

# **STUDIES ON VARIETAL EVALUATION OF CARNATION (*Dianthus caryophyllus*)**

**By**

**NEERAJ KUMAR**

**Thesis submitted to the CCS Haryana Agricultural University in  
partial fulfilment of the requirements for the degree of :**

**MASTER OF SCIENCE  
IN  
HORTICULTURE**



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CCS HARYANA AGRICULTURAL UNIVERSITY  
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*Dedicated  
To My  
Beloved Parents*

## **CERTIFICATE - I**

This is to certify that this thesis entitled, "**Studies on varietal evaluation of carnation (*Dianthus caryophyllus*)**", submitted for the degree of Master of Science in the subject of Horticulture to the Chaudhary Charan Singh Haryana Agricultural University, Hisar, is a bonafide research work carried out by **Mr. Neeraj Kumar** under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.



**[Surinder Kumar]**  
**MAJOR ADVISOR**  
**Associate Professor**  
**Department of Horticulture**  
**CCS Haryana Agricultural University**  
**Hisar - 125 004**



## CERTIFICATE - II

This is to certify that this thesis entitled, "**Studies on varietal evaluation of carnation (*Dianthus caryophyllus*)**", submitted by **Mr. Neeraj Kumar** to the Chaudhary Charan Singh Haryana Agricultural University, Hisar, in partial fulfilment of the requirements for the degree of Master of Science in the subject of Horticulture, has been approved by the Student's Advisory committee after an oral examination on the same.



MAJOR ADVISOR



HEAD OF THE DEPARTMENT



DEAN, POSTGRADUATE STUDIES

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HISAR



[NEERAJ KUMAR]

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## 1. INTRODUCTION

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Carnation is one of the most important cut flowers of the world and occupy a place of great prominence. The carnation (*Dianthus caryophyllus*) is a member of the family caryophyllaceae. The basic chromosome number is 15. Most commercial cultivars are diploids ( $2n=30$ ) as tetraploids are less productive although tetraploid flowers are larger. The name carnation is derived from a word 'Coronation'. The genus name comes from the writing of Theophratus about 'Dias Anthos, The flower of the gods'. Linnaeus choose the species name caryophyllus after the genus of clove, as the fragrance from carnation is reminiscent of clove. Common cultivated spp. of Dianthus are *Dianthus caryophyllus*, *Dianthus barbatus* and *Dianthus chinensis*. The carnation is indigenous to the Mediterranean area. Man's improvement of native Dianthus begins in the 16th century. American type was developed in France from perpetual flowering carnation in 1840 and introduced to America in 1852. Since then hundred of cultivars for commercial flower

production were developed. Today's commercial carnations are the products of more than 200 years of breeding. Extensive breeding efforts continue to provide carnations of higher quality and productivity (Sparnaaij and Demmink, 1983).

Carnation prefers plenty of sunshine and a temperature regime of 20-25°C during the day and 10-15°C during the night for their excellent growth. Carnations have been classified as quantitative long day plants as long days promote and short days delay flower initiation (Blake, 1957). The critical photoperiod for most spray and standard carnations is about 13 hours. Relative humidity of 50-60 per cent favours its growth and flower production.

In the world areas of 'Natural climates' for carnations generally occurs near 30° North or South latitude and on the Western edge of continent e.g. South California, Mediterranean area, near Perth, Australia, near Valparaíso, Chile and in the Union of South Africa. Carnations in the United States of America rank next only to roses in popularity. Due to excellent keeping quality, ability to withstand long distance transportation, wide range of forms and remarkable ability to rehydrate after continuous shipping, it is preferred by growers as compared to roses and chrysanthemums in several flower exporting countries. Carnations are also extensively cultivated in Italy, Spain, Colombia, Kenya, Sri Lanka, Canary Island, France, Holland, Germany and in USA for production of cut flowers. While the major importers of carnations are UK, Canada and Spain, the major exporters are Colombia, Holland, Israel, Kenya, France, Peru, Greece and Mexico.



In India, carnation is not much known among growers even though it has got great economic potential as cut flowers in international market. Carnation is mostly grown in big important cities like Nasik, Pune, Srinagar, Bangalore, Coimbatore, Delhi and Calcutta under open as well as under shade. Carnation flowers are used for offering in various ceremonies such as Valentine day, Easter, Mother's day. Among the different coloured varieties, White and Pink standard carnations are in greatest demand followed by Red, Yellow, Sky Blue and bicolours. The liking of colours depends upon the time or season. During Christmas, Red standard type are preferred to other colours.

Out of several types of carnation viz. Maguerite or Chabaud, Picotee or Border, Perpetual flowering as cut flowers, only the Perpetual flowering carnation are commercially important. Perpetual flowering carnation are further grouped into two categories i.e. standard or sim type and spray carnation. The standard produces large size bloom and have a longer stalk length. The spray type produces many flowers in bunches used mainly for bedding purpose are relatively smaller.

Since no work has been done regarding carnation cultivation and identification of suitable cultivar for commercial cultivation under semi-arid region of Haryana, the present investigation was carried out to evaluate the performance of various varieties in relation to growth and flowering.

## **2. *REVIEW OF LITERATURE***

---

Different cultivars grow differently in similar environmental conditions due to differences in their biological efficiency in term of metabolism and nutrient accumulation (Arora and Khanna, 1990). Since there are large number of varieties available in carnation, these have to be tested for their performance in a particular area and selection of suitable variety is to be done after screening for desirable flower quality and growing behaviour. Following literature has been reviewed with an objective to show performance of different varieties under diverse climatic conditions all over the world.

### **2.1 In Europe**

El-Shafic (1977) studied the effect of the number of shoots retained on carnation plants. Carnation plants with three main shoots on which all secondary shoots were retained produced more flowers than plants which were pruned to leave only two secondary shoots on each of the three main

shoots. However, the plant with two secondary shoots produced larger flowers with thicker and stronger stems.

Cultivars Exquisite, Red Ivette and Scarlet Elegance were found most productive in a 2 year greenhouse trials with 7 carnation cultivars by Rejman *et al.* (1979) at Poland. In the 1st year flower stalk length was greatest in the cultivars Tony, Silvery Pink and Red Ivette and in the 2nd year flower stalk length was greatest in cultivars Red Baron, Tony and Scarlet Elegance. In both years the number of flowers on the inflorescence was greatest in Red Baron and Tony, which also produced about 80 per cent of first quality flowers.

Farina *et al.* (1983) studied the effect of planting time and density on cultivation of six new Miniriviera carnation cultivars, under the climatic conditions of San Romo, Italy. The best results were obtained with early planting (30 Jan) and a high planting density in Eolo, Cloria, Mei Ling and Mei Wong which gave high yield and high flower production per m<sup>2</sup> as compared to Mediterranean carnations.

Bottcher *et al.* (1984) studied the behaviour of four miniature carnation cultivars viz. White Royalette, Ancora, Cerise Royalette and Royalette planted on 9th March and 4th May, 1983 and the buds were terminally removed at weekly interval. They found that highest yield and profits were obtained from March planting with peak harvest in August and late December. The early cv. Ancora was found to be the most prolific and economic.

✓ Adillon *et al.* (1985) evaluated cultivars White Sim and Scania (Sim group) and cultivars Oscar, Rubino, Astor, Cabrils-4, Alico and Londenelle (Mediterranean group) for cut flower production. Total flower production (October to May) was found highest in the Sim cultivars but winter flower production (November 1 to March 31) was higher in the Mediterranean type cultivars as compared to Sim cultivars and was highest in cv. Astor (4.6 flowers/plant).

✓ Gelder and Uitermark (1985) compared nine glass house carnation cultivars with Scania as standard under climatic condition of Aalsmer, Netherlands. The planting was done on 31st January. Data on plant growth, the peak cropping period, average stem length of first quality flowers were assessed on 10th February. Winter flower production of all cultivars except Zeechino (Mignon type) and Maiko (Miniature spray) was poor, as was winter quality of the Chinese type and other Mignon cultivars. Total yields/m<sup>2</sup> were highest with Maiko followed by Pulcino (Mignon type).

✓ Carbonell *et al.* (1985) conducted comparative trial of 10 miniature carnation cultivars outdoor for measuring shoot production. Cultivar Odean produced highest total shoot yield (15th September to 30th April) and winter shoot yield (1st November to 31st March) i.e. 15.1 and 9.35 shoots/plant respectively, while Lilli-Ann (13.21 and 7.87 shoots/plant respectively) and Tony 12.37 and 5.41 shoots/plant respectively.

Eighteen cultivars were evaluated for cut flower production by Cabbot Roig *et al.* (1985) at Spain. They reported that total flower production (1st October to 15th July) was highest in Astor, Tanga, Duge and Manon (10.5, 10.0, 9.7 and 9.6 flower/plant respectively). Flower production from 1st October to 31st May was highest in Astor, Tanga, Praline and Duge (6.5, 5.7, 5.3 and 5.0 flowers/plant respectively). Flower production from 1st November to 31st March was highest in Tanga, Praline, Red Oca and Tiziano (4.5, 4.2, 3.3 and 2.8 flower/plant respectively).

Loeser (1986) evaluated varietal comparison of four groups of carnation viz. ordinary, micro, miniature and Chinese. He reported that out of the ordinary carnation studied cv. Castellano was the tallest (140 cm), with longest stems (71% >60 cm), largest flower (76 mm diameter), high yields (543 stem/m<sup>2</sup>). He further added that the micro carnations with the shortest stems (30-40 cm), smallest flowers (33-35 mm diameter) but highest yields (1088-1984 stem/m<sup>2</sup>) were represented by cultivars Eolo, Eolo Bianca and Mammolo. The best quality cultivars in miniature carnations were cultivars Polo, Smarty, Eveline, Red Borbara and Ronja. The Chinese carnation include cultivars Mei Bao, Mei Wan and Mei Fu. They were of excellent quality with yield 3 times those of miniature cultivars but with only 3 flowers/stem.

Rudnicki (1986) tested six carnation cultivars for cut stem yield. Cut stem yield obtained by harvesting at tight bud stage (petals not visible, bud

diameter 15 mm) was higher by 9-12 per cent in cv. Scania 3C, 5 per cent in cv. Lona, 37 per cent in cv. Shocking Pink Sim, 35 per cent in cv. Samantha, 21 per cent in cv. Dusty Sim and 62 per cent in cv. Alice, compared to controls which were harvested at brush stage.

Chesneaux *et al.* (1987) evaluated 163 carnation cultivars of three types i.e. large flowered, spray and miniature in St. Laurent du Var region of France, to ascertain their productivity (in term of flowering stems/plant) during the winter season (September to March). They reported that the cultivars of large flowered type exhibited overall productivity only slightly lower than that of the spray type. Miniature cultivars produced twice as many flowers as those belonging to other two categories. For all 3 types, the rhythm of production showed down appreciably during January and February especially for cultivars belonging to the miniature group.

Delfosse (1987) conducted a trial on winter productivity of various carnation varieties in France. Data were tabulated on total, extra grade I, and grade II flower yields. Cultivar Lompilem 'Fonza' was the only Mediterranean cultivar to out yield Baruklo quantitatively and to be of superior quality but other cultivars were also of higher quality. The range in yield of miniature cultivars was greater than in Mediterranean cultivars. Yields of single flowered cultivars were quantitatively and qualitatively superior to those of multiflowered cultivars.

Fourteen carnation cultivars grown in greenhouse were evaluated from July 1985 to June 1986 at Sofia region of Bulgaria by Atanasova (1988). Cultivars Salmony, Exquisite and Mirna were the most productive yielding  $>200$  flowers/m<sup>2</sup> and Tony, Red Baron, Salmony, Jolivette and Mirna had the highest quality cut flowers. For combined yield and quality cultivars Salmony, Mirna, Sam's Pride, Silvery Pink and White Lilli Ann were recommended for cultivation in Bulgaria.

Mynett *et al.* (1989) conducted trials for evaluation of cropping of new green house carnation cultivars by growing 31 standard, 6 spray and 3 Chinese cultivars for two years. Among the standard cultivars Vanya, Tanga, Sonia, Praline, Shocking Pink Sim, Zbyszko, Scania 3C, Jasmina, Astor, Pallas and Olgo were outstanding for their high cut flower yields viz. 180 flowers/m<sup>2</sup> in the 1st year and 270 flowers/m<sup>2</sup> in the 2nd year. Of the spray cultivars Olenka, Pepito and Nike gave high yields viz. 450/m<sup>2</sup> in both the 1st and 2nd year. All the Chinese cultivars viz. Moi Fu, Mci Ling and Mei Wan gave high yields, especially in first year.

Groshkov (1990) studied varietal collection of greenhouse carnation in the unheated plastic greenhouse at Sofia region of Bulgaria. He reported that of 18 widely grown varieties, Valentina, Samontha, Scania, Nora and Shocking Pink Sim (in descending order) gave the highest yield of cut flowers. Variety Sir Arthur Sim, Red Lena, Shocking Pink Sim, Scania and Samantha, gave the highest percentage of extra and first quality flower. Overall Valentina was the best for useful characters.



Nijssen and Hoogeveen (1990) compared fifteen large flowered glasshouse carnation cultivars for yield and flower quality. External flower appearance was good for all cultivars although crop quality was disappointing in a few cases.

