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# Evaluation of carnation germplasm for its growth and flowering performance

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## ABSTRACT

Investigations on evaluation of 50 cultivars of carnation *(Dianthus caryophyllus* L) with respect to growth and flowering parameters were carried out under naturally ventilated polyhouse condition at experimental farm of the Department of Floriculture and Landscape Architecture, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP during 2012-13. Cultivars like Don Pedro, Hermes, Snow Storm, Baltico and EC-19 were found superior with respect to plant height, stem length and number of cut flower stems per plant. Plant height varied from 50.41 cm in case of EC-5 to 95.61 cm in Don Pedro. Stem length which is the most important parameter from cut flower point of view was recorded highest in cultivar Hermes (71.10 cm) which was found statistically at par with cultivars Snow Storm (70.56 cm) and Don Pedro (68.15 cm) whereas minimum stem length (36.84 cm) was recorded in cultivar EC-5. Flower quality with respect to flower diameter differed significantly among cultivars. Flower size varied from 6.56 cm in case of cultivar Tempo to 5.21 cm in cultivar EC-9. Significantly the highest number of flowers per plant was recorded in cultivar Baltico (6.20) followed by cultivar EC-19 (5.77) and EC-8 (5.73) whereas minimum number of flowers per plant was observed in cultivar Kleos (3.67) followed by cultivar Hermes (3.93). Earliness in flowering was recorded in cultivar EC-10 (141.40 days) followed by cultivars EC-20 (153.87 days) and Rendez Vous (153.97 days) however late flowering was recorded in cultivar EC-1 (178.80 days) which was found statistically at par with cultivars Gaudina (177.47 days) and EC-2 (172.93 days). Significant differences existed for the stem sturdiness amongst the different carnation cultivars. Maximum 'A' grade flowers (95.56%) were recorded in cultivar Liberty followed by cultivars Madras, Arka Flame and Kleos (86.67%) whereas maximum number of 'B' grade flowers were recorded in cultivars EC-13 and Cool (71.11%). Based on the present findings it can be concluded that the cultivars Don Pedro, Hermes, Tempo, EC-9, Baltico and Liberty performed best with respect to growth, earliness in flowering, flower yield and quality.

**Keywords:** Carnation; flower yield; flower quality; crop improvement; exotic collection (EC)

## INTRODUCTION

Carnation (*Dianthus caryophyllus* L) belonging to the family Caryophyllaceae is one of the most important commercial cut flowers in the global florist trade and ranks within the top ten cut flowers of the world. It is an important flower crop having great commercial value as a cut flower due to its excellent keeping quality, wide array of colour, forms and ability to withstand long distance transportation. Carnation apart from producing cut flowers can also become useful in gardens for bedding and edging for borders, pots and rock gardens. Considering the importance and popularity of cultivating this crop there is prime need for improvement and to develop genotypes suitable for cultivation under Indian conditions.

The performance of carnation genotypes varies with region, season and growing environment. In India depending upon the regions there is a wide difference in temperature, light intensity and humidity which not only affect the yield and quality of the flowers but also limit their availability for a particular period of the year. To produce quality flowers carnation needs to be grown under cover that is in greenhouse which provides the plants with the optimum conditions of light, temperature, humidity, carbon dioxide etc for proper growth and to achieve maximum yield of best quality flowers (Bhalla et al 2006). Though there are different types of the greenhouses naturally ventilated polyhouses are preferred in mild climate in which temperature is reduced by ventilation (Ryagi et al 2007).

Growth, development, productivity and post-harvest quality of any flower crop largely depend on the genetic potential of the cultivar and environmental conditions under which they are grown. The other factors like nutrition, season, pests and diseases, production technology and cultural practices can influence the performance of the crop. Testing of various genotypes for suitability and adaptability with respect to flowering, flower quality and yield parameters are of prime importance. A systematic study of vegetative characters would facilitate the breeders to select suitable genotypes for planned breeding programme.

## MATERIAL and METHODS

The investigations were carried out to study the performance of carnation (*Dianthus caryophyllus* L) genotypes under naturally ventilated polyhouse at the research farm of Department of Floriculture and Landscape Architecture, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2012-2013. The experimental farm is located 1,276 m above mean sea level at the latitude of 32°512 02 2 N and longitude of 77°112 302 2 E. The prevalent climate of this area is sub-temperate characterized by mild summers and cool winters. The

experiment included 50 standard carnation genotypes evaluated for their yield and quality attributes. The experiment was laid out in randomized block design (RBD) replicated thrice. The rooted cuttings were planted on the raised beds of 1 m width with spacing of 20 × 15 cm. Uniform package of practices was followed throughout the cropping season to grow a successful crop. The data were collected on vegetative and flowering parameters. To measure the stem sturdiness of cut flowers they were held horizontally at a point of 25 cm above the basal cut end and the angle of deviation of cut flower head below the horizontal plane with the natural curvature of the stem towards the gravity was recorded.

