EVALUATION OF CHRYSANTHEMUM (*Dendranthema grandiflora* Tzvelev.) CULTIVARS FOR GROWTH, YIELD AND STORAGE LIFE UNDER OPEN FIELD CONDITIONS

BY

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THESIS SUBMITTED TO Dr. Y.S.R. HORTICULTURAL UNIVERSITY IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF

MASTER OF SCIENCE IN HORTICULTURE

(FLORICULTURE AND LANDSCAPE ARCHITECTURE)

DEPARTMENT OF FLORICULTURE AND LANDSCAPE ARCHITECTURE
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SEPTEMBER, 2013

DECLARATION

I, **SANTHI SWAROOPINI BANTU** hereby declare that the thesis entitled **"Evaluation of Chrysanthemum (***Dendranthema grandiflora* Tzvelev.**) cultivars for growth, yield and storage life under open field conditions"** submitted to Dr.Y.S.R. Horticultural University, Venkataramannagudem, for the Degree of **Master of Science in Horticulture (Floriculture and Landscape architecture)** is the result of original research work done by me. I declared that no material contained in the thesis has been published earlier in any manner.

Place : Anantharajupet

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CERTIFICATE

Ms. SANTHI SWAROOPINI BANTU has satisfactorily prosecuted the course of research and that the thesis entitled **"EVALUATION OF CHRYSANTHEMUM (*Dendranthemagrandiflora*Tzvelev.) CULTIVARS FOR GROWTH, YIELD AND STORAGE LIFE UNDER OPEN FIELD CONDITIONS"** submitted the result of original research work and is of sufficiently high standard to warrant its presentation to the examination.

I certify that neither the thesis nor its part thereof has not been previously submitted by her for a degree of any University.

Place: Anantharajupet

Date: **(Dr. K. SWARAJYA LAKSHMI)**

CHAIRMAN

ACKNOWLEDGEMENTS

I humbly present my accomplishment with blessing of LORD ALMIGHTY, inspiration from my teachers and love of my parents and friends.

I am in dearth of words in expressing my gratitude and sincere regards with heartfelt thanks to my Major Advisor and Chairman of Advisory Committee Dr. K.SWARAJYALAKSHMI, Associate Professor, Department of Horticulture, HC&RI, Anantharajupet for her towering presence and inspiring guidance, scientific proficiency, constructive criticism and her constant goading and whole hearted cooperation in the preparation of this manuscript. I wish to express my bountiful appreciation and thanks for the pains she has taken for critically going through the manuscripts and for the assistance rendered during the preparation of the thesis.

I am extremely thankful and sincere gratitude to Dr.R.Nagaraju, Scientist, Department of Horticulture, HC&RI, Anantharajupet and member of my Advisory Committee who rendered valuable help, suggestions, genuine co-operation and constant encouragement provided at every stage of the thesis preparation.

I am humbly offer my sincere thanks to Dr. K. Jyothirmayi madhavi, scientist, Department of plant pathology, FRS, Sangareddy, and member of my Advisory Committee, for her counsel esteemed suggestions, timely help attention bestowed in the production of thesis.

I would also like to thank Dr. M.L.N. Reddy, Dr. P. Baburathan, Dr. C. Madumathi, Smt. Sadarunisa, Sri M. Balakrishna, and other Professors, Associate Professors and Assistant Professors of College of Horticulture, Dr. Y. S. R. Horticultural University, Anantharajupet for providing worth full suggestions, meticulous guidance, parent like caring and encouragement during the investigation.

I am also grateful to Ravi, Prakash, Renuka Prasad, Parthasarathy for their help and cooperation during my research work.

I thank ALMIGHTY for blessing me with such a wonderful parents Sri Janardhana rao and Smt Sarada for their dedicated efforts and enthusiasm in shaping my career. There is no match to the affection and love given to me by my sister Sireesha and also I am thankful for the cooperation given to me by my cousin brothers Pavan and venkatesh.

I feel in dearth of words to express my thankfulness to my friends Lakshmidurga, Deepthi, Manasa for their support and criticism during the course of thesis work ,my friends Munthaj, Sailaja, Sushmitha, Aruna, Basha, who really showed magnificent support and affection in all the situations in completing my thesis and research work .

I wish to take this oppurtunity to thank all my seniors Namratha, Mythri, Rasool, Subba reddy, Ashok reddy for their cooperation and whole hearted help during the course of my work.

I would like to thank my beloved juniors Prathibha, Kulkarni, Anusha, Devi for their help.

I am overwhelmed with gratitude to all my respondents, without whose whole hearted co-operation, this study would not have been fruitful memory.

I extend my gratitude to the DR. Y.S.R Horticultural University, Venkataramannagudem for providing financial and technical support in the form of stipend and advanced infrastructure during my course of study.

(B SANTHI SWAROOPINI)

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LIST OF SYMBOLS AND ABBREVIATIONS

%	:	percent
@	:	at the rate of
&	:	and
^{0}C	:	Degree Celsius
AICRP	:	All India Co-ordinated Research Project
ANOVA	:	Analysis of variance
CD	:	Critical difference
cm	:	Centimetre
cv.	:	Cultivar
DAT	:	Days after transplanting
df	:	Degrees of freedom
dSm^{-1}	:	Decisiemen per meter
EC	:	Electrical conductivity
etc.,	:	and so on
et al.	:	and others
Fig.	:	Figure
FYM	:	Farm yard manure
g	:	Gram
G	:	Genotype
GA	:	Genetic Advance
GAM	:	Genetic Advance as percent of Mean
GCV	:	Genotypic Co-efficient of Variation
ha	:	Hectare
HC & RI	:	Horticulture College and Research Institute
h^2	:	Heritability in broad sense
i.e.,	:	that is
IU	:	International Units

kg	:	Kilogram
kg ha^{-1}	:	Kilogram per hectare
KVK	:	Krishivignankendra
m	:	Meter
m^2	:	Meter square
mg	:	Milligram
ml	:	Milliliter
MSL	:	Mean sea level
MSS	:	Mean sum of squares
No.	:	Number
NHB	:	National Horticulture Board
P	:	Phenotype
PCV	:	Phenotypic Co-efficient of Variation
pH	:	puissance de hydrogen
$Plant^{-1}$	:	per plant
pp	:	Page number
q ha^{-1}	:	Quintal per hectare
RBD	:	Randomised Block Design
RH	:	Relative humidity
RHSCC	:	Royal Horticulture Society Colour Charts
r	:	Number of replication
SCA	:	Specific Combining Ability
SE(d)	:	Standard error difference
S.Em$\pm$	:	Standard error of mean
SS	:	Sum of Squares
tha^{-1}	:	Tonne per hectare
viz.,	:	namely
A.P.	:	Andhra Pradesh

Name of the author : **B. SANTHI SWAROOPINI**

Title of thesis : **"EVALUATION OF CHRYSANTHEMUM (*Dendranthema grandiflora* Tzvelev.) CULTIVARS FOR GROWTH, YIELD AND STORAGE LIFE UNDER OPEN FIELD CONDITIONS"**

Degree to which it is

submitted : **MASTER OF SCIENCE IN HORTICULTURE**

Faculty : **HORTICULTURE**

Department : **FLORICULTURE AND LANDSCAPE**

ARCHITECTURE

Major Advisor : **Dr. K. SWARAJYA LAKSHMI**

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VENKATARAMANNAGUDEM

Year of submission : **2013**

ABSTRACT

The present experiment entitled **"Evaluation of Chrysanthemum (*Dendranthema grandiflora* Tzvelev.) cultivars for growth, yield and storage life under open field conditions"** carried out at Horticultural College and Research Institute, Anantharajupet, Dr. Y.S.R. Horticultural University, Andhra Pradesh during the kharif season of year 2012-13 to select suitable cultivars for commercial cultivation and the data collected from this experiment was further utilized for the genetic analysis viz., heritability, PCV (Phenotypic coefficient of variation), GCV (Genotypic coefficient of variation), correlation and path coefficient analysis.

The experiment laid out with 13 different treatments in a randomized block design (RBD) with three replications. The treatments include twelve cultivars viz., Geethanjali, Rekha, Co-3, Raichur, Silper, PAU-B-107, Pusa Anmol, Pusa Semidouble, Rajamundry, Shanthi, Yelllow Double, White Double along with one check (Chandini).

Among the vegetative characters, cv.Geethanjali recorded maximum plant height (26.07, 42.28, 53.63, 58.31 cm) at 30, 60, 90 and 120 DAT, Where as cv.PAU-B-107 recorded Maximum plant spread (22.73, 40.20, 48.08, 51.27 cm) and numbers

of primary branches (5.96, 10.87, 14.97, 16.30) at all the stages of crop growth and also produced maximum number of suckers plant^{-1} (21.50).

Significant variation was observed for flower characters among different cultivars. Early flower bud initiation (63.33 days), minimum days taken to 50% flowering (93.00 days), lowest number of days to first harvest (112.33 days), maximum duration of flowering (71.83 days) and maximum flower diameter (5.90 cm) was recorded by the cv.Co3. Maximum number of flowers spray^{-1} (16.50), maximum number of flowers plant^{-1} (169.33) and maximum flower weight (5.40 g) were recorded by the cv.PAU-B-107. Spray length was maximum in cv.Geethanjali (25.23 cm) followed by cv.Raichur (25.10 cm).