Sparnaaij *et al.* (1990) conducted a trial on 20 genotypes representing wide variation in flowering time and response to long days. The genotypes were planted in the month of September under a winter light intensity of 15 W/m<sup>2</sup> for 8 hrs/day. In one half of the trial, the day length was increased to 24 hrs for 25 days in December-January and at the end of February, the plants were transferred to a glasshouse where they were observed until all primary shoots had flowered. They observed that average flowering dates varied from 132 days from pinching in *D. chinensis* hybrid to 181 days in the Mediterranean cv. Raggio di Sole. They further reported that long day (LD) response was most pronounced in the earliest flowering Diantini selections and least in traditional commercial cultivars. The proportion of shoot actually responding to LD varied from 28 per cent in the traditional cultivars to 54 per cent in the Diantini x *D. Au Woodii* cv. Doris group of genotypes.

Boikov (1992) tested the new Bulgarian cultivars of carnation at Sofia region of Bulgaria. The flower size was more than 12 cm with a strong fragrance and long, strong thick stem which do not break easily at the nodes.

Kim *et al.* (1992) studied the flowering and growth characteristic of 15 carnation cultivars in order to assess their suitability for cut flower



production in winter season. Galil, Rimon and Beta had longer flower stem and less calyx splitting. The number of average cut flowers/plant were 8-10 but shocking Pink and White Sine produced 15 and 11 respectively. The total number of first grade cut flower of Beta was >90 per cent of the total while for Galil, Shocking Pink, Red Lena and White Sim it was about 85 per cent. Galil, Beta, Shocking Pink and Red Lena of the standard type were found suitable for cut flower production in winter season.

A study of 15 varieties of *Dianthus caryophyllus* (11 standard and 4 miniature types) introduced from France in Romania was done by Cantor (1993). The best overall performance in Romania was shown by Tanga, Pallas Orange, Buffalo, Carola of standard type and the miniature types Opale and Juanito, which combined good yield and flower quality characteristics.

## 2.2 In USA

Powell (1979) carried observations on growth of carnation cv. White Sim in natural or 24 h long days length. He reported that the number of leaf pair produced before flower initiation and the final length of each flowering stem were affected by the date at which the shoot appeared and in position on the plant.

Goldsberry (1987) evaluated Dwarf *Dianthus caryophyllus* for pot plant production. It was observed that the cultivars selected require approximately

12 weeks, depending upon environmental conditions, from pinching to flowering.

### 2.3 In Asia

Cultivars Ocean Spray, White Elegance and Fiona performed best among 20 spray carnation, in a 4 year trial, assessed for yield and quality in Japan by Namikawa (1980). The number of flowers were greater for plants pinched once only but there was no significant difference in the flower quality of plants pinched once or twice.

#### 2.3.1 India

Khanna *et al.* (1986) carried trials over 3 years to study the effect of pinching on growth and flower production of carnation cv. Marguerite Scarlet. Data on plant height, days to flower and number of flowers/plant were tabulated. He reported that pinching delayed flowering and the delay increased with the severity of pinching.

Gill and Arora (1988) studied the performance of 10 sim carnation under subtropical climatic condition of Punjab. Irrespective of flowering time, maximum flower production was achieved during March and April. Time taken for flower production varied from 120-180 days. Extent of calyx splitting varied with the time of flowering from December to April and it occurred in all cultivars tested.

Saini *et al.* (1991) studied the performance of different cultivars of *Gladiolus floribundus* L. under Hisar condition. They reported that out of

six cultivars viz. George Mazure, Pusa Suhagin, Sylvia, Melody, Miniature and Morning Kiss, best spike length (61-79 cm) was noted in cvs. Pusa Sohagin, George Mazure and Sylvia.

The possibility of all the year round production in India was investigated by Gill and Aulakh (1993) by comparing the monthly temperature maxima and minima in 5 areas of India with 2 of the main carnation growing area of the world namely greenhouse production in Europe and outside production at Naivasha in Kenya. Western part of southern India, such as Kodaikanal, Ooty and Conoor have temperature profiles that compare well with Europe and Kenya, making suitable for all year round carnation production. The areas of Mercara in Karnataka and Poona, Nasik in Maharashtra would allow restricted cultivation and Ludhiana in the North Plains could only produce carnation during March and April.

The performance of 5 gladiolus cultivars (Agnirekha, American Beauty, Friendship, Manscer Red and True Yellow) were evaluated over 2 seasons, November 1989 to April 1990 and April to September 1990 by Leena Ravidas *et al.* (1993). They reported that in both seasons the cultivars showed significant difference in their vegetative growth, flowering duration and spike characteristic. In both seasons cv. American Beauty surpassed the other cultivars in all the vegetative growth characteristic measured and also had a longer flowering period. In general, American Beauty and Friendship produced better quality flowers.

Bhautkar (1994) evaluated carnation cultivation in glasshouse under Mahableshwar conditions in India. Out of ten carnation cultivars compared for cut flower production in pot trials under protected cultivation, cv. Eveline produced the most flower but took the longest time to initiate flower buds (119 days). Cultivars Barbara, Lena and Bianca took the shortest time to initiate flower buds (74-76 days).

Dalbir *et al.* (1994) studied the effect of summer shading on the plant growth and flower production of standard carnation cv. Espana under subtropical conditions of Punjab. The results revealed that shading treatment significantly increased plant spread, height, number of shoots and flower stem length.

Mahanta and Paswan (1994) evaluated the performance of ten gladiolus cultivars for growth, flowering and multiplication behaviour characteristics at Jorhat region of Assam (India). They reported highly significant difference among the cultivars for all the characteristics. Cultivars Copper King and Tunias Classic were superior for all the characteristics and promising for Assam conditions.

Eighteen varieties of Gladiolus were evaluated for their performance in term of floral characteristic and corm production by Aswath and Parthasarathy (1996) at Basapani region of Meghalaya (India). They reported that varieties Blue Moon, Powder Puff, Friendship and Red Majesty were superior for spike characters. For cormel production, Local, Creamy White and Dressdon Don were outstanding.

Jhon *et al.* (1996) studied the performance of 41 *Gladiolus* cultivars in Kashmir. They reported that cultivars Classic, Red Majesty, Rose Supreme, Oscar, Sunny Boy and White Prosperity were the most suitable cultivars for cut flower production, with spike ranging in length from 106.06 cm for Oscar to 120.13 cm for White Prosperity.

### **3. MATERIALS AND METHODS**

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The present investigation entitled, "Studies on varietal evaluation of carnation (*Dianthus caryophyllus*)" was conducted in the screen house of the Department of Horticulture, CCS Haryana Agricultural University, Hisar during the year 1997-98.

#### **3.1 Experimental site**

This region has typical semi arid climate with very hot and dry summer along with cold winter and humid warm monsoon season. Therefore, mean temperature fluctuation is very wide during summer and winter. The annual rainfall is unevenly distributed throughout the year, with an average of 420 mm.

The meteorological data for the experimental period, recorded at meteorological observatory of the university, Hisar, which is situated in close vicinity of the experimental site are presented in Annexure I.

### **3.2 Preparation of pot mixture**

The pot mixture was prepared by mixing two parts of soil with one part of well rotten FYM, one part of sand and one part of leaf mould. Five kg of pot mixture was filled in each pot.

### **3.3 Planting of rooted cuttings**

All the ten varieties of carnation were procured from Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.). Healthy cuttings having uniform height and equal number of leaves (variety wise) were planted in pots in evening time and 150 ml of water per pot was applied. In each pot, single cutting was planted. The planting was done on 27th November, 1997.

### **3.4 Cultural practices**

All the plants received uniform cultural practices. Measured quantity of 150 ml of water was given to each pot depending upon weather condition. First basal dose of nitrogen was applied 40 days after planting so as to supply 50 ppm of nitrogen per pot and second dose of nitrogen was applied 80 days after planting. To protect the plants from blight Dithane M-45 @ .1% was sprayed fortnightly. Weeding was done by pulling of weeds by hands at an interval of 10 days.

### 3.5 Design and layout of experiment

The design and layout followed for the experiment is as follows :

#### Experiment : Studies on varietal evaluation of carnation

Design	:	CRD
Date of planting	:	November 27, 1997
Replication	:	3
Plant unit/replication	:	10
Soil weight/pot	:	5 kg
Varieties	:	Forever
	:	Lavender Lace
	:	Pinto
	:	Impala
	:	White Giant
	:	Jessica
	:	Riffi
	:	Superstar
	:	Espana
	:	White Candy

### 3.6 Observations recorded

Collection of data was done on following parameters.



### **3.6.1. Growth parameters**

#### **a) Plant height (cm)**

The height of the plant was measured as the length from the ground level to the top of the farthest leaf tip with the help of meter rod at 0, 45, 60, 75, 90 and 105 days of planting.

#### **b) Number of leaves per plant**

Data were recorded by counting the total number of leaves per plant at 0, 45, 60, 75, 90 and 105 days of planting.

#### **c) Leaf area (sq. cm)**

At full flowering stage all the leaves were plucked from three plants selected randomly from a single replication and leaf area was taken with the help of leaf area meter.

#### **d) Number of axillary branches/plant**

Total number of axillary branches per plant were counted starting from ground level to the top of plant at the time of appearance of first floral bud.

#### **e) Internodal length (cm)**

The shoots were observed at the time of full flowering stage for their internodal length (cm) and it was calculated by dividing the shoot length by the number of nodes.

#### **f) Average length of first four laterals (at full flowering stages)**

The branches emerged after pinching were tagged or marked for noting

their growth behaviour. Length of tagged laterals were recorded from main branch/axis of the plant to apical portion of the plant. Finally average length of four Laterals was taken and expressed in centimeter.

### **3.6.2 Flowering parameters**

#### **a) Number of days taken for bud appearance**

Observations were recorded daily to find out the appearance of first flower bud of pea size and total number of days taken for bud initiation was counted from the date of planting of cuttings to the emergence of buds on individual plant.

#### **b) Number of buds/plant**

To record the number of buds/plant in each pot total number of buds produced per plant were counted.

#### **c) Number of flowers opened/plant**

From the total number of buds that appeared on the plant, total number of opened flowers were counted at full flowering stage.

#### **d) Number of underdeveloped and unopened flower buds**

The total number of underdeveloped and unopened flower buds per plant were recorded by subtracting number of opened flowers per plant from total number of buds per plant.

#### **e) Per cent opening**

Per cent opening was calculated by dividing the total number of opened

flower by the total number of buds appeared on the individual plant according to following formula :

$$\frac{\text{Total number of opened flowers}}{\text{Total number of buds appeared}} \times 100$$

**f) Number of days taken for furling of petals from the date of bud emergence**

Total number of days taken for opening of flower (camel brush stage) from the date of bud emergence was counted.

**g) Size of calyx (cm)**

Length of calyx of fully opened flower was measured with the help of scale (cm).

**h) Size of flower (cm)**

Diameter of fully opened flower was measured with the help of vernier calliper in cms at the time of measurement of the flower stalk length.

**i) Length of peduncle/stalk of terminal flower (cm)**

Flower stalk length was measured when the flower was fully opened with the help of scale. It was measured from cut end to the top of flower avoiding any sharp angle of the shoot as approved by the Society of America Florists (SAF) Grades and Standard Committee, 1972.

flower by the total number of buds appeared on the individual plant according to following formula :

$$\frac{\text{Total number of opened flowers}}{\text{Total number of buds appeared}} \times 100$$

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Length of calyx of fully opened flower was measured with the help of scale (cm).

**h) Size of flower (cm)**

Diameter of fully opened flower was measured with the help of vernier calliper in cms at the time of measurement of the flower stalk length.

**i) Length of peduncle/stalk of terminal flower (cm)**

Flower stalk length was measured when the flower was fully opened with the help of scale. It was measured from cut end to the top of flower avoiding any sharp angle of the shoot as approved by the Society of America Florists (SAF) Grades and Standard Committee, 1972.

**j) Diameter of stalk**

Diameter of stalk was measured with the help of vernier calliper in cm at the time of measurement of stalk length.

**k) Flowers of different grades (on the basis of stalk length)**

The flowers were graded as follow :

A grade : Flowers having stalk length above 30 cm

B grade : Flowers having stalk length between 20-30 cm

C grade : Flowers having stalk length below 20 cm

## **4. EXPERIMENTAL RESULTS**

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The experimental finding emanating from the present studies on varietal evaluation of carnation (*Dianthus caryophyllus*) regarding different parameters are presented in this chapter.