Accordingly cut flowers were graded into following 3 categories:

| Grade | Deviation |
|---|---|
| 'A' | $<15^{o}$ |
| 'B' | $15^{o} – 30^{o}$ |
| 'C' | $>30^{o}$ |

The data were recorded for flower yield attributes like plant height (cm), stem length (cm), number of days for bud formation, number of days for first flowering and flower quality attributes like flower diameter (cm), flower yield (number of cut stems per plant) and stem sturdiness of cut flowers (grades) using the standard method. The mean value of the data observed was taken to represent a particular genotype with respect to character. The observations on growth, flower yield, flower quality parameters like flowers size, stem sturdiness etc of different genotypes of carnation are presented in the Table 1. The flower colour of different carnation genotypes was recorded as per the RHS (Royal Horticulture Society) colour chart (Table 2).

## RESULTS and DISCUSSION

The growth and flowering parameters of carnation genotypes are given in Table 1.

### Plant height

The plant height among the different genotypes differed significantly. The range was from 95.61 to 50.41 cm. Plant height was recorded maximum (95.61 cm) in cultivar Don Pedro and the next superior cultivars were Hermes (94.70 cm) and Snow Storm (94.24 cm) the latter two being at par. However minimum plant height (50.41 cm) was observed in cultivar EC-5 which was found statistically at par with cultivars Marathon (54.29 cm), Madras (55.69 cm) and Dark Rendez Vous (55.79 cm). The results are in agreement with the findings of Gharge et al ( 2011), Mehmood et al (2014), Misra (2002), Mukund et al (2004) and Roychowdhury and Tah (2011) while working with various carnation cultivars.

### Stem length

Significantly higher cut flower stem length (71.10 cm) was recorded in cultivar Hermes which was statistically at par with

Table 1. Growth and flowering parameters of carnation genotypes under mid-hill conditions of Himachal Pradesh