Among the thirteen cultivars studied PAU-B-107 recorded maximum number of days to 50% flower wilting when kept in 200 gauge polyethylene bag (6.67 days) followed by cv.Rajamundry (5.87 days) when compared to other packing materials studied.

Cv. PAU-B-107 exhibited more resistance towards the pest and disease infestation with minimum number of *Spodoptera litura* plant^{-1} (0.67) and minimum PDI (Alterneria leaf blight) (5%).

Maximum flower yield plant^{-1} (293.33 g), yield plot^{-1} (10.56 kg) and yield hectare^{-1} (264 q) was found maximum in the cv.PAU-B-107 due to production of more number of flowers plant^{-1} which resulted into maximum net returns (Rs 2,67,510 ha^{-1}) and B:C ratio (2.08).

With respect to genetic parameters number of flowers plant^{-1}, spray length (cm), flower diameter (cm), number of flowers spray^{-1}, flower weight (g) and flower yield plant^{-1} (g) had high PCV, GCV, heritability and genetic advance as percent of mean where in improvement in these characters which can be brought through simple selection programe. In correlation studies, number of flowers plant^{-1}, flower diameter (cm), flowering duration (days) and number of flowers spray^{-1} showed significant positive correlation with yield both at phenotypic and genotypic level suggesting good scope for improvement of yield. In Path coefficient analysis, flowering duration (days), number of flowers plant^{-1} and flower weight (g) directly influenced the flower yield as first ranking components.

Further, among all the cultivars studied PAU-B-107, Co-3 and Pusa Anmol were found to be promising regarding growth and yield characters and the same may be recommended for commercial cultivation under open field conditions.

Chapter-I

Introduction

CHAPTER-I

INTRODUCTION

Chrysanthemum (*Dendranthema grandiflora* Tzvelev.) belongs to family Asteraceae (Compositae) is one of the most beautiful flowering plant referred as "Queen of the East" and also known as "Autumn flower" having diploid chromosome number 2n = 18. It is derived from Greek word (*Chryos* – golden, *anthos*-flower) and is the most important flower crops of commercial importance grown in Netherlands and Germany as a spray, cut flower and as a potted plant in America. In International cut flower trade, it ranks next to rose (Bhattacharjee and De, 2003).

It is native to northern hemisphere, chiefly Europe and Asia and distributed to almost throughout the world majorly China, Japan, Europe, USA and India. The plant is perennial in nature with herbaceous habitat and the inflorescence is composite with two types of florets i.e., ray and disc types arranged on a flattened axis known as capitulum or head. There are two types of chrysanthemum viz., spray type and standard type. Standard type of chrysanthemum is mostly grown for cut flower production and as potted flowering plant for exhibition and decoration. The spray type of chrysanthemums has genetic potentiality and mostly grown for loose flower production. Some of the spray type cultivars are also grown for cut flower production.

Chrysanthemum is a photosensitive crop, requires long days for vegetative growth and short days for flowering. The present number of varieties in the world is reported to be about 2000 and in India there are about 1000 varieties (Datta and Bhattacharjee, 2001).

In India, chrysanthemum is grown for cut flowers, loose flowers, potted plants and border plants in the garden. The major use of chrysanthemum in our country is for making garlands, veni bracelets, flower decoration and religious offerings and bedding purpose due to its wide range of diversity in the flower number, shape, size and colour. In North India various hues of red, yellow, white and purple chrysanthemums are grown in abundance for decorating the landscape either in the ground or in pots. But, in South India mostly the yellow coloured flowers are preferred and grown as loose flowers for trade. The cultivation of chrysanthemum is gaining importance in Andhra Pradesh due to its relative ease in cultivation, high returns and increasing market demand.

In Andhra Pradesh the total area under chrysanthemum cultivation is 3198 ha and production around 36777 Metric tonnes and mostly grown in the districts like Y.S.R, Chittoor and Rangareddy districts (NHB 2010).

Under normal conditions chrysanthemum flowers do not retain for more than a day and show a sign of wilting from second day. So packaging is a fundamental tool for post harvest management of highly perishable commodities and adequate packing protects the produce from physical, physiological and pathological deterioration during transport and marketing and enhancing their shelf life by retaining their attractiveness (Krishnamoorthy, 1990). Similarly the high perishability of cut flowers makes them vulnerable to large scale postharvest losses which varied between 28-35 per cent (Anonymous, 1999). Appropriate packing of flowers has potential advantage in extending their storage period and maintaining flower quality.

In southern region of Andhra Pradesh the only cultivar having monopoly is the yellow coloured Chandini. It is creating glut in the market during the season with high fluctuations in the sale price. Hence, there is immense need to introduce any alternate cultivars with availability of flowers during early and late in the season that can provide stable price to the farmers. The growth and performance of different cultivars exhibit wide range of diversity with the prevailing climatic conditions of their growing habitat. Therefore, varietal evaluation became necessary to identify the suitable variety for the specific region compelled with long storage life. So far, the research work done on the evaluation of chrysanthemum cultivars with regard to their suitability and storage life is very meagre. Hence the present investigation entitled "Evaluation of Chrysanthemum (*Dendranthema grandiflora* Tzvelev.) cultivars for growth, yield and storage life under open field conditions" was taken as up and carried out at Horticulture College and Research Institute, Anantharajupet, Dr. Y.S.R. Horticultural University, Railway koduru (Mandal), Y.S.R district with the following objectives:

1. To study the growth and yield performance of different chrysanthemum cultivars.
2. To select suitable cultivars of chrysanthemum for better yield and flower quality.
3. To evaluate storage life of different chrysanthemum cultivars under ambient conditions.
4. To estimate the genetic variability, correlation and path coefficient effects of different characters in chrysanthemum cultivars.

Chapter-II

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

Chrysanthemum is a highly versatile and accommodating flower with a wide range of type, size, colour and shape of blooms. It has earned tremendous popularity due to its ability to produce the flower round the year based on its sensitivity to photoperiods. A wide range of diversity exists in flower number, size, colour and flower duration in different chrysanthemum cultivars. Several new cultivars of chrysanthemum with attractive colours have entered the market, with the introduction of new germplasm from diverse sources. The growth and performance of these genotypes exhibit wide range of diversity with the prevailing climatic conditions of their growing habitat. Therefore, varietal evaluation becomes necessary to identify the suitable variety for the specific region. It is widely grown as an important flower crop of commercial importance in this region.

A brief review of available literature pertaining to the present investigation in Chrysanthemum and other flower crops presented in this chapter under the following headings.

2.1 Vegetative characters

2.2 Flower and yield characters

2.3 Incidence of pests and diseases

2.4 Economics of chrysanthemum and other flower crops cultivation

2.5 Storage parameters

2.6 Genetic variability, heritability, correlation studies and path coefficient analysis

2.1 VEGETATIVE CHARACTERS

Twenty six garden chrysanthemum cultivars were studied for their hardiness by Beattie and Halcomb (1984) and found that cultivars Baby Tears, Buck Eye and West Point Best proved hardy with 100 per cent survival of the plants.

In the transitional tract of Karnataka, Kanamadi and Patil (1993) studied the performance of eight chrysanthemum varieties and found significant variation among biometric characters by exhibiting maximum plant height in Basanti (82.67 cm) followed by Red Gold (70.67 cm), while Sharad Mala (26.50 cm) found the dwarfest. Considering the branching behaviour cv. Co-1 had maximum number of branches (20.33 cm) followed by Red Gold (19.67 cm).

Shanker and Tiwari (1993) evaluated twelve chrysanthemum cultivars for five morphological traits and found that the cv.Maghi (66.87 cm) was found tallest and had the greatest plant spread (30.23 cm), whereas cv.Jaya (17.69) recorded the highest number of primary branches.

Damke *et al.* (1998) assessed the performance and flower production of sixteen varieties of chrysanthemum in Western Maharastra. The results revealed that maximum plant height was with cv.Garden State (60.99 cm) followed by Local Rewadi (58.99 cm), whereas Appu (32.33 cm) recorded minimum plant height and was considered dwarf. Highest number of branches per plant was recorded by cv.Tara (38.14) followed by Zipri (34.33).

Under calcareous soils of North Bihar Mishra (1999) evaluated small flowered chrysanthemum varieties and the results indicated that the cv. Suneel performed significantly well in respect of plant height (64.33 cm) and plant spread 34.69 cm).

Deepa Isac and Chezhiyan (2002) conducted studies on evaluation of chrysanthemum cultivars for yield and related traits and reported that the Acc. 4 was a

hardy genotype and recorded profuse branching (20.80 branches plant^{-1}) with highest total phenol content of 22.36 mg/g.

Dhahiya *et al*. (2003) evaluated ten chrysanthemum varieties under semi-arid conditions of Haryana. They reported that the vegetative traits viz., plant height, spread and number of branches were observed maximum in cv. Puja (63.33 cm, 38.29 cm, 21.33) and minimum in cv. Jayanthi (40.23 cm, 21.33 cm, 10.33).

Different chrysanthemum accessions were evaluated for their performance by Balaji *et al.* (2004) and revealed that maximum plant height was noticed in cultivars Saraval (65.30) followed by Harvest Home (62.05 cm).