### **4.1 Growth parameters**

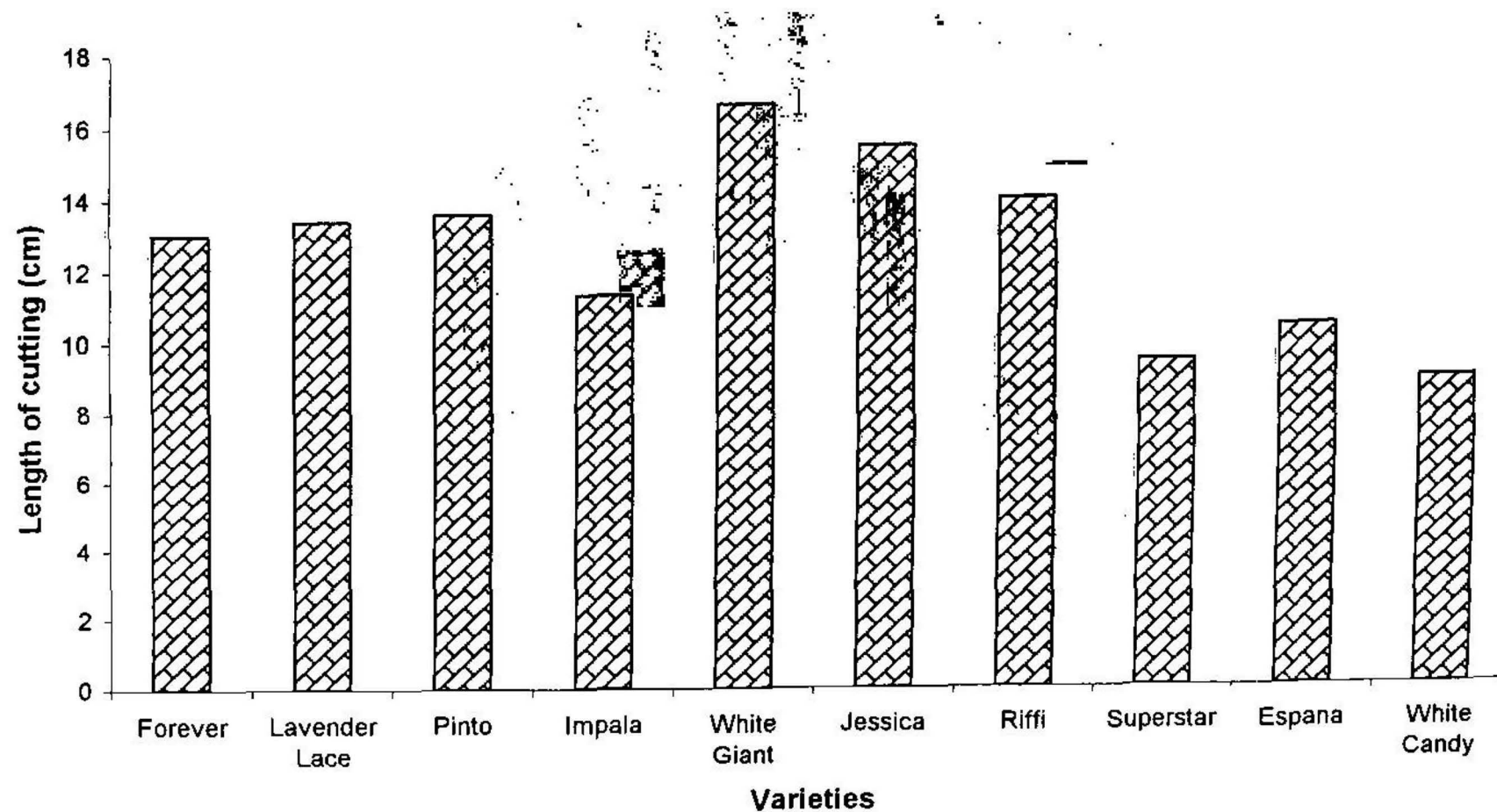
Result pertaining to growth parameters are presented below :

#### **4.1.1 Initial length of rooted cutting and number of leaves per cutting**

Data for initial length of rooted cutting and number of leaves per cutting, as depicted in Fig. 1 and 2 respectively, are presented in Table 1. The data revealed that at the time of planting maximum length of cutting (16.63 cm) was recorded in White Giant followed by Jessica (15.48 cm) and minimum length of cutting was recorded in White Candy (8.91 cm). Maximum number of leaves/cutting were recorded in Forever (14.29) followed by Lavendar Lace (14.17) and minimum number of leaves (9.40) in White Candy.

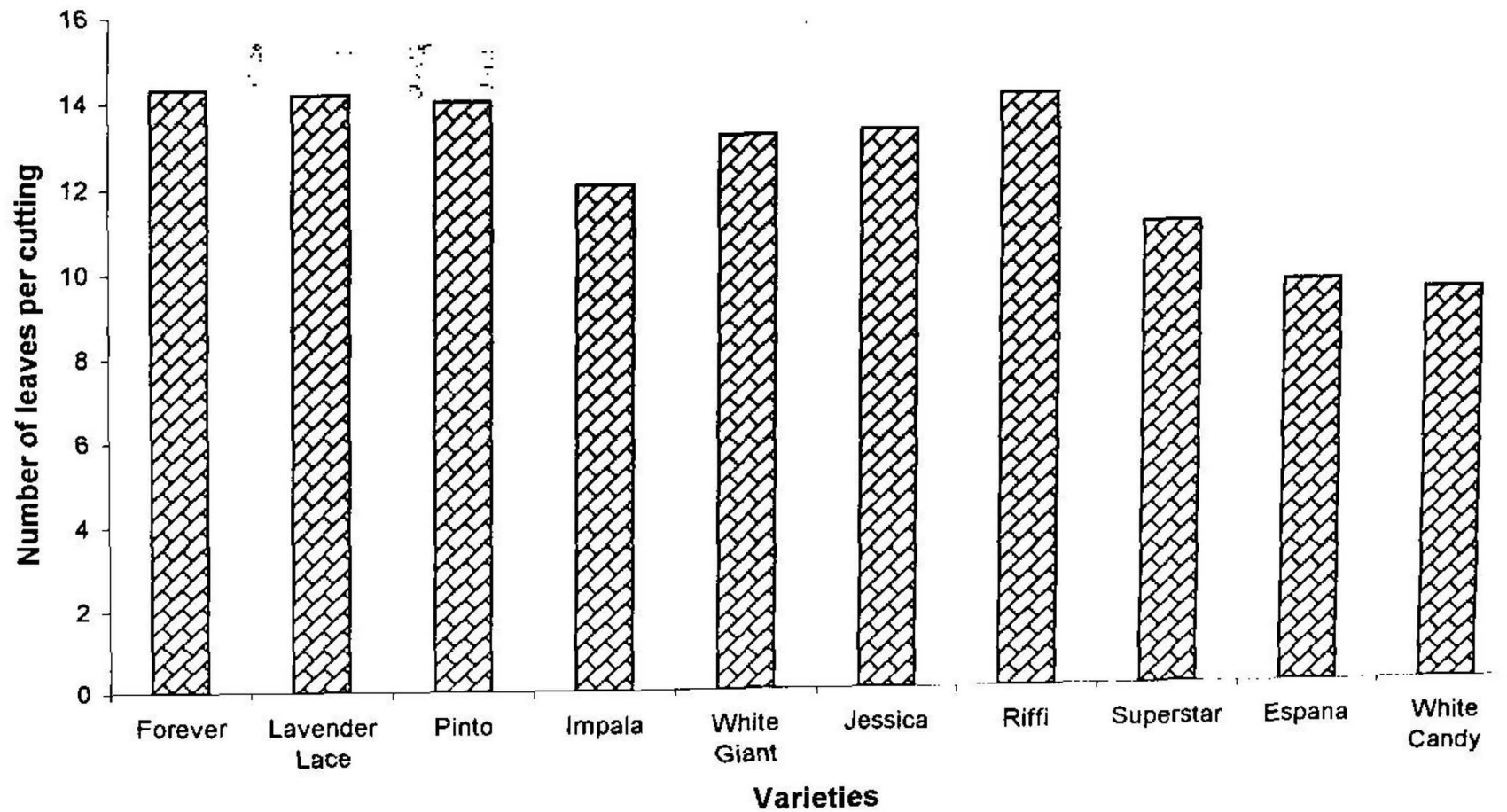
Table 1. Initial length of rooted cutting and number of leaves per cutting at the time of planting in different varieties of carnation

Varieties	Height of cuttings (cm)	No. of leaves/cutting
Forever	13.02	14.29
Lavender Lace	13.39	14.17
Pinto	13.58	14.00
Impala	11.31	12.03
White Giant	16.63	13.17
Jessica	15.48	13.27
Riffi	13.99	14.07
Superstar	9.43	11.03
Espana	10.42	9.63
White Candy	8.91	9.40



**Fig. 1 : Initial length of rooted cutting at the time of planting in different varieties of carnation.**





**Fig. 2 : Initial number of leaves per cutting at the time of planting in different varieties of carnation.**

### 4.1.2 Plant height

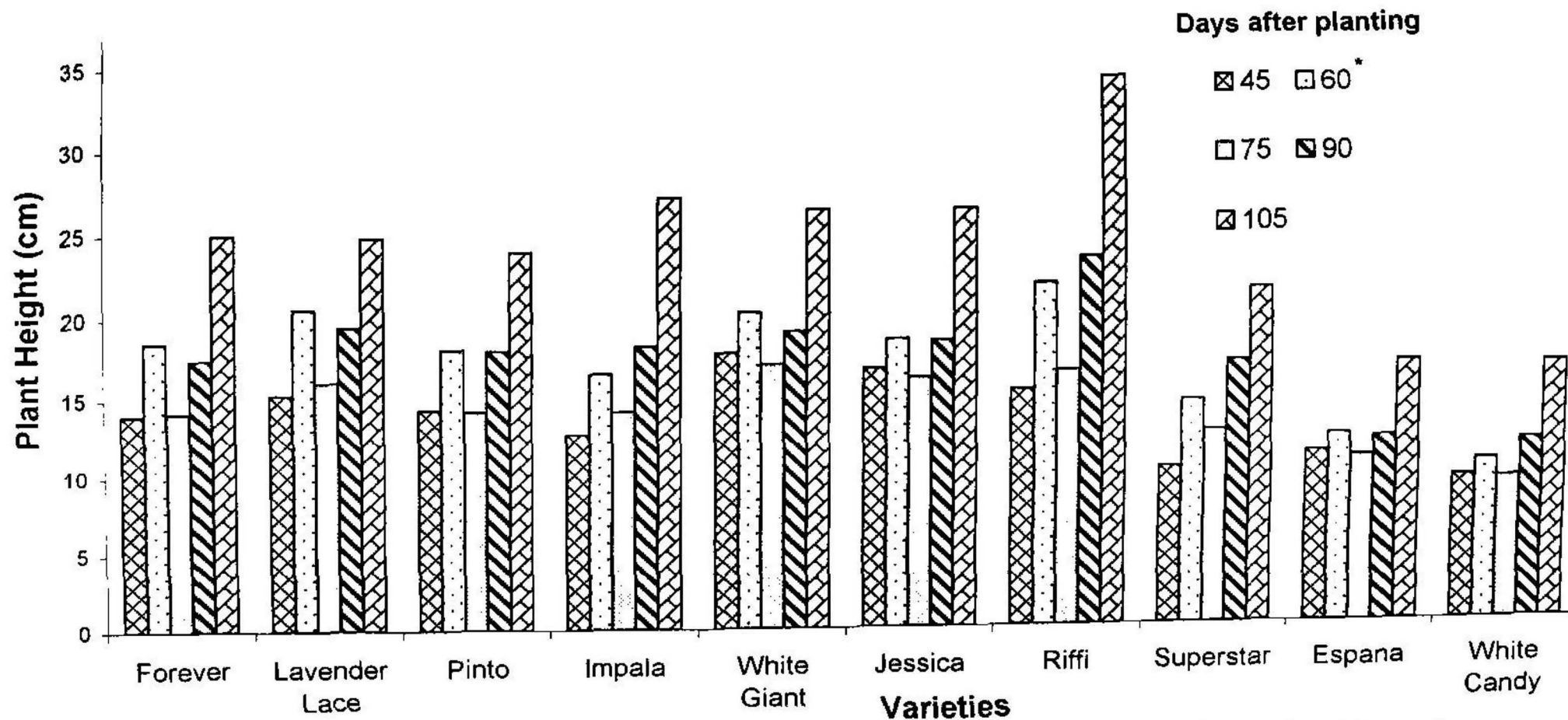
The data on plant height of different varieties recorded at different intervals, before and after pinching, are presented in Table 2 and depicted in Fig. 3. A careful examination of the data revealed that on 45th day after planting maximum height was gained by variety White Giant (17.71 cm) followed by variety Jessica (16.64 cm) whereas on 60th day after planting maximum height of plant was recorded in variety Riffi (21.82 cm) followed by Lavender Lace (20.57 cm) and the height of varieties Riffi, Lavender Lace and White Giant are statistically in close proximity with each other. On 60th day the plant of all varieties were pinched. The plant height on 75th day after planting was maximum in White Giant (16.97 cm) which was statistically at par with Riffi (16.46 cm), Jessica (16.09 cm) and Lavender Lace (16.03 cm) and minimum in White Candy (9.28 cm). Whereas on 90th day and 105th day of observation maximum height was recorded in Riffi (23.29 cm and 34.20 cm respectively) and it was found significantly higher over other varieties. Plant height in varieties Forever, Lavender Lace, Pinto, Impala, White Giant and Jessica was found to be statistically at par on 90th and 105th days of observation.