| Genotype | Plant height (cm) | Stem length (cm) | Days to bud formation | Days to first flower | Flower size (cm) | # Cut stems/plant | Stem strength (%) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | 'A' Grade | 'B' Grade |
| Aicardi | 70.32 | 49.19 | 148.78 | 170.72 | 6.50 | 4.23 | 33.33 | 60.00 |
| Arka Flame | 56.70 | 40.52 | 136.00* | 155.33 | 6.37 | 5.37 | 86.67* | 13.33 |
| Baltico | 72.34 | 54.87 | 143.00 | 163.13 | 6.12 | 6.20* | 53.33 | 46.67 |
| Bright Rendez Vous | 62.45 | 48.65 | 145.27 | 165.87 | 5.79 | 5.07 | 53.33 | 46.67 |
| Cindrella | 68.96 | 51.46 | 152.65 | 163.53 | 5.73 | 4.90 | 44.45 | 55.55 |
| Cool | 68.77 | 50.75 | 146.67 | 162.13 | 6.20 | 5.47 | 28.89 | 71.11* |
| Dark Rendez Vous | 55.79 | 41.70 | 142.20 | 163.20 | 6.09 | 4.73 | 57.78 | 42.22 |
| Don Pedro | 95.61* | 68.15* | 146.47 | 167.27 | 6.30 | 5.07 | 31.11 | 68.89* |
| Gaudina | 74.99 | 55.96 | 156.27 | 177.47 | 6.15 | 4.40 | 62.56 | 38.11 |
| Golem | 72.57 | 54.16 | 142.80 | 162.27 | 6.41 | 4.47 | 82.29* | 17.78 |
| Happy Golem | 75.73 | 56.84 | 146.27 | 162.40 | 6.17 | 5.20 | 68.89 | 31.11 |
| Hermes | 94.70* | 71.10* | 152.60 | 172.52 | 6.22 | 3.93 | 58.34 | 41.66 |
| Kleos | 65.62 | 49.57 | 141.27 | 160.87 | 6.34 | 3.67 | 86.67 | 13.33 |
| Lady Green | 68.14 | 50.60 | 148.32 | 164.02 | 5.97 | 4.57 | 63.33 | 36.67 |
| Liberty | 73.13 | 52.01 | 140.20 | 160.93 | 6.08 | 4.87 | 95.56* | 4.44 |
| Madame Colette | 87.68 | 66.04 | 147.20 | 162.87 | 6.12 | 5.27 | 51.11 | 48.89 |
| Madras | 55.69 | 38.63 | 137.80 | 163.07 | 6.18 | 4.93 | 64.44 | 35.56 |
| Marathon | 54.29 | 38.81 | 144.15 | 161.62 | 5.92 | 3.80 | 40.18 | 59.82 |
| Master | 68.68 | 50.70 | 143.20 | 162.53 | 5.76 | 4.87 | 66.67 | 33.33 |
| Nordika | 71.24 | 50.17 | 144.80 | 160.93 | 6.45 | 5.53 | 43.89 | 56.11 |
| Pink Dover | 63.51 | 47.48 | 144.80 | 161.47 | 6.29 | 5.27 | 55.56 | 44.44 |
| Raggio-di-Sole | 72.97 | 55.23 | 151.53 | 170.27 | 6.52 | 4.67 | 44.44 | 55.56 |
| Rendez Vous | 58.72 | 41.85 | 137.87 | 153.93 | 6.27 | 5.47 | 86.67 | 13.33 |
| Snow Storm | 94.24* | 70.56* | 149.73 | 171.13 | 6.52* | 4.33 | 75.56 | 24.44 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Tamarind | 65.92 | 48.25 | 145.93 | 161.13 | 6.22 | 5.40 | 51.11 | 48.89 |
| Tempo | 65.79 | 48.18 | 144.73 | 160.87 | 6.56* | 4.93 | 53.33 | 46.67 |
| EC-1 | 66.92 | 51.24 | 160.33 | 178.80 | 5.98 | 4.53 | 68.89 | 31.11 |
| EC-2 | 82.04 | 60.47 | 149.67 | 172.93 | 6.09 | 4.47 | 57.78 | 42.56 |
| EC-3 | 74.90 | 55.33 | 144.33 | 164.07 | 5.94 | 4.27 | 62.22 | 37.78 |
| EC-4 | 82.44 | 62.75 | 147.33 | 163.20 | 5.84 | 4.20 | 66.67 | 33.33 |
| EC-5 | 50.41 | 36.84 | 143.60 | 158.93 | 6.32 | 4.80 | 42.22 | 57.78 |
| EC-6 | 57.69 | 44.15 | 140.60 | 158.00 | 6.10 | 4.80 | 51.11 | 48.89 |
| EC-7 | 63.40 | 46.83 | 150.20 | 162.00 | 5.71 | 4.60 | 60.00 | 40.00 |
| EC-8 | 58.89 | 42.16 | 145.00 | 160.40 | 6.23 | 5.73* | 64.44 | 35.55 |
| EC-9 | 61.64 | 45.03 | 128.00* | 141.40* | 5.21 | 5.20 | 60.00 | 40.00 |
| EC-10 | 73.57 | 54.94 | 146.20 | 163.67 | 6.21 | 5.07 | 57.78 | 42.22 |
| EC-11 | 71.64 | 52.16 | 145.80 | 160.87 | 6.19 | 4.73 | 66.66 | 33.34 |
| EC-12 | 78.27 | 56.72 | 149.27 | 162.40 | 6.14 | 5.60 | 35.56 | 64.44 |
| EC-13 | 65.18 | 48.72 | 147.93 | 167.93 | 6.23 | 5.27 | 28.89 | 71.11* |
| EC-14 | 57.63 | 43.34 | 144.40 | 159.87 | 5.88 | 4.67 | 77.78* | 22.23 |
| EC-15 | 75.15 | 52.54 | 155.60 | 172.47 | 5.97 | 4.27 | 31.11 | 68.89* |
| EC-16 | 56.77 | 41.80 | 146.27 | 162.53 | 6.45 | 5.33 | 71.11 | 28.89 |
| EC-17 | 62.65 | 45.56 | 136.00 | 154.73 | 6.04 | 4.27 | 35.56 | 64.44 |
| EC-18 | 61.83 | 41.33 | 153.80 | 157.40 | 6.38 | 5.20 | 46.67 | 53.33 |
| EC-19 | 58.50 | 44.53 | 140.80 | 157.47 | 5.75 | 5.77* | 57.78 | 42.22 |
| EC-20 | 61.66 | 47.34 | 136.67 | 153.87 | 6.39 | 4.73 | 66.67 | 33.33 |
| EC-21 | 82.23 | 62.11 | 144.20 | 163.27 | 6.00 | 5.00 | 62.22 | 37.78 |
| EC-22 | 71.28 | 53.13 | 146.93 | 161.87 | 5.93 | 4.33 | 31.11 | 68.89* |
| EC-23 | 60.08 | 45.66 | 144.69 | 167.89 | 6.11 | 4.18 | 51.48 | 48.52 |
| EC-24 | 65.28 | 49.06 | 147.27 | 163.67 | 6.45 | 4.80 | 68.89 | 31.11 |
| $CD_{0.05}$ | 6.27 | 5.00 | 7.10 | 7.864 | 0.33 | 1.02 | 19.92 | 19.98 |