Bhaskaran *et al*. (2004) evaluated the performance of chrysanthemum cultivars under open field conditions of Bangalore. They reported that the tallest plants (54.03cm) were recorded by cv. Cassa, whereas the shortest plants were observed in cv. Button type local whereas cv. Red Gold produced the highest number of branches plant^{-1} (60.33) compared to the other cultivars and the lowest number of branches plant^{-1} (25.26) was observed in Arka Swarna.

Among seventeen chrysanthemum genotypes evaluated, Harvest Home (2365.54 cm^2), Mutant No.9 (2024.34 cm^2), Selection-5(1822.82 cm^2) and Karnool(1557.70 cm^2) were found superior for their vegetative growth in terms of plant spread, number of branches and number of suckers plant^{-1} respectively (Balaji *et al.*, 2004).

In an experimental trial conducted significant variations were observed for 55 chrysanthemum genotypes by Dilta *et al*., 2005 in sub-tropical conditions of Himachal Pradesh and recorded the maximum plant height with cv. Gulmohar (78.33 cm) and found minimum in cv. Mini Queen (40.33 cm).

Balaji *et al*. (2006) studied the performance of six China aster cultivars under North Karnataka conditions. The cultivar PG White recorded the highest plant height (66.4cm), while the plant spread was observed to be maximum in PG Purple (2749.4 cm^2). PG Violet produced the highest number of primary branches (23.6).

Poornima *et al*. (2006) studied the performance of China aster genotypes viz., Poornima, Shashank, Kamini, Violet Cushion and Local Type. Cultivars Poornima and Shashank were vigorous in terms of plant height (60.33cm). Minimum plant height was recorded in Violet Cushion (42.34cm) followed by local type (40.16cm). Maximum numbers of branches were recorded in cv. Violet Cushion (35.75cm) while minimum numbers of branches were recorded in local type (17.89cm).

Under polyhouse cum rain-shelter and open conditions Talukdar *et al*. (2006) evaluated eighteen standard chrysanthemum varieties to study their performance. Among them, cultivar Temptation was found tallest (85.67 cm) under polyhouse cum rain shelter whereas under open field conditions, cultivar Snow Ball exhibited maximum plant height of 84.00 cm.

Chavan *et al*. (2010) evaluated six China aster varieties and they found that the variety Phule Ganesh White was found superior among all the growth parameters studied and produced significantly highest plant height (78.33 cm), primary branches (25.99), but the plant spread (38.54 cm) recorded was higher in variety Phule Ganesh Pink.

Parul Puneetha and Sharma (2011) assessed the performance of 15 genotypes of chrysanthemum under Himalayan conditions for all morphological characters. Genotype Saifali recorded the maximum plant height (75.34 cm). However, genotype Paris produced the highest plant spread (36.23 cm), maximum number of primary branches (20.29) per plant.

2.2 FLOWER AND YIELD CHARACTERS

Heidemans and Stalk (1984) evaluated twenty two chrysanthemum cultivars. Among the cultivars Record, Clinstar, Cappa Yellow, Prego and Fame were considered best. Cv. Bright Lameet, Impala and Lucky Strike were considered best for spring culture.

In crop improvement studies, 27 chrysanthemum cultivars introduced from different sources were tested for Tamil Nadu condition. Cultivars showed significant

differences for their bio metric characters, of which Hazur yellow and Baggi proved superior with high yield potential (Chezhiyan *et al.* 1985).

Tewari and Umasankar (1990) evaluated twelve chrysanthemum varieties and the maximum yield plant^{-1} was obtained in the Cv.Maghi (298.33 g) and minimum yield was recorded in the cv.Viva (78.37 g).

Boe and Drugun (1991) studied the performance of chrysanthemum varieties and reported that a new garden chrysanthemum cv.Dakota Sunburst for Northern gardens produced flowers of fluffy appearance with very long flowering period (78.33 days).

Laskar and Yadav (1991) reported that the chrysanthemum cultivars Basanthi, Jubilee and Alison were found best for cultivation under West Bengal conditions.

Gondhali *et al*. (1997) have grown nine cultivars of chrysanthemum to study the flowering and quality of spray cut flowers. Among these cultivars, cv.Indira was found to be the best with respect to spray quality (15.77cm), number of flowers spray^{-1} (24.33cm) and maximum spray length (23.14cm).

Hemalatha Barigidad and Patil (1997) evaluated 15 chrysanthemum genotypes and reported that cv. Indira with reddish yellow flowers proved superior for flowering traits viz., number of flowers plant^{-1} (179.33) and yield per plant (288.63g). Concerned to the yellow cultivars of market preference, cv. Banglore with highest yield (297.99g) was found best for cultivation in transitional tract of Karnataka.

Palai *et al*. (1999) evaluated thirty three accessions of spray chrysanthemums under Bhubaneshwar conditions and revealed that the ACC-13 was found ideal for cut flower purpose, while ACC-22 and ACC-4 for maximum number of flowers per spray (20.50) and maximum flower yield sq.m^{-1} (5.6 kg) respectively.

Anuradha *et al*. (2000) evaluated chrysanthemum varieties for pot culture under North Indian conditions. The results revealed significant differences among varieties for all the morphological and floral characters studied. Pol Rose, Arun

Singar, Sharad Singar, Suhag Singar and Bindiya were considered highly suitable for pot culture.

Deka and Paswan (2001) evaluated six standard cultivars of chrysanthemum. Among the cultivars, the cv.Snow Ball and Temptation were best suitable as potted plants for exhibition or decorative purposes.

For Kalyani conditions, Mukesh Kumar *et al.* (2002) reported that chrysanthemum cultivars Basanthi, Bazuria Red, Dhruba White, Jaya, Maharaja, Pink Star and Sharad Mala were suitable for commercial cultivation.

Uma Sanker and Nainwal (2002) evaluated twelve chrysanthemum cultivars to know the better variety for cut flower production and concluded that cv.Maghi performed well with the highest number of flowers (269.33).

Dhahiya *et al*. (2003) evaluated ten chrysanthemum varieties for their floral and yield characters for two years under semi-arid conditions of Haryana. Weight of flowers recorded maximum in Basanthi (4.40g) and minimum in Gauri (1.10g), whereas maximum number of flowers and yield plant^{-1} were registered by cv.Puja (169.33, 268.59g) and minimum by cv. Jayanthi (78.99, 110.39g).

Dhiman (2003) opined that number of days taken to first flower bud appearance and first flowering signify the earliness. Given importance to the flowering traits, it was reported that Flirt was early to flower (120.33 days) followed by Ajay (134.60 days). For commercial exploitation of the varieties for different purposes under Kullu valley, it was reported that Ajay, Fiji and Flirt with medium sized flowers were found suitable for cultivation as loose flowers. On contrary, large flowers like Pink Prince, Tata Century, Thaichung and Snow Ball were well suited for garden display or exhibition purpose.

Jayanthi and Vasanthachari (2003) evaluated the chrysanthemum cultivars for different purposes under Bangalore conditions. The studies indicated that cultivars Nilima, Red Gold, Ravi Kiran, Yellow Star, Chandrika, Raja White, Royal Mundial, Lassa and Regal West Land were suitable for cut flower purpose. Punjab Anuradha,

Usha Kiran, Chandini, Kirti, Local Yellow and Kasturi Shevantigae were suitable for loose flower production. However, cultivars Chandrika, Raja White, Red Gold and Ravi Kiran were recommended for dual purpose.

Madhumita Choudhary *et al*. (2003) conducted an experiment on evaluation of spray chrysanthemum varieties for yield characters under open and polyhouse conditions and they reported that planting under open filed conditions exhibited significantly better growth, earliness in flowering (74.39days), flower number (71.25), flower size (7.59cm) and yield (2.24kg/m^2) compared to polyhouse planting. However, the blooming period (41.68days) of the flowers was found significantly better under poly house condition.

Manohar Rao and Pratap (2003) evaluated seven chrysanthemum varieties for their flowering behaviour and based on flower production and colour, cv.Basanthi was identified as high yielder (298.33g).

In an evaluation trial of chrysanthemum by Vasanthachari (2003) among twenty cultivars studied cultivars Red Gold, Ravikiran, Nilima, Raja White, Chandrika, Cassa, Arka Ravi and Royal Mundial were found suitable for cut flowers, while Ushakiran, Chandini, Punjab Anuradha and Kirti were reported for loose flower purpose.

Bhaskaran *et al*. (2004) evaluated the performance of chrysanthemum cultivars viz., Ravikiran, Chandrika, Yellow Star, Red Gold, Nilima, Kasturi Shaventigae, Cassa, Arka Swarna, Arka Ravi and Button type local under open filed conditions of Bangalore. They reported that the duration of flowering was longest (51.66 days) in cv.Yellow Star and Shortest (23.33 days) in cv,Chandrika . The highest yield per plant was recorded by Red Gold (365g) followed by Nilima (324g) and Yellow Star (287g).

Dilta *et al. (*2005) opined that days to flowering signify the early or late flowering habit of the genotypes. They reported that the cv.Surf was the earliest to flower (98.33 days) with longer period of flowering (79.33days).

