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Varietal Evaluation of Carnation (*Dianthus caryophyllus* L.) under Mid-Hill Conditions of Thunag Valley, Himachal Pradesh, India

Preeti Sharma [a], Jagreeti Gupta [a], Bandana Kumari [a], Himani Sharma [a] and Arti Ghabru [a*]

[a] College of Horticulture and Forestry, Neri, Hamirpur, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Carnation (*Dianthus caryophyllus* L.) is one of the most important cut flower crops worldwide, valued for its colour diversity, long vase life, and suitability for commercial floriculture. Its successful cultivation, however, depends on varietal adaptability to specific agro-climatic conditions. Selection of appropriate carnation cultivars for mid-hill conditions is critical for maximizing cut-flower yield and marketability. The present investigation was conducted during 2021–22 in a farmer's polyhouse at Thunag, Mandi district of Himachal Pradesh to evaluate the performance of eight standard carnation cultivars, namely Happy Golem, Liberty, Kleos, Dover, Gaudina, Baltico, Bizet and Dona. Observations were recorded on vegetative growth, floral traits, and keeping quality. The performance of eight commercial carnation varieties was evaluated under mid-hill conditions to

**Corresponding author: Email: arti.adore@gmail.com;*

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identify superior cultivars for cut flower production. Significant variability was observed among cultivars. 'Bizet' exhibited superior vegetative vigour with maximum Plant height (97.36 cm), longest stems (81.47 cm), and highest number of leaves per plant (154.18). Conversely, 'Kleos' and 'Liberty' produced comparatively shorter plants and stems. In terms of flowering, 'Bizet' was the earliest to bloom (148.73 days), while 'Gaudina' was the latest (177 days). Flowering duration was longest in 'Kleos' (16.17 days) and shortest in 'Dona' (12.47 days). For yield attributes, 'Liberty' recorded the highest number of flowers per plant (6.72), followed by 'Happy Golem' (6.21), while 'Dover' produced the least (4.34) number of flowers. Flower diameter was maximum in 'Dona' (7.01 cm), followed by 'Baltico' (6.53 cm) and minimum (5.93) in Dover. Post-harvest quality, assessed through vase life, varied significantly: 'Liberty' exhibited the longest vase life (12.6 days), whereas 'Bizet' recorded the shortest (8.18 days). Overall, 'Bizet' performed best in terms of vegetative growth and early flowering, 'Liberty' was superior in yield and vase life, and 'Dona' excelled in flower size. These results suggest that 'Liberty' and 'Dona' are most suitable for commercial cultivation under mid-hill conditions of Thunag valley, while 'Bizet' may be preferred for earliness and vegetative vigour.

Keywords: Carnation; varietal evaluation; Thunag valley; Dianthus caryophyllus.

1. INTRODUCTION

Flowers are an integral part of our day to day life. For many centuries, they have held significant place in our lives and are seen as symbols of love, admiration, beauty and loving thoughts. Floriculture is emerging as a profitable sector within horticulture, offering potential for high returns, employment generation, and export opportunities. Flower cultivation has gained popularity among growers and has seen growth in area, production, and productivity over the last twenty years, as supported by data. As per National Horticulture Board, the area under Floriculture production in India during 2023-24 was 285 thousand hectares, with a production of 2284 thousand tonnes loose flowers and 947 thousand tonnes cut flower (NHB, 2023-24). India's total export of floriculture for the year 2023-24 was USD 86.03 Million.

Among cut flowers, Carnation occupies a prominent position due to its ruffled petals, spectrum of colours, post-harvest longevity and economic value. The flower became widely popular for mass production in the mid-1800s (Galbally and Galbally, 1997). Carnation can also be used as a pot plant, for bedding purpose and edging the borders etc. In France and the Netherlands, carnations are commercially used for the extraction of perfume. In addition to its beautiful flowers it possesses various healing properties: oil derived from the plants can be beneficial for skin irritations, while tea made from carnations has been a popular remedy since ancient times and may assist in alleviating stress and anxiety. Carnation flowers are also considered to possess alexiteric, antispasmodic, cardio-tonic, diaphoretic, and carnervine tonic properties (Esmail 2017 and Chandra et al, 2016). The sugar-coated petals of carnation are consumed as candies and can also serve as decorative elements in salads.