*Significant values

Table 2. Flower colour of carnation genotypes under mid-hill conditions of Himachal Pradesh

| Cultivar‘ | Flower colour |
|---|---|
| Aicardi | Red- 45 B |
| Arka Flame | Red purple- 60 A |
| Baltico | White- 155 D |
| Bright Rendez Vous | Yellow- 3 D (primary colour) and Red- 48 B (secondary colour) |
| Cindrella | Red- 55 A |
| Cool | White- 155 B |
| Dark Rendez Vous | Yellow- 2 D (primary colour) and Red purple- 59 B (secondary colour) |
| Don Pedro | Red- 46 B |
| Gaudina | Red- 45 B |
| Golem | Red purple-72 B |
| Happy Golem | White 155 D (primary colour) and Red purple- 72 A (secondary colour) |
| Hermes | Yellow- 3 D |
| Kleos | Red- 48 B |
| Lady Green | Yellow green- 145 C |
| Liberty | Green yellow- 1 D |
| Madame Colette | White- 105 C |
| Madras | Yellow- 13 D (primary colour) and Red purple- 64 A (secondary colour) |
| Marathon | Red purple- 71 A |
| Master | Red- 45 B |
| Nordika | White- 155 B |
| Pink Dover | Red- 56 D |
| Raggio-di-Sole | Orange- 25 D (primary colour) and Red purple - 58 C (secondary colour) |
| Rendez Vous | Purple-72 B (primary colour) and Purple violet - 82 D (secondary colour) |
| Snow Storm | White- 55 B |
| Tamarind | Orange red- 35 B (primary colour) and Orange- 29 C (secondary colour) |
| Tempo | Red- 36 D (primary colour) and Red purple 59 B (secondary colour) |
| EC-1 | Yellow- 3 C |
| EC-2 | White- 155 B |
| EC-3 | Red- 46 B |
| EC-4 | Red- 46 B |
| EC-5 | White- 155 A (primary colour) and Purple- 77 A (secondary colour) |
| EC-6 | Red- 48 D |
| EC-7 | White- 55 B |
| EC-8 | Yellow- 2 C (primary colour) and Red purple- 59 B (secondary colour) |
| EC-9 | Red- 42 A |
| EC-10 | White- 155 B |

| | |
|---|---|
| EC-11 | Red purple- 57 C |
| EC-12 | Yellow- 3 C |
| EC-13 | Red- 48 D |
| EC-14 | Red- 45 B |
| EC-15 | Yellow green- 1 C |
| EC-16 | Yellow orange-16 C (primary colour) and Red- 39 B (secondary colour) |
| EC-17 | Red– 49 A |
| EC-18 | Orange– 24 D (primary colour) and Red- 54 B (secondary colour) |
| EC-19 | Red- 42 A |
| EC-20 | Orange- 24 C (primary colour) and Red- 52 A (secondary colour) |
| EC-21 | White- 155 B |
| EC-22 | Red- 45 B |
| EC-23 | Yellow- 3 C |
| EC-24 | Yellow orange- 22 D (primary colour) and Red- 48 B (secondary colour) |

cultivars Snow Storm (70.56 cm) and Don Pedro (68.15 cm). However minimum stem length (36.84 cm) was recorded in cultivar EC-5 which was found statistically at par with cultivars Madras (38.63 cm), Marathon (38.81 cm), Arka Flame (40.52 cm) and EC-18 (41.33 cm). The difference in stem length among the different cultivars may be attributed to the inherent genetic characters associated with the genotypes and also due to the growing environmental conditions as reported by Dalal et al (2009), Prahlad (2009) and Tarannum and Naik (2014). Stem length variations among different cultivars might be due to their genetic make up as has been reported in carnation by Misra (2002), Shiragur et al (2004) and Singh et al (2013).

**Number of days for bud formation**

The cultivar EC-9 was first to show its visible flower bud taking 128.00 days after planting followed by cultivars Arka Flame and EC-17 (136.00 days) whereas cultivars EC-2 (160.33 days), Gaudina (156.27 days), EC-15 (155.60 days) and EC-18 (153.80 days) were very late to initiate buds. These variations for flower bud formation may be attributed to genetical make up of varieties as reported by Patil (2001) and Reddy et al (2004).