### 4.1.3 Number of leaves

Data pertaining to number of leaves per plant are presented in Table 3 and depicted in Fig. 4. A careful examination of data revealed that in variety Riffi number of leaves were significantly higher on 45th and 60th days of the planting. As the growth progressed the number of leaves increased irrespective of the variety. The maximum number of leaves per

Table 2. Plant height (cm) at different intervals, before and after pinching, in different varieties of carnation

Varieties	Before pinching		After pinching			Mean
	Days of observation					
	45	60	75	90	105	
Forever	13.99	18.55	14.18	17.49	24.96	18.88
Lavender Lace	15.27	20.57	16.03	19.44	24.79	20.08
Pinto	14.26	18.03	14.12	17.94	23.92	18.66
Impala	12.65	16.48	14.06	18.15	27.11	19.77
White Giant	17.71	20.19	16.97	19.02	26.33	20.69
Jessica	16.64	18.48	16.09	18.41	26.33	20.28
Riffi	15.26	21.82	16.46	23.39	34.20	24.68
Superstar	10.22	14.50	12.56	16.97	21.39	16.97
Espana	11.08	12.19	10.78	12.00	16.78	13.19
White Candy	9.42	10.47	9.28	11.68	16.64	12.53
CD (at 5%)	2.30	3.03	1.75	2.13	3.39	

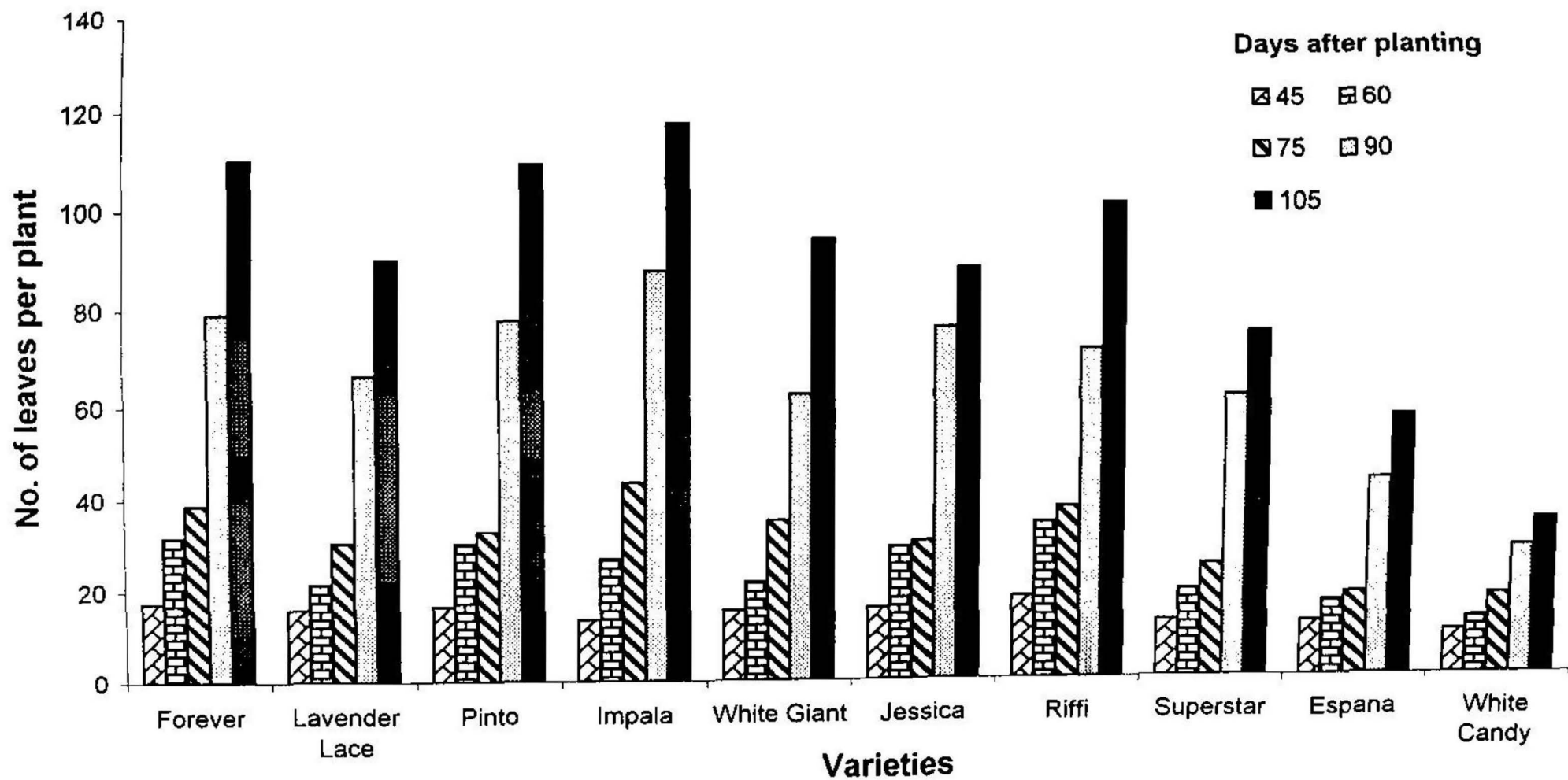


**Fig. 3 : Plant height (cm) at different intervals, before and after pinching, in different varieties of carnation.**

**\* - Pinching was done on 60th day after planting.**

Table 3. Number of leaves/plant at different intervals in different varieties of carnation

Varieties	Days of observation					
	45	60	75	90	105	
Forever	17.47	31.87	38.80	79.27	110.17	55.64
Lavender Lace	16.09	21.59	30.48	66.37	90.20	44.95
Pinto	16.67	30.37	32.97	77.81	109.27	53.42
Impala	13.63	26.81	43.38	87.86	117.53	57.84
White Giant	15.47	21.69	35.10	62.13	93.97	45.67
Jessica	15.93	29.40	30.47	76.07	88.03	47.98
Riffi	18.10	34.57	37.83	71.47	100.93	52.45
Superstar	12.53	19.50	24.83	61.43	74.77	38.61
Espana	12.03	16.58	18.31	43.26	56.97	29.34
White Candy	9.78	12.68	17.86	28.43	34.51	20.61
CD (at 5%)	2.74	5.41	6.98	13.60	17.57	



**Fig. 4 : Number of leaves per plant at different intervals in different varieties of carnation.**

plant were recorded in variety Impala on 75th, 90th and 105th day of observation i.e. 43.38, 87.86 and 117.53 respectively. Whereas minimum number of leaves per plant were recorded in variety White Candy (17.86, 28.43 and 34.51 respectively) on 75th, 90th and 105th day of observation.

#### **4.1.4 Number of axillary branches**

Number of axillary branches produced per plant by different varieties are presented in Table 4 and depicted in Fig. 5. From the perusal of data it is evident that a significant difference among different varieties in relation to axillary branches was noted. Number of axillary branches per plant varied between 1.47 to 4.67, 2.41 to 6.07 and 2.46 to 6.27 for 75th, 90th and 105th day of observation, respectively in different varieties. It is clear from the data that variety Pinto produced maximum number of axillary branches per plant on 75th, 90th and 105th day of observation followed by Impala. Varieties Forever, Lavender Lace, Pinto, Impala, White Giant and Jessica were found statistically at par with each other in producing number of axillary branches. White Candy produced minimum number of axillary branches per plant (2.46).

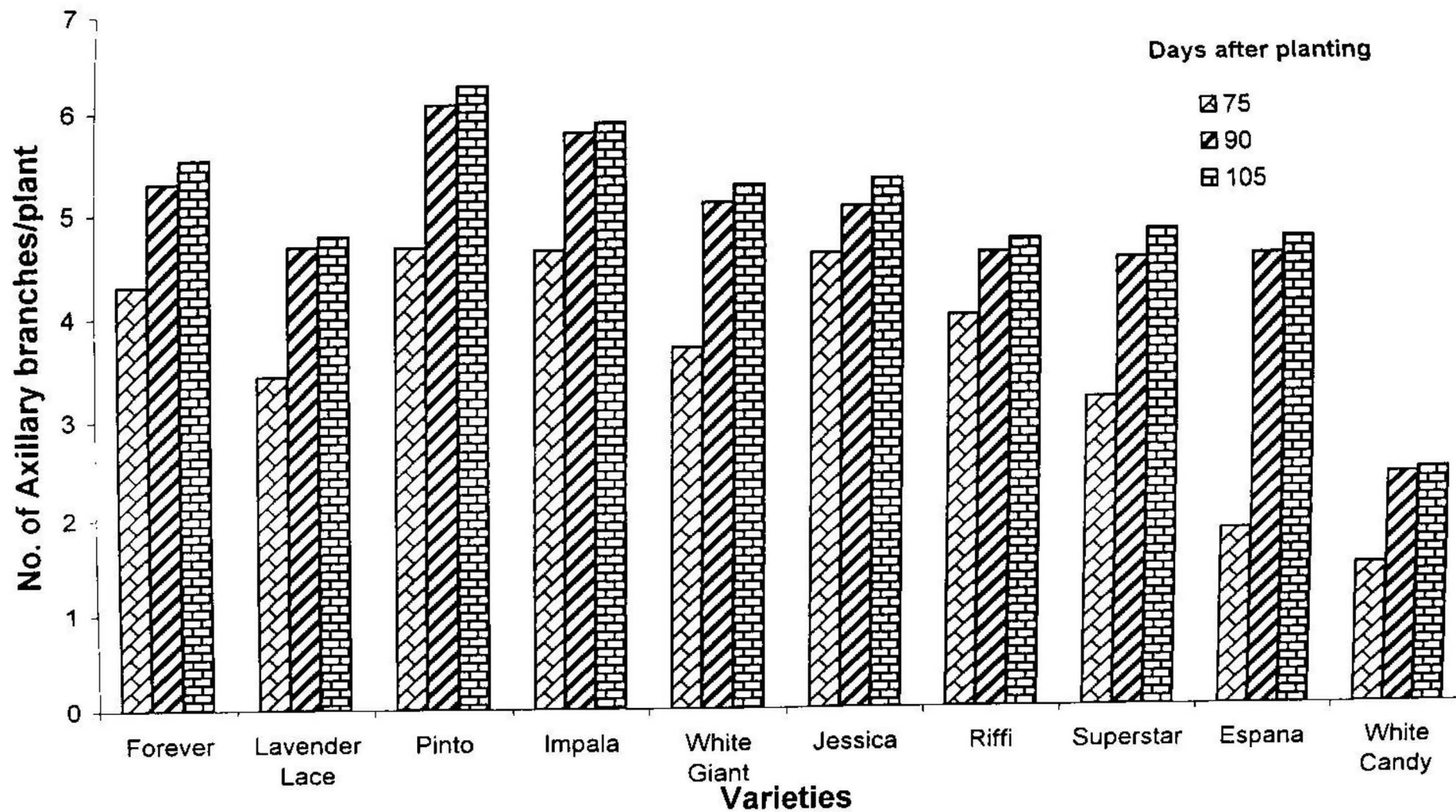
#### **4.1.5 Leaf area**

The data on total leaf area of the plant is presented in Table 5 and depicted in Fig. 6. It is evident from the data that there was a significant difference in total leaf area among different varieties. The maximum leaf

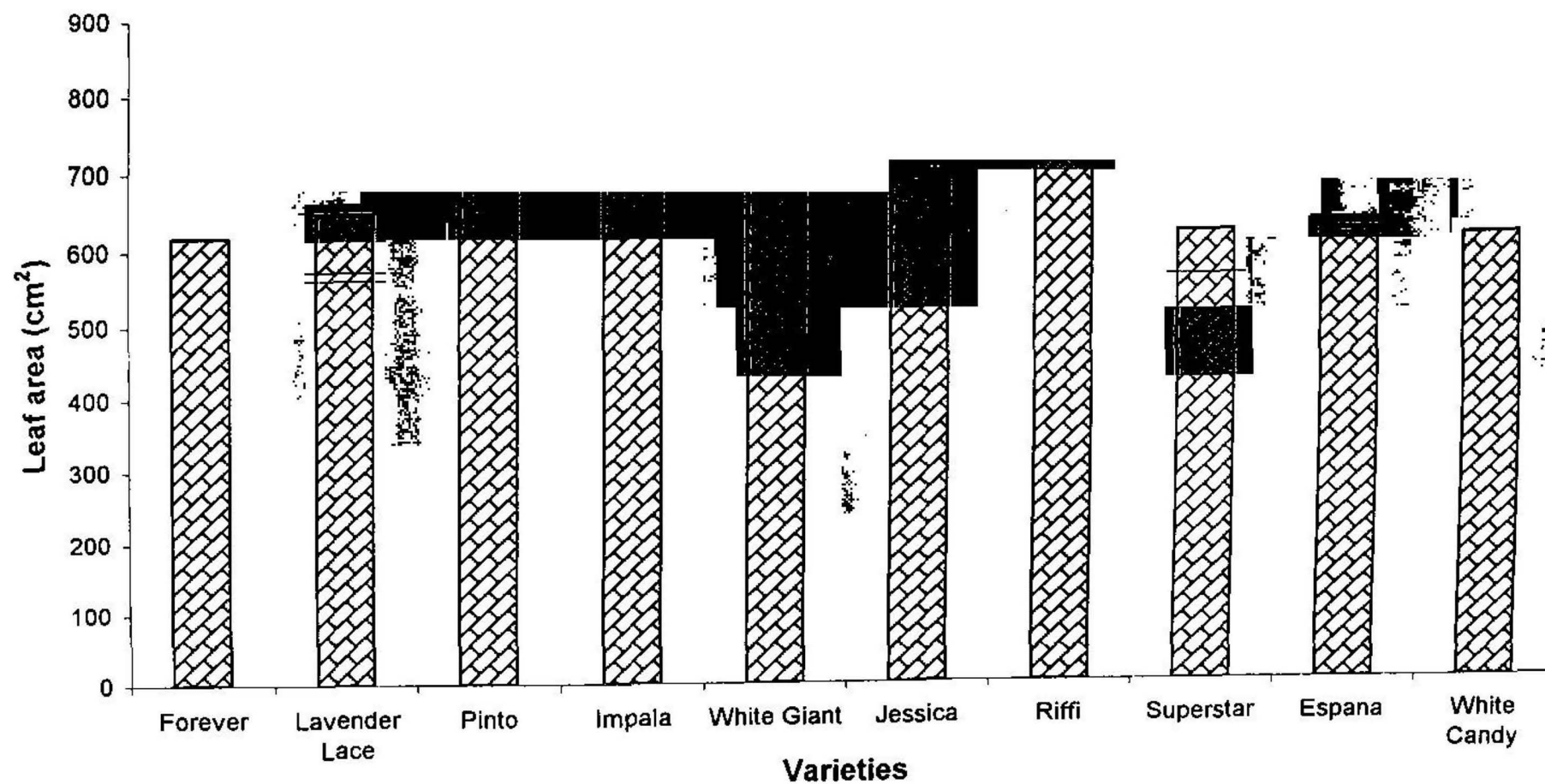
Table 4. Number of axillary branches/plant at different intervals in different varieties of carnation