Carnation is a half hardy herbaceous perennial plant, with flat and soft that is linear in shape and can range in color from green to a greyish-blue (Gharge et al., 2011). The flowers possess wide petals with frilled rims and are found in terminal or solitary locations along the growing stem. Carnation prefers moderate temperatures and is categorized as a cool-season plant. The optimal temperature range for carnations is deemed to be between 10°C and 20°C, while exposure to 7°C encourages branch development. Duration of 12 hours of sunlight combined with humidity levels between 50-60% is seen as highly beneficial for plant growth and flower production.

In India, carnation cultivation has gained momentum particularly in states like Himachal Pradesh, Uttarakhand, parts of Jammu and Kashmir, Kodaikanal and Ooty in Tamil Nadu, Darjeeling in West Bengal where the cool temperate climate under protected conditions promotes optimal flowering and quality (Maitra & Roychowdhury, 2013). Himachal Pradesh, with its favourable agro-climatic conditions, has the potential to greatly enhance the growth of floriculture to meet the demands of the local market and for export opportunities. The total area under flower production in Himachal Pradesh during 2023-24 was 285.74 hect out of which 85.09 area has been occupied by Carnation cultivation. Thunag, located in Mandi district of Himachal Pradesh at an altitude of ~1900 m above mean sea level, experiences a

generally temperate climate with a heavy rainfall during monsoon, mild summers, and cold winters making it conducive to carnation production in poly houses. However, a serious challenge in floriculture is that the performance of different cultivars can vary significantly from one location to another due to elusive microclimatic variations. Factors such as slight differences in temperature fluctuations, light intensity, and humidity patterns can greatly influence a plant's growth, yield, and flower quality. Hence, the selection of suitable varieties is a critical factor influencing the success of carnation cultivation. The present study aimed to assess the performance of eight carnation cultivars in terms of their vegetative growth, floral attributes and post-harvest quality under the specific environmental conditions of Thunag valley with the following objectives.

1.1 Objective of the Study

- To evaluate the performance of eight carnation cultivars in the specific microclimate of the Thunag valley.
- Evaluation of Vegetative growth, floral attributes and post-harvest quality.

2. MATERIALS AND METHODS

The field trial was carried out in a controlled environment during the growing season of 2021–22 at a progressive farmer's poly house located in Thunag, Mandi (31.6°N latitude, 77.1°E longitude), with an elevation of 1900 meters above sea level. Eight commercially available carnation varieties were selected for the study: Kleos, Domingo, Gaudina, Bizet, Yellow Liberty, White Liberty, Baltico, and Pink Dona. Disease free planting material was procured from private companies (Rise and Shine and KF Bioplants). Planting was done on raised beds using four-row planting system with spacing of 20 x 15 cm between each row and plant. Uniform series of cultural practices was followed throughout the crop production. Observations of various vegetative parameters (plant height, stem length and number of leaves) and flowering parameters (days taken for flower formation, number of flowers per plant and vase life) were recorded during the peak flowering period in the year 2022.