Balaji *et al.* (2006) found that the china aster cultivar Phule Ganesh White performed best in terms of flower yield (236.33g) followed by Phule Ganesh (228.19g).

Selections made from 15 chrysanthemum varieties developed at IIHR to breed early and off season varieties suitable for Bangalore conditions. Among the genotypes tested, two open pollinated seedlings, IIHR-1(Pink) and IIHR-2(Brown) were found promising (Janakiram and Meenakshi, 2007).

Kishan Swaroop *et al.* (2008) evaluated twenty genotypes of chrysanthemum for different characters for cut flower and other purposes under Delhi conditions. On the basis of morphological characters, Thaichain Queen, Tata Centenary, Snow Ball and Snow Don could be grouped as cut flower genotypes while remaining could be as potmums, decorative and loose flowers.

Peddilaxmi *et al*. (2008) evaluated seven yellow coloured chrysanthemum varieties for growth, flowering and yield. They reported that the maximum number of flowers per plant were recorded with cultivar Raichur (114.01) followed by Basanthi (112.12) but the yield plant^{-1} was highest with Raichur (230.40 g) followed by Silper (146.38 g). Among the various cultivars evaluated, Raichur was found most suitable for Hyderabad conditions.

Simrat Singh *et al*. (2008) evaluated twenty open pollinated chrysanthemum cultivars for various floral characters to categorize them for their suitability for garden decoration, pot culture, loose flowers and cut flower production. From the study, it was concluded that accessions B-7, B-14, B-16 and B-28 were suitable for growing in the garden, accessions A-115 and B-4 were found to be suitable for cut flower. Mostly Korean double, Korean semi-double and decorative flower types (B-1, B-2, B-5, and B-6) were found suitable for loose flower purpose. The accession B-11 was found to be suitable for pot culture on account of its compact and dwarf growth.

Among 15 genotypes of chrysanthemum assessed for their performance under mid hill conditions of Garhwal Himalaya by Parul Puneetha and Sharma, in 2011

White Anemone, Shanti and Charming were found to be highly suitable to grow under Garhwal conditions for cut and loose flowers.

2.3 INCIDENCE OF PESTS AND DISEASES

Reddy *et al.* (2004) studied Screening of chrysanthemum germplasm for resistance to two-spotted spidermite, Tetranychus urticae and bud borer, *Helicoverpa armigera* results revealed the six collections viz., Angel Bell, Arka Swarna, Chandrika, Nilima, Snow Ball and Collection No.9 were least susceptible (<10% damage) to bud borer while three varieties viz., Collection No.10, Collection No.12 and Heavenly Tech were found to be highly susceptible (>50%).The study on Pests infesting ornamental plants in hilly region of west Bengal revealed the tobacco caterpillar *(Spodoptera litura)* was serious on Gladiolus, Chrysanthemum and *Anthurium*. Cutworm *(Agrotis segetum)* damaged the seedlings of Gladiolus. Among the Coleopteran pests, the Blister beetle *(Mylabri s*p.) was the most important feeding on the flowers of Gladiolus and China rose. The steel blue beetle, *Altica* p. and white spotted flea beetle *(Monolepta signata)* was found infesting Gladiolus and Chrysanthemum respectively. Among non-insect pests the red spider mite, *Tetranychus urticae* was very important causing pest to Carnation, Gerbera and Chrysanthemum during dry summer months (Pal and Sarkar 2009).

Arunkumar *et al.* (2011) studied on evaluation of fungicides for the management of chrysanthemum leaf blight caused by *Aternaria alternate* (Fr.) Keissler under field condition reported in field evaluation of fungicides, botanicals and bio-agent, Hexaconazole (0.1%) effectively controlled the disease incidence which recorded very less per cent disease index (4.49) followed by Chlorothalonil (0.2%) and Mancozeb (0.2%).

2.4 ECONOMICS OF CHRYSANTHEMUM AND OTHER FLOWER CROPS CULTIVATION

Zawanberg (1990) compared the cost and returns of the five major greenhouse cut flower crops, *viz.* carnation, chrysanthemum, freesia, gerbera and roses in

Netherlands over a ten year period. According to him chrysanthemum production had showed lowest increase in labour cost. Rapid growing cycle and closer planting resulted in higher productivity.

Kumari (1992) study on Chrysanthemum cultivation in Andhra Pradesh has estimated the cost of cultivation of Chrysanthemum hectare^{-1} as Rs. *55,633* and an annual net returns hectare^{-1} as Rs. 14,807. The study further identifies that lack of alternative marketing channels and wide fluctuations in prices in flower markets are the major problems in the case of Chrysanthemum cultivation.

Subramanyam and Sudha (1992) studied the input expenditure towards aster crop in Karnataka which was Rs.9, 678 per hectare in kharif, Rs.9, 861 per hectare in rabi and Rs.9, 833 per hectare in summer showing that there was much difference in different seasons.

Chengappa *et al.* (1998) compared the net returns across flowers such as rose, chrysanthemum, aster, tube rose, gladiolus, in and around Bangalore. The study indicated that the net returns was maximum in rose (Rs.79, 671) followed by tuberose (Rs.57, 666) and gladiolus (Rs.61, 097). In terms of returns per rupee of investment it was observed that tuberose yielded the maximum input output ratio at 1:3.28 followed by gladiolus (1:2.98), chrysanthemum (1:2.92) and aster (1:2.04).

The economic viability and feasibility analysis indicated that the production of carnation is highly profitable and economically viable with a Net Present Value of Rs. 3, 56,302 in Bangalore and Rs.1,12,839 in Pune. Results indicated that growers could expand the area under this cut flower, but should undertake self-marketing in distant markets to reap higher profits (Mysore *et al*. 2005).

2.5 STORAGE PARAMETERS

Nirmala and Reddy (1993) studied on shelf life of jasmine (Jasminum sambac) flowers as influenced by packaging and reported ventilation under ambient conditions packaging jasmine flowers in polyethylene bags extended the shelf life to

three days (Jasminum sambac) to beyond seven days (Jasminum multiflora) compared to non-packed control flowers.

Madaiah and Reddy (1994) studied on influence of polythene packing on the postharvest life of Tuberose (cv.single) florets reveled the Packaging tuberose florets in 300 gauge polyethylene bags with was found most effective for extending shelf life and significantly reduced physiological loss of weight (PLW).

Karuppaiah *et al.* (2006) studied effect of different packages on the postharvest behaviour and shelf life of jasmine and reported that flowers stored in 200-gauge polyethylene bags recorded the lowest physiological weight losses and phenol content than flowers stored in bamboo baskets with muslin cloth and gunny bags.

Symilarly the experiment on the dry storage of flowers of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. Shanti was observed that the flowers packed in polyethylene and stored in cold store at 10 degrees centigrade expressed maximum fresh weight of flowers (16.24 g), minimum physiological loss in weight (0.69%) (Suresh kumar *et al.* 2011).

Anil kumar *et al.* (2012) "Studies on dry storage of chrysanthemum (Dendranthema grandiflora Tzvelev.) cv. Snow Ball flowers and reveal the minimum weight loss (5.16%) were observed when cut flowers were packed in wax paper for 24 h in cold storage, however, minimum vase life, flower size, volume of solution consumed and total sugar were recorded in flowers wrapped in newspaper and stored for 72 h at ambient conditions.

2.6 GENETIC VARIABILITY, HERITABILITY, CORRELATION STUDIES AND PATH COEFFICIENT ANALYSIS

Shanmugam *et al.* (1972) evaluated the white and yellow cultivars of chrysanthemum,and worked out correlation co-efficients between the yield, number of

laterals, duration of flowering and size of flowers. The relationship was significant for the traits studied except for size of flowers in Cv. White.

In chrysanthemum, Chaugule (1985) reported that weight of flowers exhibited a significant and positive correlation with characters such as plant spread, number of branches plant^{-1} and shelf life of flowers at both phenotypic and genotypic level.

Chattopadhyay *et al.* (1991) conducted correlation and genetic variability studies in eleven chrysanthemum cultivars and reported positive and significant correlation between number of flowers plant^{-1} and number of branches plant^{-1}.

Raghava *et al.* (1992) reported high genotypic coefficient of variation for flower yield plant^{-1}, number of flowers plant^{-1} and flower size in chrysanthemum. High heritability and genetic advance was recorded for number of flowers plant^{-1} and flower yield plant^{-1}.

Sirohi and Behera (2000) conducted a trail with fifty seven genotypes of chrysanthemum for variability studies. The phenotypic coefficients of variation (PCV) were higher than those of genotypic coefficients of variation (GCV) for all the characters studied. However, higher GCV and PCV estimates were found for number of flowers plant^{-1} followed by number of branches plant^{-1} and disc diameter. High heritability with high genetic advance was observed for number of branches plant^{-1}, disc diameter, number of petals flower^{-1} and flower yield.

In chrysanthemum Deka and Paswan (2002) reported positive and significant correlation of flower yield with number of branches and number of leaves plant^{-1}. A positive effect of size of flowers was observed on flower yield followed by number of flowers, plant height and duration of flowering.