**Number of days for first flowering**

Cultivar EC-9 (141.40 days) was earliest to come into flowering whereas maximum number of days for first flowering was recorded in cultivar EC-1 (178.80 days) which was found statistically at par with cultivars Gaudina (177.47 days), EC-2 (172.93 days), Hermes (172.52 days) and Snow Storm (171.13 days). These variations might be attributed to genetical make up and physiological differences among the genotypes as reported

previously by Krishnappa et al (2000) and Patil (2001) in carnation.

**Flower size**

The flower diameter was found superior in cultivar Tempo (6.56 cm) as compared to all genotypes followed by cultivars Snow Storm and Raggio-di-Sole (6.52 cm) and minimum in cultivar EC-9 (5.21 cm) followed by cultivars EC-7 (5.71 cm) and Cindrella (5.73 cm). Similar variation in flower diameter of the different genotypes of the carnation was reported by Gurav et al (2004) and Roychowdhury and Tah (2011).

**Number of cut stems per plant**

Flower yield is an important parameter which decides the significance of suitability of the particular genotypes for commercial cultivation that ultimately reflects on cost of cultivation. There was a significant difference among the genotypes for flower yield. Significantly highest number of cut stems per plant was recorded in cultivars Baltico (6.20) followed by EC-19 (5.77) and EC-8 (5.73) and minimum in cultivar Kleos (3.67) followed by cultivars Hermes (3.93) and EC-23 (4.18). Similar variations in carnation with respect to flower yield were also observed by Reddy et al (2004), Sathisha, (1997) and Tarannum and Naik (2014). The difference in flower production in naturally ventilated greenhouse grown carnation cultivars was also noticed by Maitra and Roychowdhury (2013), Shahakar et al (2004) and Shahakar and Sable (2003).

**Stem sturdiness (grades)**

***'A' grade cut flowers***

Flower quality parameter in terms of stem sturdiness decides the significance of suitability and economic value of the particular genotypes in the international cut flower trade. Maximum 'A' grade flowers (95.56%) were recorded in cultivar Liberty statistically at par with cultivars Arka Flame (86.67%), Rendez Vous (86.67%), Kleos (86.67%), Golem (82.29%) and EC-14 (77.78%) and minimum number of 'A' grade flowers (31.11%) were recorded in cultivars Don Pedro, EC-15 and EC-22.

***'B' grade cut flowers***

Maximum number of 'B' grade flowers (71.11%) was recorded in cultivar EC-13 and Cool which was followed by cultivars EC-16, Don Pedro and EC-22 (68.89%) whereas minimum number of 'B' grade flower production was recorded in cultivar Liberty (4.44%) followed by cultivar Kleos (13.33%).

There are several carnation cultivars with different shades of colours available now for production. Although, in most of the Indian markets, there is no special preference for any colour but red, yellow, white and pink flower types are preferred to others in the international markets. Information on flower colour of 50 carnation genotypes studied under mid-hill conditions of Himachal Pradesh is presented in Table 2. Cultivars categorised under red group were, Aicardi, Gaudina,

Don Pedro, Master, EC-3, EC-4, EC-6, EC-9, EC-14, EC-19 and EC-22. Yellow coloured cultivars were Liberty, Hermes, EC-1, EC-12, EC-15 and EC-23. Cultivars having white colour were Snow Storm, Cool, Baltico, Nordika, Madame Colette, EC-2, EC-7, EC-10 and EC-21. Cultivar Lady Green had green colour. Some cultivars were also categorised under red purple group like Golem, Marathon, Arka Flame and EC-11. Some cultivars had bicoloured petals like Happy Golem and EC-5 having white as primary colour and margins of petals were of red purple colour. Similar pattern was also found in cultivars Rendez Vous, Dark Rendez Vous, Bright Rendez Vous, Madras, Tempo and EC-8. In some cultivars striated and speckled petals were observed eg in case of Raggio-di-Sole, Tamarind, EC-16, EC-18, EC-20 and EC-24.

## CONCLUSION

Based on present findings it can be concluded that cultivars viz Don Pedro, Hermes, Tempo, Arka Flame, EC-9, Baltico and Liberty have emerged as promising genotypes with respect to growth, earliness in flowering, flower yield and quality parameters during the entire period of their growth. These cultivars are suitable for commercial cultivation under naturally ventilated polyhouses in mid-hill conditions of Himachal Pradesh. Hence selection of the above characters in the promising genotypes will be helpful in improving the flower yield and these characters should be given prime emphasis during selection for improvement of carnation.

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