3. RESULTS AND DISCUSSION

3.1 Vegetative Growth Parameters

For cut flower production, plant height is a crucial characteristic; a greater plant height leads to longer stalks and improved quality of cut flowers. The observations recorded for different vegetative and floral parameters during the research were enlisted in Table 1. It has been shown in the Table that the plant height (97.36 cm) and stem length (81.47 cm) were observed to be highest in the variety Bizet among the varieties examined. In contrast, the variety Kleos exhibited the shortest plant height (67.32 cm) while variety Liberty had the shortest stem length (51.18 cm). Similar findings with variations in plant height and stem length have been documented by Jose et al. (2017), Chauhan et al. (2014) and Singh et al. (2013). This variation in plant height, can be attributed to its inherent vigorous growth habit, environmental conditions and other cultural practices followed as described by Dalal et al. (2009) and by Tarannum and Naik in (2014). The cultivar Bizet produced the highest number of leaves per plant, with an average of 154.18, followed by cultivar "Happy Golem" at 149.86 while the lowest number (87.60) of leaves was possessed by "Dover". The height of the plant may influence these outcomes. These results regarding the number of leaves align with the findings of Kumar and Singh (2003), Shiragur et al. (2004), and Sarkar and Sharma (2016).

3.2 Floral Parameters

Studied varieties shows a considerable variation in their flowering characteristics because of difference in their genetic composition. As shown in Table 1, the number of days taken to flowering ranged from 148.73 days in 'Bizet' to 177 days in 'Gaudina'. This variation is significant because it enables us to manage flower production and potentially boost profits by providing flowers to the market at different times. The flowering duration refers to the span of time during which a plant blooms, beginning with the emergence of its first flower to the end of its flowering period. In terms of flowering duration, cultivar "Kleos" exhibited the longest period (16.17 days) followed by cultivar "Dover" (15.82 days); on the other hand variety "Dona" displayed the shortest duration of flowering (12.47 days). These differences could be linked to genetic factors and physiological variations between the genotypes, as noted earlier by Karrow and Sharma (2010), Verma et al. (2012), Roni et al. (2014) and Vanlalhruaii et al. (2024).

Flower yield is an essential aspect that influences the economic potential of certain genotypes, playing a significant role in

Table 1. Morphological and floral characteristics of different cultivars

S. No.	Name of Cultivar	Plant height (cm)	Stem length (cm)	Number of leaves (NO.)	Days taken to flowering (NO.)	Flowering duration (days)	Number of flowers per plant (NO.)	Flower Diameter (cm)	Vase Life (days)
1.	Baltico	71.33	58.93	98.50	155.91	14.43	5.96	6.53	10.13
2.	Bizet	96.7	81.47	154.8	148.73	15.6	6.61	6.19	8.18
3.	Dona	69.79	56.70	138.48	158.52	12.47	4.36	7.01	10.34
4.	Dover	70.68	60.85	87.60	156.39	15.8	4.34	5.93	10.56
5.	Gaudina	75.78	57.72	131.51	177.0	13.75	4.62	6.24	11.64
6.	Happy Golem	85.73	66.84	149.8	161.70	13.4	6.21	6.08	11.73
7.	Kleos	67.32	53.57	114.45	171.74	16.17	5.03	6.34	10.67
8.	Liberty	74.66	51.18	127.72	160.93	15.20	6.72	6.39	12.6
Mean		76.49	60.90	125.36	161.365	14.60	5.48	6.33	10.73

determining their suitability for commercial cultivation which ultimately impacts farming cost. The cultivar “Liberty” exhibited the highest number of flowers per plant (6.72) followed by “Happy Golem” (6.21) while “Dover” (4.34) had the lowest yield which was comparable to cultivar Dona (4.57) and Gaudina (4.62). The variation in number of flowers produced per plant could be accredited to the dissimilarity in carbohydrate production and accumulation resulting from increased photosynthetic activity, as perceived by Tarannum and Naik (2014). Regarding flower size, cultivar “Dona” recorded biggest flower with a diameter of 7.01 cm followed by “Baltico” and “Liberty” with a flower size of 6.53 cm and 6.39 cm respectively and it was observed minimum (5.93 cm) in cultivar “Dover” This disparity in flower diameter may stem from genetic factors or greater availability of carbohydrates during the developmental stage of flower bud according to the findings of Roychowdhury and Tah (2011), Dona Ann Jose et al. (2017) and Anand et al. (2021)