Genetic variation, heritability, and correlation for vegetative and flowering characteristics were studied in 2 indigenous (Sonar Bangla and Pride of Jamshedpore) and 10 exotic (Kenroku Kangiku, Balcombe Perfection, Snow Ball, Chandrama, Okaihama, Melody Lane, Pink Cloud, Silk Brocade Pink, Ghenzyskhan, and Gambit) chrysanthemum (*Dendranthema morifolium*) cultivars. Significant variation was

observed for plant height; number of leaves; individual leaf area; length, width, and number of lobes of leaf; days to flower bud emergence; stalk length and weight; and shelf-life of flowers. High heritability associated with high genetic advance as the percentage of mean was observed for leaf area and flower weight, indicating the presence of additive gene action. The other traits exhibited high heritability associated with moderate and low genetic advance, indicating the presence of non-additive gene action. Most of the correlations were positive. Flower diameter and weight were significantly correlated with plant height, leaf number and area, and stalk length and diameter (Pal and George 2002).

Genetic variability was studied with 12 chrysanthemum (*Chrysanthemum morifolium*, syn. *Dendranthema morifolium*) cultivars (Aparajita, White Prolifica, Birbal Sahni, Flirt, Jaya, Mercury, Mountaineer, Nanako, Punjab Anuradha, Raja, Ravi Kiran and Vasantika) under two environmental conditions open field and polyhouse (West Bengal, India during 2002-03) for various growth and floral characters. The phenotypic coefficients of variation were higher than those of genotypic coefficients of variation for all the characters studied. High heritability coupled with high genetic advance was observed in the yield of flowers plant^{-1} (g) and the number of branches plant^{-1}over environments, flower freshness after full bloom (days) under open field and flower diameter (cm) under protected condition (Ghimiray *et al*. 2005).

Mishra *et al*. (2006) estimated genetic characters in 27 cultivars of spray type chrysanthemum (Chrysanthemum morifolium). They observed wide range of variability for flower yield and 8 related quantitative characters. The phenotypic coefficient of variation (PCV) was found to be higher than the genotypic coefficient of variation (GCV) for all characters. Estimates of genotypic coefficient of variation (GCV), heritability (broad sense) and genetic advance exhibited higher values for number of branches plant^{-1}, average flower weight, number of flowers spray^{-1} and number of flowers plant^{-1} suggesting additive gene action for expression of these characters.

In China aster, the correlation studies indicated that among ten characters studied in five genotypes, highly significant varietal differences were noticed in respect to all characters. Flower yield plant^{-1} was significantly and positively associated with plant spread, number of branches and number of leaves plant^{-1} (Poornima *et al*. 2006).

Forty four germplasm of three species of marigold were evaluated under conditions of Uttarakhand, to ascertain genetic parameters suchas variability, heritability, genetic advance and correlation. Significant positive correlation was found between number of flowers plant^{-1}, days taken to bud initiation and flower diameter, days taken to flowering and average fresh weight of flower (Deepthi Singh and Santhosh Kumar, 2008).

Studies on genetic variability, heritability and genetic advance were carried out among ten genotypes of chrysanthemum for characters to identify elite genotypes to be used in breeding programme. The results showed high phenotypic and genotypic co-efficient of variation for traits like number of suckers plant^{-1} and flower disc diameter. High heritability values were obtained for all the characters except number of sprays plant^{-1} and plant spread. In high heritability estimate coupled with high genetic advance as per cent of mean was observed for number of suckers per plant, flower disc diameter and number of flowers plant^{-1} (Baskaran *et al*. 2009).

Correlation analysis was carried out on 15 diverse *Chrysanthemum morifolium* genotypes of spray chrysanthemum. The results reveal that the estimate of correlation for inter-association of the parameters was found to be more pronounced in open field observation than polyhouse. The most of the growth and yield parameters showed highly positive correlation among themselves. Both in polyhouse and open field flower yield, flower size and flower stalk length were positively correlated with most of the growth parameters (Gantajt and Pal, 2009).

Correlation and path analysis were carried out in 24 genotypes of chrysanthemum. The results indicated that the primary branches plant^{-1}, plant spread and flowering duration showed positive significant correlation with number of flowers plant^{-1} at both genotypic and phenotypic level. The path coefficient analysis at

genotypic level revealed that day to flowering, number of primary branches plant^{-1} and plant spread had highest direct positive effect on number of flowers plant^{-1}. At phenotypic level flowering duration, number of primary branches plant^{-1} and plant spread showed highest direct positive effect on number of flowers plant^{-1}. Highest direct negative effect was observed via plant height after full bloom on number of flowers plant^{-1} at phenotypic level whereas at genotypic level it was observed via days to flower bud initiation followed by plant height at flower bud initiation stage. Hence direct selection for number of primary branches plant^{-1}, plant spread and flowering duration is suggested for getting yield improvement (Kumar Mukesh *et. al.* 2012).

Chapter- III

Material and Methods

CHAPTER III

MATERIAL AND METHODS

The present experiment entitled "Evaluation of Chrysanthemum (*Dendranthema grandiflora* Tzvelev.) cultivars for growth, yield and storage life under open field conditions" was carried out at Horticultural College and Research Institute, Anantharajupet during the year 2012-13. The material used and methods followed during the course of investigation were presented below.

3.1 LOCATION OF EXPERIMENTAL SITE

The experimental site, Horticultural College and Research Institute, Anantharajupet falls under arid subtropical zone with an average rainfall of 700 mm. It is situated at an altitude of 162 meters (531 feet) above mean sea level. The geographical situation is 13.98^0N latitude and 79.40^0E longitude.

3.2 WEATHER DURING CROP GROWTH PERIOD

The meteorological data pertaining to monthly mean rainfall, sunshine hours, average minimum and maximum temperatures and relative humidity were recorded during the period of experimentation (July 2012 to February 2013) and presented in Appendix I.

3.3 EXPERIMENT DETAILS

3.3.1 Experimental material

The experimental material consist of 13 Treatments representing the twelve spray cultivars of chrysanthemum obtaining from All India Coordinated Research Project on Floriculture, Rajendranagar, Hyderabad and KVK, Kadapa along with one local check cultivar *i.e.* Chandini and mentioned in Table 1.

Table 3.1. Name of the cultivars of chrysanthemum

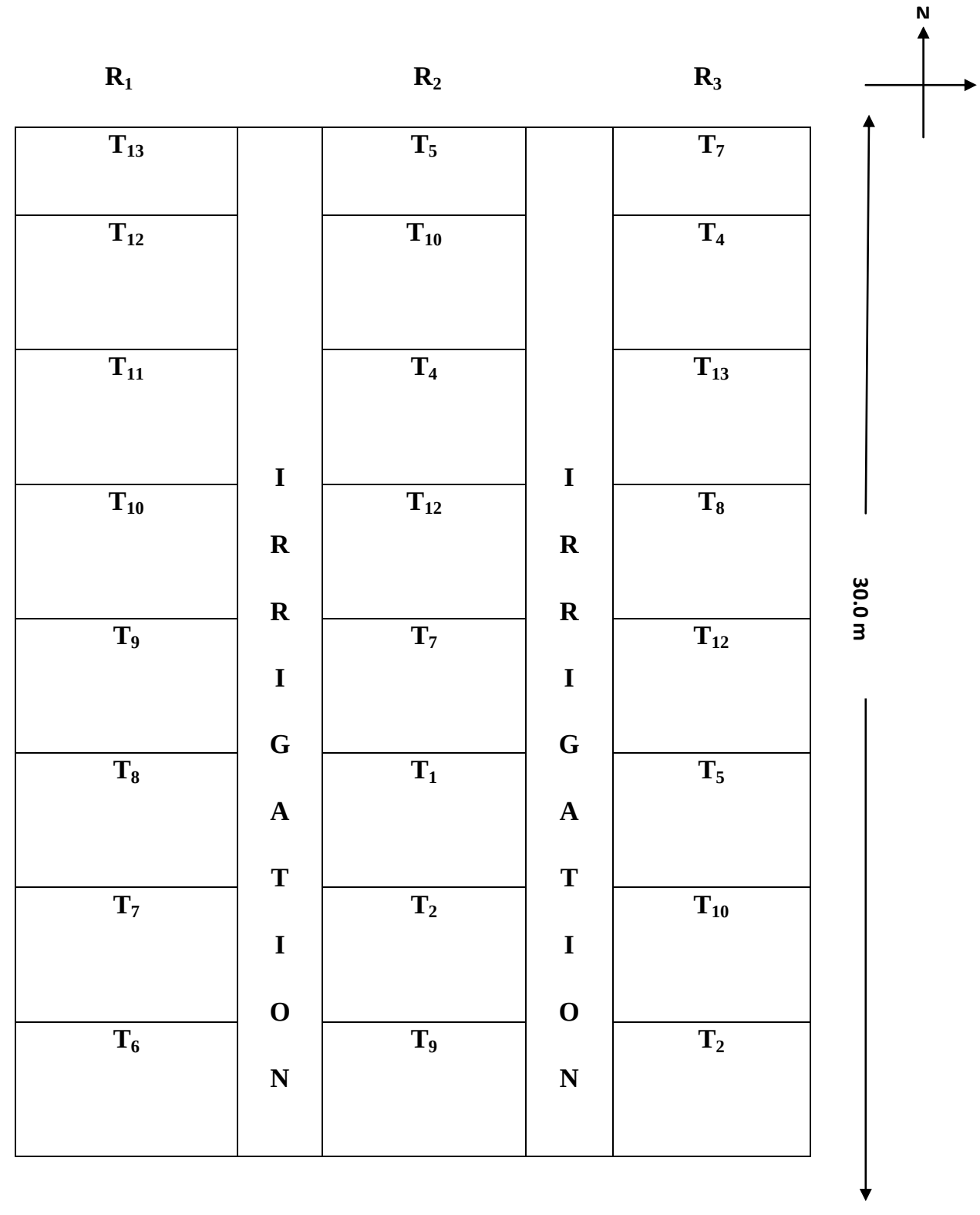
Treatment/cultivar	Cultivar name	Source
T_1	Geethanjali	AICRP on floriculture, Rajendranagar, Hyderabad.
T_2	Rekha	-do-
T_3	Co-3	-do-
T_4	Raichur	-do-
T_5	Silper	-do-
T_6	PAU-B-107	-do-
T_7	Pusa anmol	KVK, Kadapa.
T_8	Pusa Semidouble	-do-
T_9	Rajamundry	-do-
T_{10}	Shanthi	-do-
T_{11}	Yellow Double	-do-
T_{12}	White Double	-do-
T_{13}	Chandini (check)	Local

