	7.80	8.13	7.97	3.20	3.20	3.20
T_{29}	Provujee	16.00	16.30	16.15	4.27	4.50	4.38
T_{30}	SP Kamla	16.03	16.27	16.15	4.40	4.60	4.50
T_{31}	Suryadev	19.03	19.60	19.32	5.70	6.10	5.90
T_{32}	Tenzing Norgay	15.53	16.03	15.78	4.70	4.60	4.65
T_{33}	Piusenia Purple	16.00	16.40	16.20	4.30	4.20	4.25
T_{34}	Piusenia Pink	14.40	14.87	14.63	4.40	4.33	4.37
T_{35}	Piusenia Red	16.10	16.70	16.40	4.27	4.30	4.28
T_{36}	Piusenia White	16.80	17.40	17.10	4.60	4.80	4.70
T_{37}	Piusenia Orange	16.00	16.20	16.10	4.20	4.30	4.25
CD		**0.17**	**0.20**		**0.18**	**0.15**	
SE(m)		**0.06**	**0.07**		**0.06**	**0.05**	

Flowering times varied significantly reflecting genetic diversity controlling floral induction and development. Early flowering in 'Matungini' (53.05 days) and Gargi (56.45 days) provides flexibility for multiple crops per year, aligning with the photoperiod sensitivity reported by Kumar *et al*. (2021), Kumar *et al*. (2024) and Verma & Kulkarni (2017). Late-flowering, dark-petalled cultivars such as Blackout required over 90 days to flower, paralleling Burnett *et al*. (2023) who found pigment traits associated with delayed anthesis. 'Matungini' also exhibited the longest flowering duration of 82.78 days, thereby extending harvest windows and improving market supply continuity, as reported by Pandey *et al*. (2017) and Singh *et al*. (2023). Vase life ranged from 3.20 days in 'Minu' to 6.83 days in Giani Zail Singh, denoting genetic variability in postharvest longevity influenced by water relations and ethylene response (Younis *et al*., 2014; Burnett *et al*., 2023). Varietal differences in flowering behaviour and vase life are further supported by Nag and Tamrakar (2023) and Srivastava and Trivedi (2022), emphasizing their commercial significance in low hill agro-climates.

Conclusion

Among the 37 dahlia cultivars tested under low hill conditions, 'Matungini' produced the highest yield with an average of 18.17 cut flowers per plant, followed by 'Giani Zail Singh' (16.67) and 'Suryadev' (15.83). In terms of vase life, 'Giani Zail Singh' showed the longest post-harvest longevity (6.83 days), followed by 'Anarkali' (6.25 days) and Suryadev (5.90 days). Considering both flower yield and vase life together, 'Giani Zail Singh' and 'Suryadev' emerged as the most balanced cultivars for commercial cut flower production under low hill conditions, while 'Matungini' excelled in yield but had shorter vase life.

Table 4 : Abbreviation used in Paper.

Abbreviation	Full Form / Meaning
Dahlia	*Dahlia variabilis* L. (scientific name of the plant)
ANOVA	Analysis of Variance (statistical method for data analysis)
CD	Critical Difference (statistical parameter in results)
DAT	Days After Transplanting
RCBD	Randomized Complete Block Design (experimental design)
NPK	Nitrogen-Phosphorus-Potassium (type of fertilizer)
MT	Metric Tonne
RHRTS	Regional Horticultural Research and Training Station
UHF	University of Horticulture and Forestry
Kg	Kilogram
Cm	Centimetre
Mm	Millimetre
MT	Metric Ton
FAO	Food and Agriculture Organization
MAFF	Ministry of Agriculture, Forestry and Fisheries (Japan)
USDA	United States Department of Agriculture
NHB	National Horticulture Board
MoAFW	Ministry of Agriculture & Farmers Welfare (India)
APEDA	Agricultural and Processed Food Products Export Development Authority (India)
RHS	Royal Horticultural Society
SE(m)	Standard Error of Mean

Disclaimer:

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and arranged the planting material. Manish Kumar conducted the field experiments, collected data, performed statistical analyses and drafted the initial manuscript. Simran Kashyap refined language and modified the manuscript for clarity and scientific accuracy. All authors reviewed and approved the final manuscript.

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Use of Artificial Intelligence in Enhancing Scientific Writing

Artificial Intelligence (AI): Artificial Intelligence (AI)-based tools were used solely to improve the organization, clarity and language of the manuscript. These tools did not generate original research content, draw scientific conclusions, or influence the study's outcomes. All inputs, data analyses, interpretations and scientific conclusions are the work of the authors. The final content was critically evaluated and approved by both authors before submission.

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