Varieties	Days of observation			
	75	90	105	Mean
Forever	4.30	5.30	5.53	5.04
Lavender Lace	3.43	4.68	4.78	4.29
Pinto	4.67	6.07	6.27	5.67
Impala	4.64	5.79	5.89	5.44
White Giant	3.70	5.10	5.27	4.69
Jessica	4.60	5.06	5.33	5.00
Riffi	4.00	4.60	4.73	4.44
Superstar	3.19	4.54	4.82	4.18
Espana	1.84	4.57	4.73	3.61
White Candy	1.47	2.41	2.46	2.11
CD (at 5%)	1.09	1.24	1.20	





**Fig. 5 : Number of axillary branches per plant at different intervals in different varieties of carnation.**



**Fig. 6 : Leaf area (cm<sup>2</sup>) at full flowering stage in different varieties of carnation.**

area was recorded in variety Pinto (762.38 cm<sup>2</sup>) followed by Riffi (759.51 cm<sup>2</sup>) and minimum was recorded in variety White Candy (614.64 cm<sup>2</sup>). Varieties Pinto and Riffi exhibited very little variation between themselves and were found statistically at par with each other. Leaf area in varieties Forever, Super Star, Espana and White Candy were found statistically at par to each other.

#### **4.1.6 Internodal length**

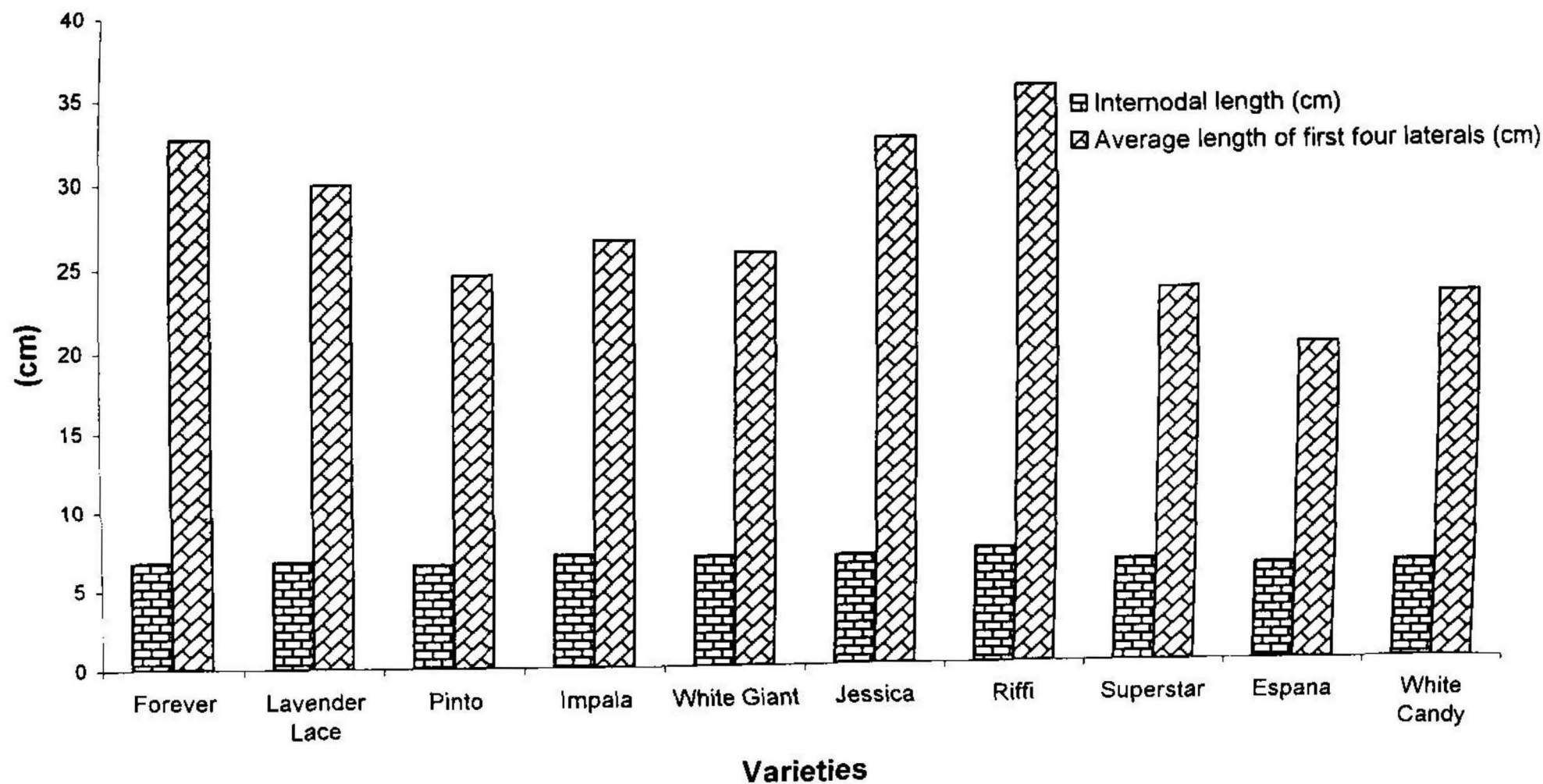
Data regarding internodal length among different varieties is presented in Table 5 and depicted in Fig. 7. Internodal length in variety Riffi (7.28) was found significantly higher as compared to minimum in variety Espana (6.08 cm). The differences in internodal length in varieties Forever and Lavender Lace exhibited very little variation and were statistically at par with each other. Similarly, White Giant and Jessica were statistically at par.

#### **4.1.7 Average length of first four laterals**

It is clear from the data presented in Table 5 (Fig. 7) that maximum average length of first four laterals was recorded in variety Riffi (35.56 cm) which was found significantly higher followed by Forever and Jessica (32.62 cm and 32.49 cm respectively). Varieties Forever and Jessica were found statistically at par. However minimum length was noted in variety Espana (20.06 cm).

Table 5. Leaf area, internodal length, average length of first four lateral branches at full flowering stage in different varieties of carnation

Varieties	Total leaf area (cm <sup>2</sup> )	Internodal length (cm)	Average length of first four laterals (cm)
Forever	617.65	6.74	32.62
Lavender Lace	647.85	6.77	29.95
Pinto	762.38	6.55	24.52
Impala	688.15	7.07	26.54
White Giant	712.96	6.89	25.75
Jessica	686.94	6.88	32.49
Riffi	759.51	7.28	35.56
Superstar	622.26	6.44	23.45
Espana	621.58	6.08	20.06
White Candy	614.64	6.18	23.01
CD (at 5%)	12.77	0.08	2.73



**Fig. 7 : Internodal length, average length of first four lateral branches at full flowering stage in different varieties of carnation.**

## **4.2 Flowering parameters**

Results pertaining to flowering parameters are presented below :

### **4.2.1 Number of days taken for bud emergence**

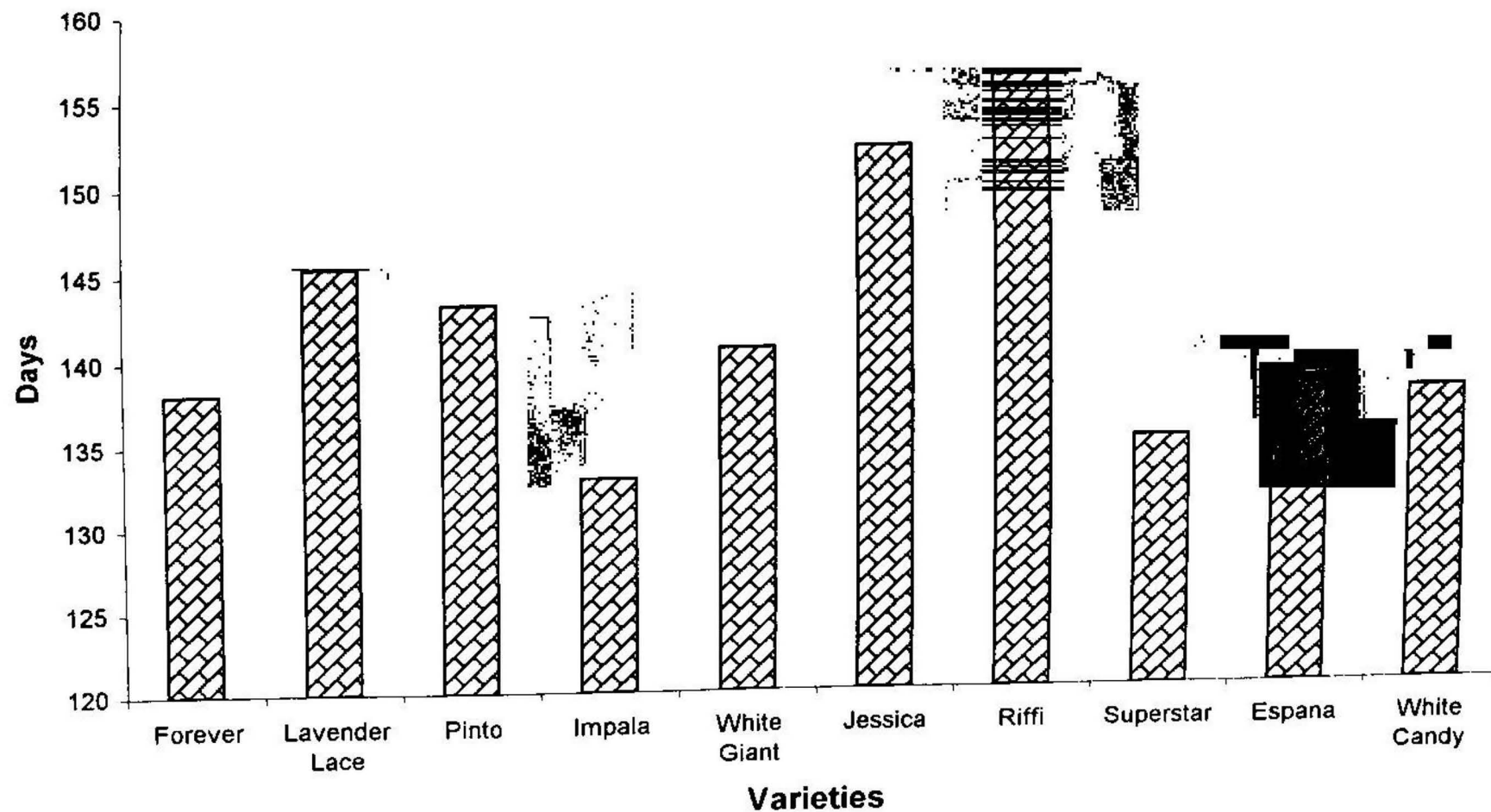
Data on days taken for bud emergence (from date of planting) are presented in Table 6 and depicted in Fig. 8. The data show that variety Impala took minimum number of days for bud emergence (132.91) and was found significantly higher to varieties Lavender Lace, Pinto, Jessica and Riffi. Impala was found significantly at par to varieties Forever, White Giant, Super Star, Espana and White Candy. Riffi took maximum number of days (156.22) for bud emergence.

### **4.2.2 Number of buds per plant**

The perusal of data presented in Table 6 (Fig. 9) regarding number of buds produced per plant by different varieties indicate that number of buds per plant ranged from 6.29 to 11.94. It is clear from the data that a significant difference regarding production of buds per plant was observed. Variety Pinto produced maximum number of buds (11.94) followed by varieties Impala (11.63), Forever (11.11). White Giant (10.78) and Jessica (10.71) which were found to be at par with each other. Variety White Candy produced minimum number of buds per plant (6.29).