The longevity of cut flowers often referred to as vase life, is an important attribute of cut flowers and is influenced by a variety of factors like genetic build up, environment factors, cultural practices employed. The current study reveals notable differences in vase life among various standard carnation cultivars. Longest vase life noted was 12.6 days in cultivar “Liberty” on the other hand vase life was documented to be shortest (8.18 days) in cultivar “Bizet”. This dissimilarity in vase life among the cultivars might be accredited to difference in accumulation of carbohydrates and the varying ability of the cultivars to produce and respond to ethylene. Additionally, this variation could also stem from differences in the genetic traits of the cultivars. Similar results referring to the variation in vase life were reported by Medeo et al. (2019), Sharma (2020) and Vanlalhruaii et al. (2024).

4. CORRELATION

Correlation is used to assess the linear connection between two qualitative variables, uncovering patterns and dependencies. It describes the strength of a relationship between two variables. The correlations among various variables are presented in Table 2, showing that the number of leaves have a positive correlation with plant height and stem length. The results are in line with the Gowda (1989) who observed the positive correlation in plant height, spike length and number of leaves in Gladiolus. The investigation further revealed that number of flowers per plant has a positive correlation with plant height, stem length, number of leaves, and flowering duration. This implies that a cultivar with more plant height, stem length, and number of leaves will result into more number of flowers per plant, subsequently boosting the plant's yield.

Table 2. Correlation matrix between different traits in standard carnation

Traits	1	2	3	4	5	6	7	8
1	1.00000	0.90075*	0.718094	-0.44815	0.02651*	0.37487	-0.42428	0.626862*
2		1.00000	0.4965*	-0.58867	0.091731	-0.3627	-0.72377	0.37766
3			1.0000	-0.058867	-0.41151	0.14469*	-0.10206	0.413685
4				1.00000	-0.11181	-0.03263	0.599807*	-0.41482
5					1.0000	-0.55618	-0.22716	0.212629
6						1.00000	-0.05906	-0.17434
7							1.000000	-0.02626
8								1.00000

1. Plant height (cm);2. Stem length (cm);3. Number of leaves (number); 4. Days taken to flowering (days);
5. Flowering Duration (days); 6. Flower Diameter (cm); 7. Vase Life (days); 8. Number of flowers/plant (number)

The results are in accordance with the findings of Karrow and Sharma (2010) and Kumar et al (2012) in chrysanthemum.

Another crucial factor that influences flower quality is the diameter of the flower. There was a significant positive correlation observed between flower size and both plant height (in cm) and the number of leaves. This indicates that selecting genotypes based on characteristics like plant height and leaf count is vital for enhancing flower size. These findings align with those reported by Vishnupriya et al. (2015) and Lydia and Ponnuswami (2019) in their studies on marigold.

5. CONCLUSION

The present study on varietal evaluation of Carnation (*Dianthus caryophyllus* L.) under agro-climatic conditions of Thunag valley, Himachal Pradesh, was done to identify the best performing varieties of Carnation for the hilly regions of the state. The investigations showed significant differences among the evaluated cultivars in terms of vegetative growth, flowering behaviour, and post-harvest performance. 'Bizet' exhibited robust vegetative growth and early flowering, making it suitable for staggered production and early market entry. 'Liberty' proved superior for flower yield and vase life, highlighting its suitability for commercial cut flower business where both yield and post-harvest longevity are essential. 'Dona' stood out as the best performer for flower size, which is a desirable attribute for premium markets.

Based on their overall performance, 'Liberty' and 'Dona' may be recommended for large-scale commercial cultivation under the protected conditions of Thunag valley, whereas 'Bizet' can be exploited for its earliness and vigorous vegetative traits. The observed variability among cultivars emphasizes the importance of site-specific varietal selection to maximize productivity and profitability in carnation cultivation. Conducting further multi-location trials over several years would be beneficial to confirm these results and improve recommendations for growers in temperate environments.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

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

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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