3.3.2 Layout of the experiment

The present field experiment was laid out in Randomized Block Design with three replications. Thirty six plants of each cultivar were planted in each replication (2.0 m x 2.0 m spacing). Randomization was followed in each replication. Irrigation and drainage channels were laid out for efficient management. The layout plan of the experiment was illustrated in Fig. 3.1.

Details of Layout

Location	:	Horticulture College and Research Institute, Anantharajupet
Crop	:	Chrysanthemum (*Dendranthema grandiflora* Tzvelev.)
Cultivars	:	13 (12 + 1 check)
Season	:	Kharif, 2012-13
Number of treatments	:	13
Number of replications	:	3
Design	:	RBD (Randomized Block Design)
Plot size	:	2.0 m x 2.0 m
Spacing	:	30 cm x 30 cm


N
R1
R2
R3
T13
T5
T7
T12
T10
T4
T11
T4
T13
T10
T12
T8
T9
T7
T12
T8
T1
T5
T7
T2
T10
T6
T9
T2
IRRIGATION
IRRIGATION
30.0 m
7.0 m

T_5	C H A N N E L	T_3	C H A N N E L	T_{11}
T_4		T_{11}		T_6
T_3		T_8		T_1
T_2		T_{13}		T_9
T_1		T_6		T_3

-0.5m- **-0.5m-**

Design: RBD **Replications**: 3 **Treatments**: 13

Fig. 3.1. Field layout of the experimental plot of chrysanthemum

3.4 CULTURAL PRACTICES

3.4.1 Characteristics of the soil

Selected experimental site has the uniform topography composed of red sandy loam soils with a pH of 7.76 and EC 0.168 ds m^{-1} along with the available N:P:K was 220, 23.5 and 250 kg ha^{-1}.

3.4.2 Land preparation

The experimental field was ploughed thoroughly and incorporated with well decomposed FYM @ 25 t ha^{-1}. The plots measuring 2.0 m x 2.0 m were prepared

according to the layout plan to accommodate 36 plants per plot. Totally there were 39 plots in the experiment for 13 Treatments in 3 replications.

3.4.3 Transplanting

Thirty five days old healthy rooted cuttings with 2-3 fresh leaves (Obtained from AICRP Floriculture, Rajendranagar and KVK, Kadapa) were planted in the respective plots on 25th July 2012 and irrigation was given immediately after transplanting there by subsequent irrigations were given as and when required.

3.4.4 Fertilizer application

Recommended dose of nitrogen @ 125 kg ha^{-1} in the form of urea and potassium @200 kg ha^{-1} in the form of muriate of potash were applied in split doses. Half of the nitrogen and potassium were applied at the time of transplanting as basal and the remaining nitrogen and potassium were applied, after pinching i.e. 40 days after transplanting. The entire recommended dose of phosphorus @ 200 kg ha^{-1} was applied in the form of single superphosphate at the time of transplanting as basal.

3.4.5 Intercultural operations

Uniform cultural operations were carried out for all the treatments. The first hand weeding was done at 20 days after transplanting and subsequent weedings were carried out at regular intervals. A total of six weedings were done throughout the experimental period depending upon the weed population to keep the plots clean and free from weeds. Pinching was done in all the cultivars at 40 days after transplanting. However, Dimethoate @ 2 ml l^{-1} and Mancozeb @ 2.5 gm l^{-1} were sprayed twice as a prophylactic measure i.e. once before flowering and the other one after second picking of flowers for the prevention of pest and disease attack.

3.5 OBSERVATIONS RECORDED

For observation purpose five plants were selected randomly in each plot and tagged for recording the data. Observations on growth, yield and Storage quality

parameters were made in all the treatments at different stages of crop growth. The details of observations recorded were presented below.

3.5.1 VEGETATIVE CHARACTERS

3.5.1.1 Plant height (cm)

Height of the plant was measured from the base of the plant to the top of the plant canopy at 30, 60, 90, 120 days after transplanting. Average plant height for respective days was calculated and expressed in centimeters.

3.5.1.2 Plant spread (cm)

Plant spread was calculated by measuring the canopy spread in North-South and East-West directions of five labeled plants at 30, 60, 90, 120 days after transplanting and the mean was calculated.

3.5.1.3 Number of primary branches plant^{-1}

The total numbers of primary branches of five labeled plants were recorded at 30, 60, 90, 120 days after transplanting. Averages were worked out and recorded.

3.5.1.4 Number of suckers plant^{-1}

After completion of flowering the total number of suckers arising from the main stem was counted from tagged plants and average was worked out.

3.5.2 FLOWER AND YIELD CHARACTERS

3.5.2.1 Days taken to first flower bud initiation

Average number of days taken for first flower bud appearance in each plot from the date of transplanting was recorded.

3.5.2.2 Days taken to 50% flowering

The data on number of days taken for 50% flowering was recorded by counting the number of days taken from transplanting of the rooted cuttings to till 50 % of the plants produce flowers.

3.5.2.3 Days taken to first harvest

The data on number of days taken to first harvest was recorded by counting the number of days taken from transplanting of the rooted cuttings to first harvest of the flowers.

3.5.2.4 Number of flowers spray^{-1}

At random ten sprays were selected and number of flowers spray^{-1} counted and the average was expressed.

3.5.2.5 Number of Flowers plant^{-1}

The number of flowers plant^{-1} was recorded from each treatment per replication and average number of flowers per plant was worked out.

3.5.2.6 Spray length (cm)

Ten flower sprays were selected at random and spray length was measured from the point of origin to the point of flower pedicel attachment and the mean was expressed in centimeters.

3.5.2.7 Flower diameter (cm)

The flower diameter from the peripheral end of the one petal to peripheral end of the opposite petal was measured in centimeters.

3.5.2.8 Flower weight (g)

Individual weight of the 25 flowers from each plot was recorded and the mean was worked out and expressed in grams.

3.5.2.9 Flower colour

Flower colour of the each variety was determined as per the R.H.S. colour chart available at AICRP on Floriculture, Rajendranagar.

3.5.2.10 Duration of flowering

Number of days taken from the first flower opening to the fading of the last flower was recorded per plant as the total duration of flowering.

3.5.2.11 Flower yield plant^{-1} (g)

From the tagged plants the fresh weight of the flowers was recorded and average yield of flowers plant^{-1} was recorded in grams.

3.5.2.12 Flower yield plot^{-1} (g)

The yield of flowers plot^{-1} in grams was calculated on the basis of fresh weight of flowers from each treatment per replication and average yield plot^{-1} worked out.

3.5.2.13 Flower yield hactare^{-1} (q)

The yield of flowers hectare^{-1} was computed from the yield obtained from each plot and the mean yield was calculated.

3.5.3 INCIDENCE OF PESTS AND DESEASES

No serious incidence of pests and diseases was observed. Among pests and diseases of chrysanthemum, the Bud borer (*Spodoptera litura*) and Leaf blight (*Alternaria alternate*) with low incidence, were observed.

3.5.3.1 Incidence of Bud borer (*Spodoptera litura*)

At the vegetative stage, there was no incidence of *S.litura* but the infestation was observed at flower bud stage. From 60 DAT onwards the observations recorded with 15 days interval during flowering period and average was calculated. For

counting of *S.litura*, ten plants were selected randomly in each replication and counted the number of caterpillars per plant from each selected plant and mean was worked out.

3.5.3.2 Incidence of Leaf blight disease (*Alternaria alternata*)

At the vegetative stage, incidence of leaf blight was observed. From 30 DAT onwards the data recorded with 15 days interval during vegetative growth period and average was calculated. For calculating disease incidence 10 plants were examined randomly in each replication and scored for disease severity by following 0-5 scale. The details of scales are as shown below.

0. No disease symptoms.
1. A few spots towards tip covering 10 per cent leaf area.
2. Several dark brown patches covering up to 20 per cent leaf area
3. Several patches with paler outer zone covering up to 40 per cent leaf area.
4. Leaf blight covering up to 75 per cent leaf area or breaking of the leaves from center.
5. Complete drying of the leaves or breaking of the leaves from center.