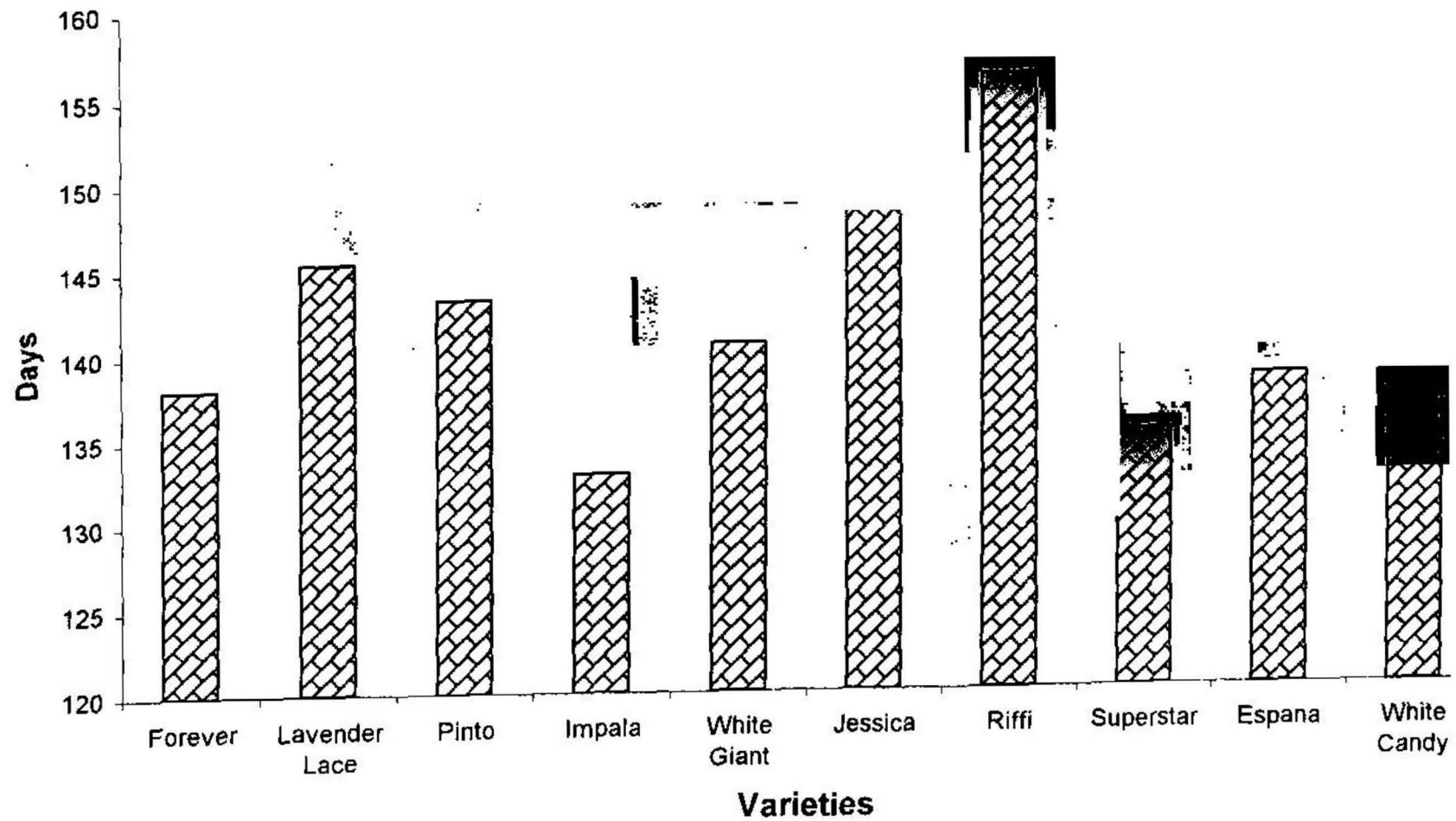
Table 6. Number of days taken for bud emergence, number of buds/plant, number of flower opened/plant and number of under-developed and unopened flower buds/plant in different varieties of carnation

Varieties	No. of days taken for bud emergence	No. of buds/plant	No. of flower opened/plant	No. of under-developed and unopened flower buds/plant
Forever	138.07	11.11	4.18	6.93
Lavender Lace	145.41	9.37	5.26	4.12
Pinto	143.24	11.94	4.09	7.85
Impala	132.91	11.63	6.76	4.87
White Giant	140.61	10.78	5.29	5.49
Jessica	152.22	10.71	5.05	5.64
Riffi	156.22	9.49	4.10	5.38
Superstar	135.08	9.88	4.29	5.59
Espana	138.39	8.92	3.49	5.43
White Candy	137.74	6.29	2.44	3.79
CD (at 5%)	7.84	1.84	0.97	1.11

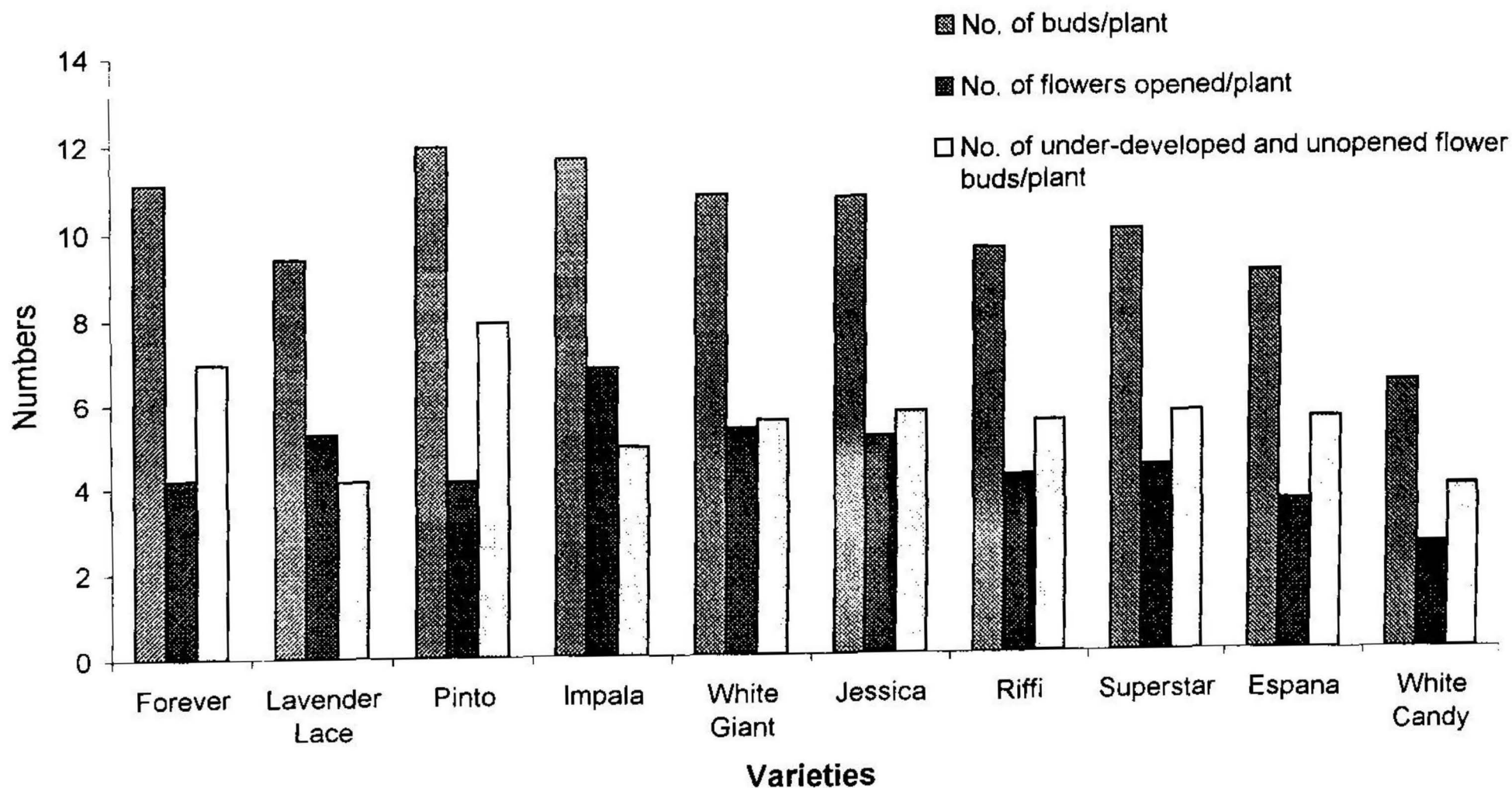


**Fig. 8 : No. of days taken for bud emergence in different varieties of carnation.**





**Fig. 8 : No. of days taken for bud emergence in different varieties of carnation.**



**Fig. 9 : No. of buds/plant, no. of flowers opened/plant, no. of under-developed and unopened flower buds/plant in different varieties of carnation.**

#### **4.2.2.1 Number of flowers opened per plant**

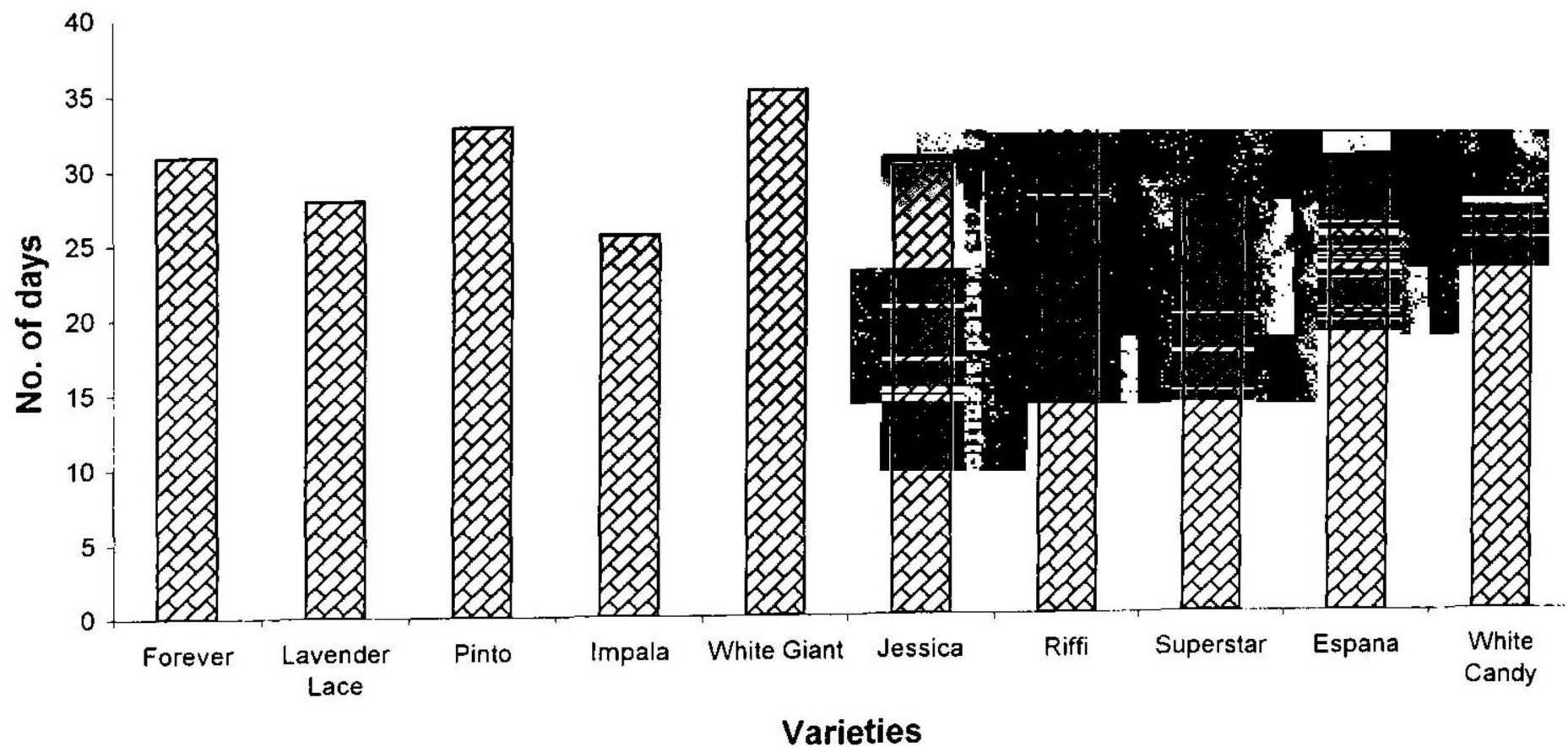
Data presented in Table 6, Fig. 9 indicate that the number of flowers opened per plant varied significantly among different varieties. The maximum number of flowers opened per plant was recorded in variety Impala (6.76) followed by White Giant (5.29) and Lavender Lace (5.26) and the minimum number of opened flowers was in White Candy (2.44). A careful examination of the data indicate that the varieties White Giant, Jessica and Lavender Lace were statistically at par with each other. Similarly, varieties Forever, Pinto, Riffi and Superstar were also at par with each other.

#### **4.2.2.2 Number of under developed and unopened flower buds per plant**

Data on under developed and unopened flowers per plant are presented in Table 6 and depicted in fig. 9. It is clear from the data that maximum number of unopened and under developed flower buds per plant (7.85) were recorded in variety Pinto and minimum number (3.79) in variety White Candy. Varieties Forever and Pinto exhibited very little variation between themselves and were found at par with each other. Varieties White Giant, jessica, Riffi, Superstar, Espana were also statistically at par with each other.

#### **4.2.3 Number of days taken for furling of petals**

The data related to the number of days taken for opening of flowers from the date of bud emergence are presented in Table 7 and depicted in Fig. 10. The data indicate that number of days taken for opening of flowers



**Fig. 10 : No. of days taken for furling of petals from the date of bud emergence in different varieties of carnation.**

✓

varied between 25.51 to 35.17 days. The minimum number of days for opening of flower (25.51) was recorded in Impala followed by varieties White Candy, Superstar and Lavender Lace (26.74, 27.58 and 27.87 respectively). Whereas, variety White Giant took maximum number of days for opening of flower (35.17).