Per cent disease index (PDI) was calculated by using the following formula (Wheeler, 1969).

$$PDI = \frac{\text{Total Sum of numerical ratings}}{\text{Total number of leaves examined x maximum disease grade.}} \times 100$$

3.5.4 ECONOMICS (BENEFIT COST RATIO)

Based on the yield data, the gross returns and net returns were calculated for each treatment. The benefit cost ratio (B:C) was determined by dividing the net returns with the total cost of each treatment on hectare bases. Details of total cost of

cultivation and price of chrysanthemum flowers for one hectare given in Appendix – II.

3.5.5 STORAGE PARAMETERS

3.5.5.1 Storage life (days)

In the present study conducted for observing the storage life of flowers with different packing materials. The packing materials such as gunny bags, 200 gauge Polyethylene bags of size 29 x 28 cm and single layered bamboo baskets with gunny cloth along with news paper as cushioning material were used. A sample of 250 grams flowers of each cultivar was taken and each sample was packed with packing materials as per the treatment to observe the storage life.

In case of gunny bag packing, after keeping the flowers inside the ends of gunny bag was folded, while in bamboo basket packing the entire basket was lined with newspaper which is used for cushioning purpose above that the flowers were kept and top of the basket was covered with gunny cloth. In 200 gauge polyethylene bag packing the flowers were kept inside after making some irregular punching to the polyethylene bag because punching and ventilation holes help to maintain optimum concentration of CO_2 and O_2 finally open ends of the polyethylene bag tied with a rubber band.

All the thirteen cultivars flowers were separately packed in each packing material under ambient room conditions.

3.5.5.1.1 Days taken to 50% flowers wilt

The data on days taken to 50% flowers wilt was recorded by count the number of days taken for half of the flowers wilting in each packing material

3.5.5.1.2 Physiological loss in weight

The total physiological loss in weight in every packing material has separately calculated by following formula, and expressed in percentage.

$$PLW\ (\%) = \frac{\text{Final weight - Initial weight}}{\text{Initial weight}} \times 100$$

3.6 STATISTICAL ANALYSIS

The mean value of five plants was computed for each of the genotype for seventeen characters were subjected to statistical analysis.

3.6.1 Analysis of variance

Data was subjected to analysis by the method outlined by Panse and Sukhatme (1985) using the mean values to find out the significance. The model of analysis of variance table adopted is given below.

The data for different characters were statistically analysed on the basis of the model suggested by Cochran and Cox (1950) for RBD.

$Y_{ij} = \mu + b_i + t_j + e_{ij}$

Where,

Y_{ij} = Performance of the j^{th} genotype in the i^{th} block

μ = general mean

b_i = true effect of i^{th} block

t_j = true effect of j^{th} genotype

e_{ij} = random error associated with i^{th} block and j^{th} genotype.

The analysis of variance for each character was carried out as indicated below

Sources of variation	**Df**	**SS**	**MSS**	**F ratio**
Replications Treatments Error	r-1 t-1 (r-1) (t-1)	RSS T_rSS ESS	RMSS T_rMSS EMSS	RMSS/EMSS T_rMSS/EMSS
Total	(rt-1)	TSS		

Where,

r = Number of replications

t = Number of genotypes or treatments

df = degrees of freedom

SS = sum of squares

MSS = Mean sum of squares

RSS = Replication Sum of squares

T_rSS = Treatment sum of squares

ESS = Error sum of squares

TSS = Total sum of squares

RMSS = Mean sum of squares due to replications

T_rMSS = Mean sum of squares due to treatments

EMSS = Mean sum of squares due to error

The test of significance was carried out by 'F' table values given by Fisher and Yates (1963).

3.6.2 Components of variance

$$\text{Genotypic variance } (V_g \text{ or } \sigma^2 g) = \frac{\text{Genotype MSS-Error MSS}}{R}$$

Environmental variance (V_e or $\sigma^2 e$) = Error mean sum of squares

Phenotypic variance (V_p or $\sigma^2 p$) = $V_g + V_e$

Significance of treatment MSS was assessed by referring to F table values at 1 and 5 percent probabilities. Further, computation was carried out only when the treatment effects were found significant.

Critical difference (C.D.)

In order to compare the means of various entries CD was calculated by using the formula.

Critical difference (CD) = S.E(d) x 't' at error d.f.

$$S.E(d) = \sqrt{\frac{2 \times \text{error MSS}}{r}}$$

Where,

t = is the table value at 5 per cent or 1 per cent probability level, respectively

r = number of replications.

3.6.3 Genotypic and Phenotypic variances

The genotypic and phenotypic variances were computed based on the expected mean sum of squares as follows:

$$\sigma^2 g = \frac{M_2 - M_3}{r}$$

$$\sigma^2 p = \sigma^2 g + \sigma^2 e \quad \text{(or)} \quad \frac{M_2 - M_3 + M_3}{r}$$

Where, $\sigma^2 g$ = Genotypic variance (GV)

$\sigma^2 p$ = Phenotypic variance (PV)

$\sigma^2 e$ = Environmental variance (EV)

M_2 = Treatment mean sum of squares

M_3 = Error mean sum of squares

r = replication

3.6.4 Coefficient of variation

Genotypic and phenotypic coefficients of variation were computed according to Burton (1952) based on the estimate of genotypic and phenotypic variance as follows:

$$GCV = \frac{\sqrt{GV}}{\overline{X}} \times 100$$

$$PCV = \frac{\sqrt{PV}}{\overline{X}} \times 100$$

Where,

GCV = Genotypic coefficient of variation

PCV = Phenotypic coefficient of variation

GV = Genotypic variance

PV = Phenotypic variance

$\overline{X}$ = General mean of character

Further, the PCV and GCV were classified as suggested by Sivasubramanian and Madhava Menon (1973):

0 – 10% : Low

10 – 20% : Moderate

20% and above : High

3.6.5 Heritability

Heritability in broad sense refers to the proportion of genetic variance to the total observed variance in the population. It has been estimated as per the formula given by Lush (1940).

$$h^2 (b) = \frac{\text{Genotypic variance } (\sigma^2 g)}{\text{Phenotypic variance } (\sigma^2 p)} \times 100$$

Where, $\sigma^2 g$ and $\sigma^2 p$ are the genotypic and phenotypic variances. Further, the range of heritability in broad sense was classified as suggested by Johnson *et al*. (1955).

Less than 30% : Low

30 – 60% : Moderate

More than 60% : High

3.6.6 Genetic Advance as per cent Mean (GAM)

Genetic advance as per cent mean was worked out for each character adopting the formula given by Johnson *et al*. (1955)

$$GAM = \frac{GA \times 100}{\overline{X}}$$

Where,

GA = Genetic advance = $k \times \sigma^2 p \times h^2$

K : Selection differential which is equal to 2.06 at 5% intensity of selection (Lush, 1940)

$\sigma^2 p$: Phenotypic standard deviation

h^2 : Estimated heritability, and

$\overline{X}$: General mean

The range of genetic advance as per cent of mean was classified according to Johnson *et al*. (1955)

Low : Less than 10%

Moderate : 10 – 20%

High : More than 20%

3.6.7 Correlation Coefficient Analysis

The relationship between two or more quantitative characters is of great interest and carried much practical significance. Correlation is a measure of symmetrical association between two or more than two characters (Burton, 1951).

Genotypic and phenotypic correlation coefficients

Phenotypic and genotypic correlations were worked out by using formula suggested by Falconer (1964).

Phenotypic coefficient of correlation (r_p)

$$r(x_i.x_j)_p = \frac{COV\ (x_i.x_j)_p}{\sqrt{V\ (x_i)_p\ .\ V\ (x_j)_p}}$$

Where,

$r(x_i.x_j)_p$ = Phenotypic correlation between i^{th} and j^{th} character.

$COV\ (x_i.x_j)_p$ = Phenotypic covariance between i^{th} and j^{th} character.

$V\ (x_i)_p$ = Phenotypic variance of i^{th} character.

$V\ (x_j)_p$ = Phenotypic variance of j^{th} character.

Genotypic coefficient of correlation (r_g)

$$COV\ (x_i.x_j)_g$$

$$r(x_i.x_j)_g = \frac{\text{COV}\,(x_i.x_j)_g}{\sqrt{V\,(x_i)_g \;.\; V\,(x_j)_g}}$$

Where,

$r(x_i.x_j)_g$ = Genotypic correlation between i^{th} and j^{th} character.

$\text{COV}\,(x_i.x_j)_g$ = Genotypic covariance between i^{th} and j^{th} character.

$V\,(x_i)_g$ = genotypic variance of i^{th} character.

$V\,(x_j)_g$ = genotypic variance of j^{th} character.