#### **4.2.4 Per cent opening of flower**

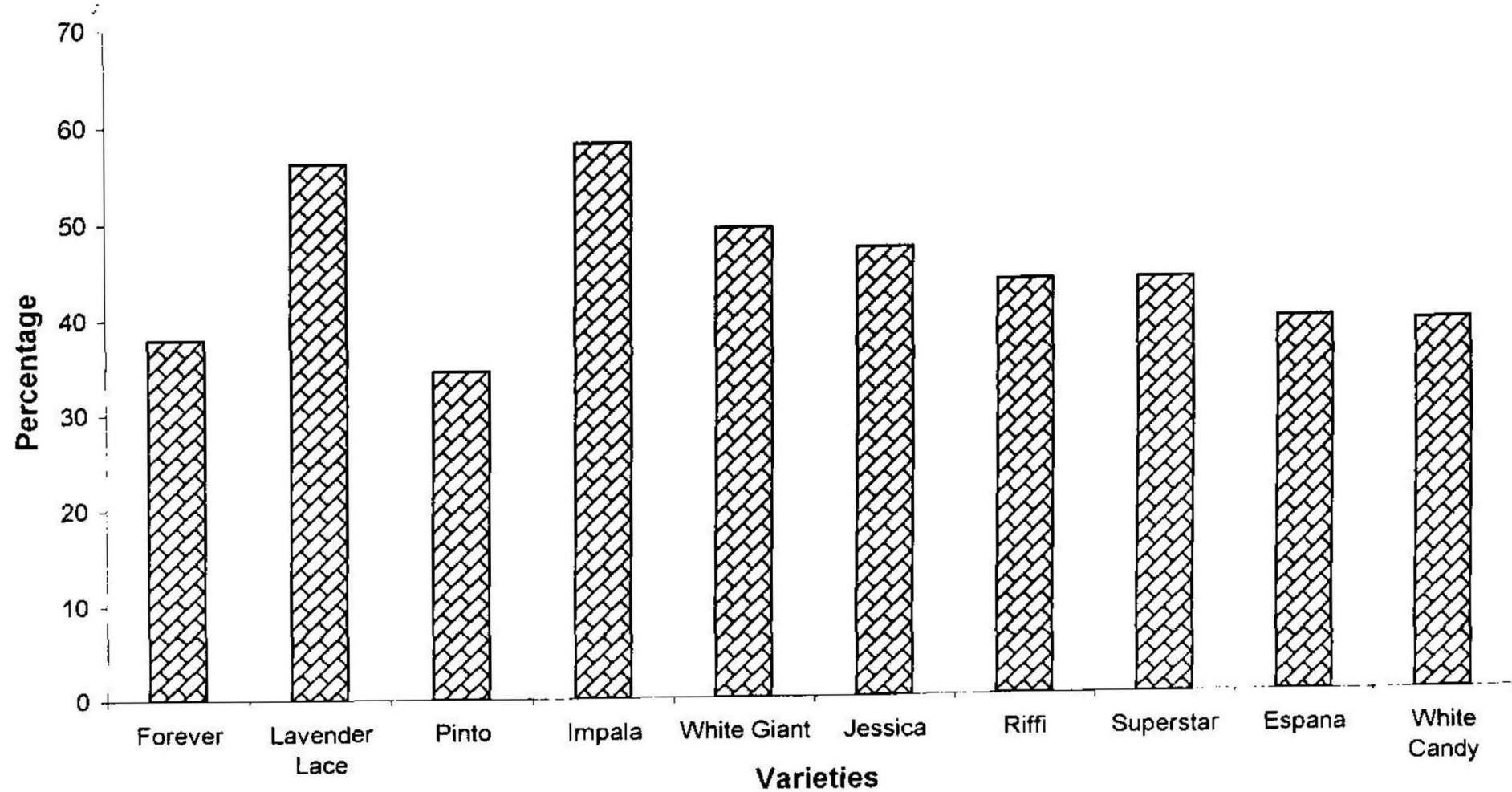
From perusal of data presented in Table 7, Fig. 11, it is clear that per cent opening of flowers varied significantly among different varieties. Per cent opening of flowers was significantly higher in Impala over other varieties except Lavender Lace. Maximum per cent opening was recorded in variety Impala (58.04%) followed by Lavender Lace (56.18%) and White Giant (49.07%). However, Lavender Lace and Impala were significantly at par with each other. Minimum per cent opening of flowers was observed in variety Pinto (34.35%).

#### **4.2.5 Size of flower**

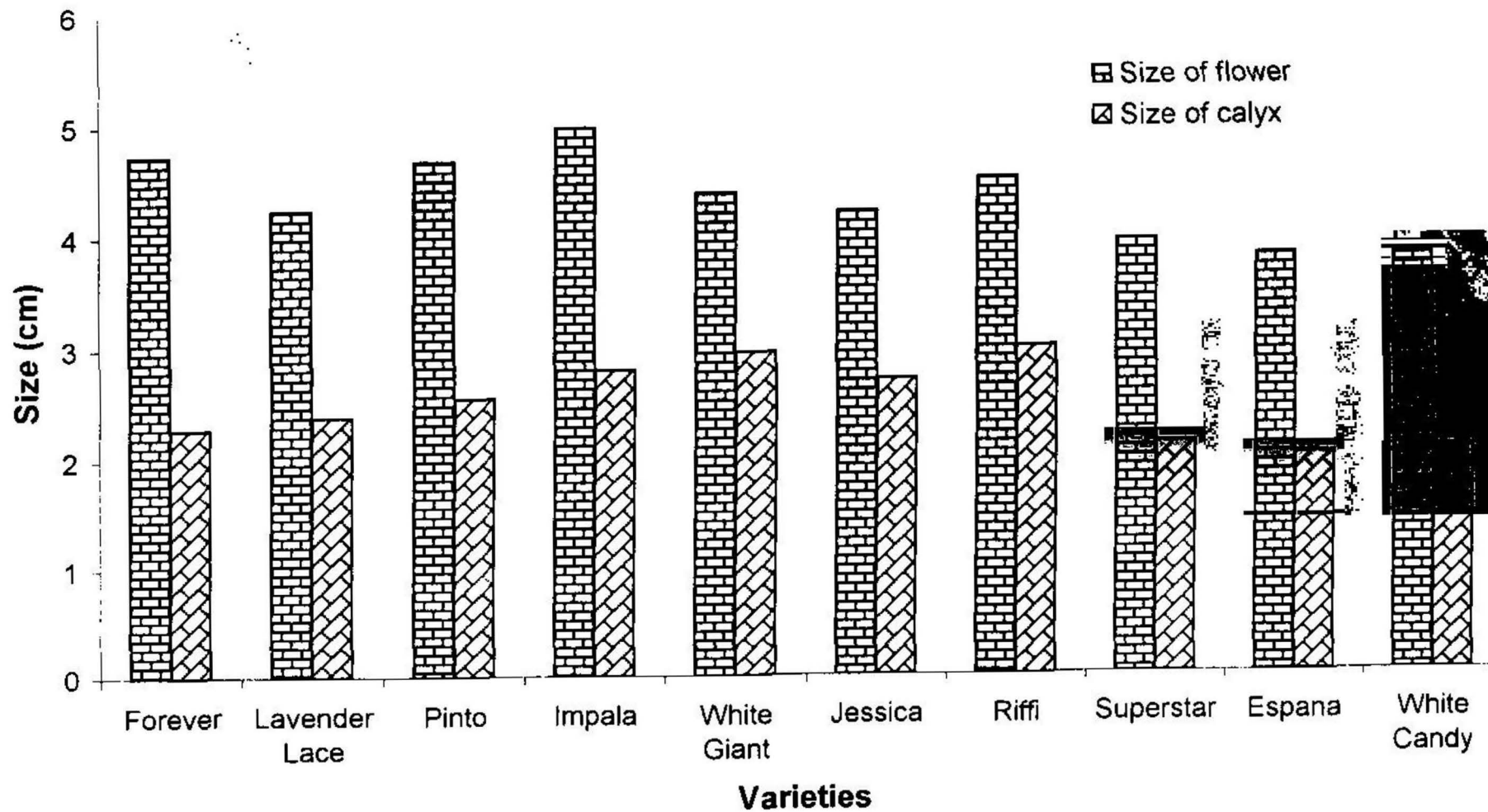
The data pertaining to size of flower produced by different varieties are presented in Table 7 and depicted in Fig. 12. While comparing the size of flower produced by different varieties, a significant difference was observed. Variety Impala produced significantly larger size of flower (4.97 cm) followed by Forever (4.73 cm) and Pinto (4.67 cm). Whereas, White Candy (3.76 cm) showed significantly smaller size of flower as compared to other varieties.

Table 7. Number of days taken for furling of petals from the date of bud emergence, per cent opening of flower, size of flower (cm) and size of calyx (cm) in different varieties of carnation

Varieties	No. of days taken for furling of petals from the date of bud emergence	Per cent opening of flower	Size of flower (cm)	Size of calyx (cm)
Forever	30.91	37.87	4.73	2.28
Lavender Lace	27.87	56.18	4.23	2.38
Pinto	32.79	34.35	4.67	2.54
Impala	25.51	58.04	4.97	2.78
White Giant	35.17	49.07	4.37	2.94
Jessica	29.93	46.87	4.20	2.69
Riffi	32.81	43.29	4.49	2.97
Superstar	27.58	43.37	3.92	2.10
Espana	29.77	39.04	3.78	1.99
White Candy	26.74	38.57	3.76	2.03
CD (at 5%)	2.88	4.06	0.09	0.10



**Fig. 11 : Percent opening of flowers in different varieties of carnation.**



**Fig. 12 : Size of flower (cm) and size of calyx (cm) in different varieties of carnation.**



#### 4.2.6 Size of calyx

The size of calyx as recorded in different varieties is shown in Table 7 and depicted in Fig. 12. The data presented clearly indicate that size of calyx varied significantly and it ranged between 1.99 to 2.97 cm among different varieties. The data showed that variety Riffi produced larger size of calyx (2.97 cm) followed by White Giant (2.94 cm) and Impala (2.78 cm). Whereas, variety Espana produced smaller size of calyx (1.99 cm).

#### 4.2.7 Diameter of stalk

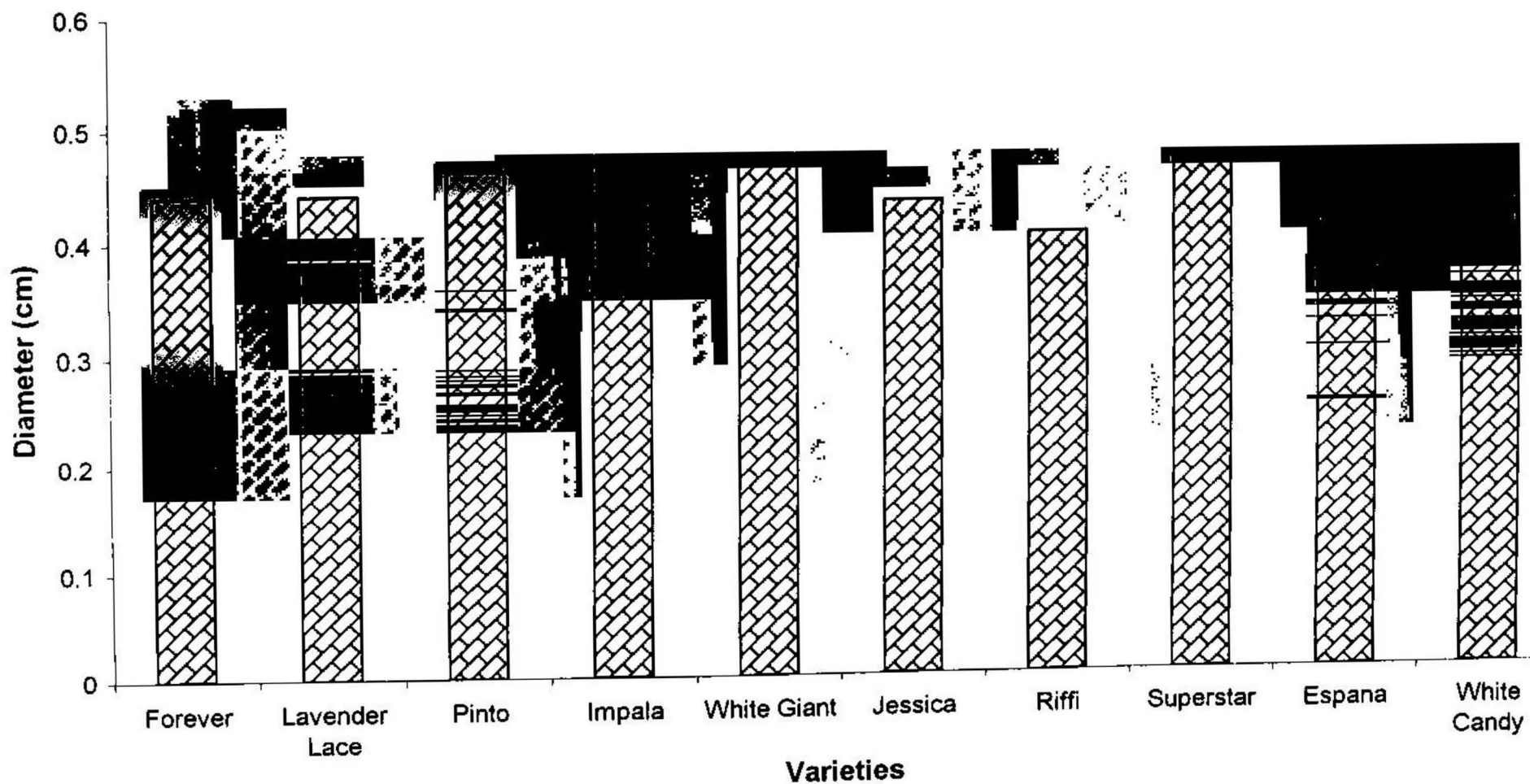
The trend regarding diameter of stalk of plant in various varieties of carnation is presented in Table 8 and depicted in Fig. 13. It is evident from the data that diameter of stalk varied significantly among different varieties and it ranged between 0.40 to 0.50 cm in varieties Riffi and Impala respectively. The diameter of stalk in variety Impala was significantly higher as compared to Forever, Lavender Lace, Jessica, Riffi, Espana and rest of the varieties were found statistically at par with Impala.

#### 4.2.8 Length of peduncle/stalk of terminal flower

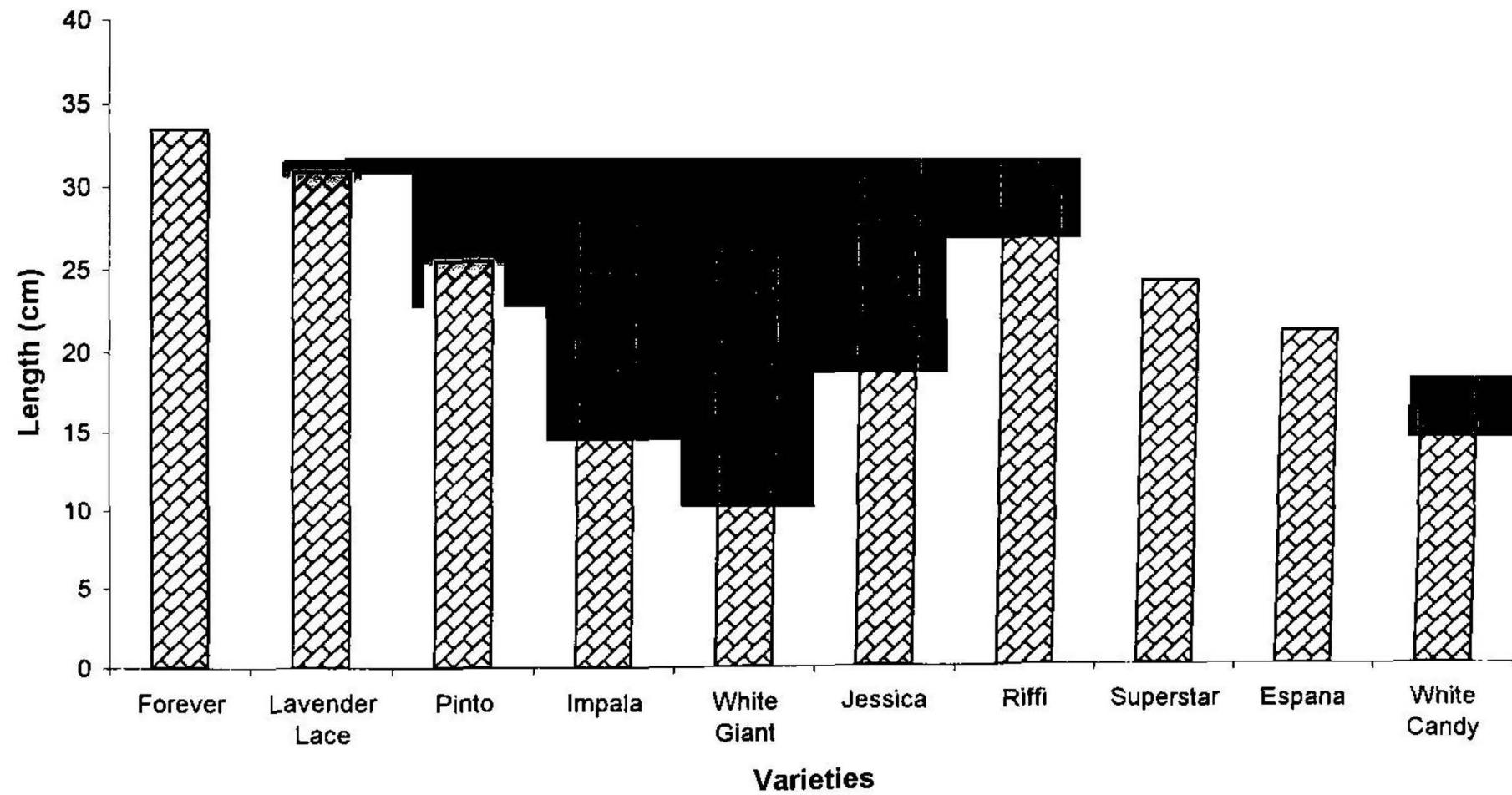
Length of peduncle/stalk is an important character for this crop which determine the flowering quality and ultimately the cost. It is apparent from the data presented in Table 8 (Fig. 14), that stalk length varied significantly owing to varieties. It ranged between 21.07 to 36.55 cm in varieties. Variety Riffi recorded maximum stalk length (36.55 cm) which was significantly

Table 8. Average diameter and length of stalk of different varieties in carnation

Varieties	Diameter of stalk (cm)	Length of peduncle/stalk of terminal flower (cm)
Forever	0.44	33.42
Lavender Lace	0.44	30.88
Pinto	0.46 ✓	25.46
Impala	0.50	27.61
White Giant	0.48	26.62
Jessica	0.43	33.31
Riffi	0.40	36.55
Superstar	0.48	24.13
Espana	0.43	21.07
White Candy	0.46	24.34
CD (at 5%)	0.04	2.89



**Fig. 13 : Diameter of stalk (cm) in different varieties of carnation.**



**Fig. 14 : Length of peduncle/stalk (cm) of terminal flower in different varieties of carnation**

Table 9. Flowers of different grades (on the basis of stalk length) in different varieties of carnation

Varieties	Flowers having stalk length below 20 cm	No. of Flowers having stalk length between 20-30 cm	Flowers having stalk length above 30 cm
Forever	1.3	1.7	1.1
Lavender Lace	1.6	2.5	1.2
Pinto	1.3	2.1	0.7
Impala	2.1	2.5	1.7
White Giant	2.0	2.8	0.5
Jessica	1.6	2.1	1.3
Riffi	2.0	1.8	0.2
Superstar	2.24	1.8	0.4
Espana	2.9	0.4	0.2
White Candy	1.3	1.0	0.1
CD (at 5%)	0.53	0.55	0.24

higher to other varieties followed by Forever (33.42 cm), Jessica (33.31 cm) and Lavender Lace (30.88 cm). However, Forever, Lavender Lace and Jessica were found statistically at par with each other. Minimum stalk length was recorded in Espana (21.07 cm).

#### **4.2.9 Flowers of different grades**

To fetch maximum price in the market grading of flower plays an important role. The flowers having good length fetch more price. The data pertaining to average number of flowers of different grades is presented in Table 9. It is evident from the data that maximum number of 'A' grade flowers, having stalk length above 30 cm were produced by Impala (1.7) followed by Lavender Lace. Whereas maximum number of 'B' grade flowers having stalk length between 20-30 cm was observed in White Giant (2.8). Variety Espana (2.9) produced maximum number of 'C' grade flowers. So it is concluded that among different varieties, variety Impala was found best in producing maximum number of 'A' grade flowers.

## 5. *DISCUSSION*

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Yield of a crop is cumulative result of interaction between the genetic potential of the plant and the environment in which it is grown. Each and every crop shows its growth potential and flowering under the ideal environmental and agronomical conditions. Maximum yield is the combined function of inter plant and intra plant competition. Therefore, for a successful cultivation of any crop it is necessary to expose it for optimum climatic condition during the growing period to get good growth and production of better quality flower. Since carnation is an important cut flower which is commercially grown in different states, but no work was conducted on this crop in Haryana, therefore, the present investigation entitled, "Studies on varietal evaluation of carnation" was conducted and the results of the investigation presented in the preceding chapter have been discussed below in the light of available information.

## 5.1 Vegetative parameters

To study the performance of carnation variety under semi-arid condition of Hisar, the rooted cutting of ten varieties were planted in pots on November 27, 1997, having initial length and number of leaves per cutting presented in Table 1. Observations pertaining to height of plant, number of leaves/plant, total leaf area/plant, number of axillary branches/plant. Internodal length and average length of first four laterals per plant were recorded. It is clear from the data in Table 2 (in preceding chapter) that maximum height was recorded in variety Riffi which was significantly higher over other varieties. The number of leaves per plant ranged among the varieties and maximum number of leaves per plant were recorded in variety Impala. As far as production of number of axillary branches per plant by different varieties is concerned, all varieties behaved in no definite manner. However, it ranged between 1.47 to 6.27 among different varieties and variety Pinto produced maximum number of axillary branches per plant. While taking observations regarding leaf area scored by different varieties it was found that maximum leaf area was recorded in variety Pinto followed by Riffi. While going through the values of internodal length of different varieties, a significant difference was observed. However, maximum internodal length was observed in variety Riffi. The results regarding average length of first four lateral branches indicate that maximum length was recorded by variety Riffi.



The reason for variation in different vegetative parameters under different varieties might be attributed to different genetic make up of the plant and their adaptability behaviour under agroclimatic condition of Hisar.

## 5.2 Flowering parameters

The performance of any ornamental crop and its variety is judged by its flowering behaviour i.e. number of flowers, size of flower and stalk length for cut flower purpose. Under this experiment to study the flowering behaviour observations regarding number of days taken for initiation of buds from the date of planting, number of buds/plant, number of flowers opened/plant, number of under developed and unopened flower buds/plant, number of days taken for furling of petals from the date of bud emergence, per cent flower opening, size of flower, size of calyx, diameter of stalk, length of peduncle/stalk of terminal flower and number of flowers having stalk length below 20, 20-30 and above 30 cm were noted.

The data clearly indicate that among different varieties, variety Impala shows its significance in relation to minimum time taken for bud emergence, opening of maximum number of flower/plant, minimum number of days for furling of petals, larger size of flower, maximum per cent opening of flowers, maximum diameter of stalk and for flower having stalk length above 30 cm. Whereas, variety Pinto produced maximum number of buds and also number of underdeveloped and unopened flower buds/plant. Variety Riffi produced flower having maximum length of peduncle/stalk and size of calyx.



The reason for attaining good attributes by variety Impala might possibly be due to good adaptability of agroclimatic conditions of Hisar and difference in behaviour of floral characteristic may be due to genotypic variability existing among varieties.

## **6. *SUMMARY AND CONCLUSION***

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Investigation on performance of different varieties of carnation under semi-arid condition of Hisar were carried out in the screen house of Department of Horticulture, CCS Haryana Agricultural University, Hisar during November, 1997 to May, 1998. Under study ten varieties were taken with the objective to study their performance under semi-arid condition of Hisar in term of growth and flowering.

The salient findings of investigation are summarized as under :

On the basis of results it was found that height, internodal length and average length of first four lateral branches were recorded maximum in variety Riffi. Variety Impala recorded maximum number of leaves/plant. Variety Pinto showed maximum leaf area and maximum number of axillary branches/plant.

While going through the floral behaviour of different varieties, it was found that minimum number of days taken for bud emergence, opening of

maximum number of flowers, maximum diameter of stalk, minimum number of days for furling of petals from date of bud emergence, larger size of flower, maximum per cent flowers opening and maximum flower having stalk length above 30 cm was observed in variety Impala. No doubt variety Pinto developed maximum number of buds among different varieties, but it also showed maximum number of under developed and unopened flower buds/plant. Variety Riffi was found better in term of producing peduncle/stalk having maximum length and larger size of calyx.

## **Conclusion**

1. On the basis of vegetative characters i.e. number of leaves/plant, variety Impala was found best. Variety Pinto recorded maximum leaf area and maximum number of axillary branches/plant, whereas variety Riffi produced plants having maximum height, maximum internodal length and maximum average length of first four lateral branches.
2. Among different varieties, variety Impala was found best as this variety took minimum number of days for bud emergence, recorded maximum number of opened flowers/plant, achieved maximum per cent opening of flowers/plant, better size of flower, maximum diameter of stalk, minimum number of days taken for furling of petals and produced maximum number of flowers having stalk length above 30 cm.
3. Variety Riffi produced maximum peduncle/stalk length having greater size of calyx.

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## ANNEXURE-I

Monthly mean meteorological data during experiment period from November, 1997 to May, 1998

Month	Temperature(°C)		R.H. (%)	Total sunshine (hrs)	Total rainfall (mm)
	Max.	Min.			
1997					
November	25.2	10.3	49.0	5.6	0.0
December	16.2	6.6	47.6	2.4	1.0
1998					
January	19.0	3.8	47.0	6.3	0.0
February	22.5	7.5	51.0	6.7	0.0
March	26.2	13.2	43.0	7.8	0.0
April	36.3	17.9	44.0	8.6	1.0
May	41.9	23.2	33.0	9.2	314.3

Source : Meteorological Observatory, CCS HAU, Hisar.