Test of significance

Significance of correlation coefficients was tested by comparing phenotypic correlation coefficients with the table values (Fisher and Yates, 1963) at (n-2) degrees of freedom at 5 % and 1 % level where 'n' denotes the total number of pairs of observations used in the calculation.

$$t = \frac{r}{\sqrt{1- r^2}} \sqrt{n-2}$$

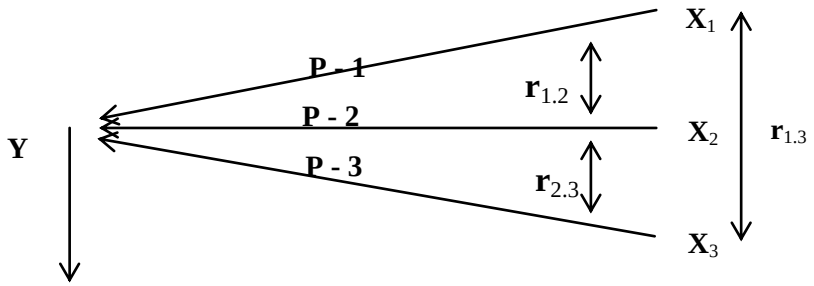
t = test of significance

r = correlation coefficient

n = number of paired observations

3.6.8 Path Coefficient Analysis

To establish a cause and effect relationship, the genotypic and phenotypic correlation coefficients will be partitioned into direct and indirect effects by path analysis as suggested by Dewey and Lu (1959). The first step in path analysis is to prepare a path diagram based on cause and effect relationship. The concept is that yield is the function of various components like X_1, X_2, X_3. Then these components show following type of association with one another.



From this figure, it is obvious that yield is the result of X_1, X_2 and X_3 and some other undefined factor denoted by 'R'. The Double arrowed lines indicate mutual association as measured by correlation coefficients and the single arrowed line represent direct influence as measured by path coefficients P_{ij}.

Path coefficients will be obtained by solving a set of simultaneous equations of the form.

$r_{ny} = P_{ny} + r_{n2} + r_{n2}P_y + r_{n3} + \ldots..$

Where,

r_{ny} = Correlation between one component and yield

P_{ny} = Path coefficient between that character and the yield

r_{n2} = Correlation between the character and each of the other yield components in turn

Matrix A **Matrix B**

$$\begin{bmatrix} r_1y \\ r_2y \\ r_ny \end{bmatrix} = \begin{pmatrix} P_1 \\ P_2 \end{pmatrix} \begin{bmatrix} 1 & r_{12} & r_{13} & \ldots.. & r_{1n} \\ r_{21} & 1 & r_{23} & \ldots.. & r_{2n} \\ r_{n1} & r_{n2} & r_{n3} & \ldots & 1 \end{bmatrix}$$

Where,

$r_{12} = r_{21}$ and so on

r_{1y} = Correlation between one component character and yield

The B matrix was inverted (B^{-1}) and path coefficients (P_{ij}) will be obtained as

$(P_{ij}) = A \times (B^{-1})$

The indirect effect of a particular character through other characters will be obtained by multiplication of direct path and particular correlation coefficients between the characters, separately.

Indirect effects = $r_{ij} \times P_{ij}$

Where,

i = 1 to 6

j = 1 to 6

$P_{ij} = P_{iY1}, P_1y_2, \ldots.., P_{ny}$

Path coefficients (P_{ij}), correlation coefficient (r_{ij}) and residual factors will be diagrammatically presented.

The residual factors i.e. variation in yield unaccounted for by these association will be calculated from the following formula.

Residual effect (X) = $1 - R^2$

Where,

$R^2 = P_{1Y}r_1y + P_2yr_2y + P_3yr_3y + \ldots + P_nyr_ny$

Where,

$P_1y, P_2y, \ldots P_ny$ = path values

$r_1y, r_2y, \ldots r_ny$ = Correlation coefficients.

Scales for path coefficients

Values of direct (or) indirect effects	**Rate (or) scale**
0.00 to 0.09	Negligible
0.10 to 0.19	Low
0.20 to 0.29	Moderate
0.30 to 0.99	High
> 1.00	Very high

Chapter-IV

Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

The experiment entitled **"Evaluation of Chrysanthemum (*Dendranthema grandiflora* Tzvelev.) cultivars for growth, yield and storage life under open field conditions"** was carried out at Horticultural College and Research Institute, Anantharajupet during the year 2012-13. The results are tabulated and enumerated under the following headings with appropriate discussion.

4.1 Vegetative characters

4.2 Flower and yield characters

4.3 Incidence of pests and diseases

4.4 Economics (Benefit Cost ratio) of chrysanthemum cultivation

4.5 Storage parameters

4.6 Genetic variability, heritability, correlation studies and path coefficient analysis

4.1 VEGETATIVE CHARACTERS

4.1.1 Plant height (cm)

Significant differences were observed for the plant height at different stages of crop growth at 30, 60, 90 and 120 DAT and presented in Table 4.2.

At 30 DAT the plant height ranged from 11.70 to 26.07 cm. The cultivar Geethanjali recorded maximum plant height (26.07 cm) followed by cv.Rekha (20.73 cm), cv.PAU-B-107 (19.78 cm) and cv.Co-3 (16.92 cm) whereas cv.Yellow Double recorded the minimum plant height (11.70 cm).

With increasing crop period, an increase in plant height was observed at 60 DAT within and even among the cultivars and ranged from 22.30 to 42.28 cm. The cultivar Geethanjali exerted its superiority by recording the maximum plant height (42.28 cm) followed by cv.Rekha (34.67 cm), cv.Co-3 (31.14 cm) and cv.PAU-B-107 (29.56 cm) whereas cv.Pusa Semidouble (22.30 cm) recorded minimum plant height.

The increasing trends of plant height continued even 90 DAT. At this stage, the crop growth further advanced and the height was ranged in between 28.50 to 53.63 cm and the maximum plant height was recorded with cv.Geethanjali (53.63 cm) followed by cv.Rekha (51.33 cm), cv.Raichur (50.63 cm), cv.Co-3 (48.74 cm) and minimum plant height (28.50 cm) was recorded by cv.Pusa Semidouble.

Significant results were observed among the cultivars at 120 DAT. Where, the plant height ranged from 42.73 to 58.31 cm. The linear increasing trend of plant height continued with the cv.Geethanjali with a maximum plant height of 58.31 cm followed by cv.Rekha (57.75 cm), cv.Raichur (55.75 cm), the minimum was recorded with cv.Pusa semi Double (42.73 cm).

During all stages of crop growth *i.e.* 30 to 120 DAT, cv.Geethanjali attained maximum plant height which was significantly superior over other cultivars followed by cv.Rekha (Table 4.2.). The difference in plant height may be the varietal character as reported by Kanamadi and Patil 1993 and Behera *et al.,* 2002 and the increase in plant height was associated with rapid meristamatic activity probably due to rapid cell division and elongation during the tender growth period (Sharova *et al*., 1977). Similar variation for the plant height in chrysanthemum was also observed by Mukesh Kumar *et al.* (2002). The plant height was considered as an important character for selection of chrysanthemum varieties for different purposes (Shanker and Tiwari, 1993) and better vegetative growth will significantly contribute towards the flower yield of chrysanthemum as stated by Raghava *et al.* (1992).

4.1.2 Plant spread (cm)

Significant results were obtained for plant spread in different cultivars at different stages of crop growth at 30, 60, 90 and 120 DAT and presented in Table 4.3.

Among the cultivars at 30 DAT plant spread ranged from 10.86 to 22.73cm. At this stage of crop growth for cv.PAU-B-107 recorded maximum plant spread (22.73 cm) followed by cv.Pusa Semidouble (19.53 cm) and cv. Geethanjali (18.38 cm) whereas cv.Yellow Double recorded the minimum plant spread (10.86 cm).

With increasing crop period an increase in plant spread was observed at 60 DAT among the cultivars and it ranged from 23.67 to 40.20 cm. The cultivar PAU-B-107 recording the maximum plant spread (40.20 cm) followed by cv.Pusa Semidouble (37.07 cm), cv.Geethanjali (35.76 cm) and minimum plant spread (23.67 cm) was recorded by cv.Yellow Double.

The increasing trends of plant spread continued even 90 DAT and ranged from 29.58 to 48.08 cm. Maximum plant spread was recorded with cv.PAU-B-107 (48.08 cm) followed by cv.Pusa Semidouble (46.99 cm) and minimum plant spread was recorded by cv.Yellow Double (29.58 cm).

At 120 DAT plant spread ranged from 30.99 to 51.27 cm. The linear increasing trend of plant spread continued in cv.PAU-B-107 (51.17 cm) and recorded maximum plant spread followed by cv.Pusa Semidouble (48.33 cm), cv.Pusa Anmol (47.39 cm) and the minimum plant spread was recorded with cv.Yellow Double (30.99 cm).

During all stages of crop growth *i.e.* 30 to 120 DAT, cv.PAU-B-107(29.99 cm) attained maximum plant spread which was significantly superior over other cultivars (Table 3). Increase in plant spread might be due to production of increased number of branches. The increasing plant spread due to increased number of branches was reported by Mishra (1999) and Balaji *et al.* (2004).

4.1.3 Number of primary branches plant^{-1}

Among the 13 cultivars significant differences were observed for number of branches plant^{-1} at 30, 60, 90 and 120 DAT and presented in Table 4.4.

At 30 DAT the number of primary branches ranged from 2.42 to 5.96. At this stage of crop growth cv.PAU-B-107 recorded maximum number of primary branches (5.96)

followed by cv.Co-3 (5.16), cv.Geethanjali (4.56) which is statistically on par with cv.Rekha (4.35) and the cv.Yellow Double showed the minimum number of primary branches (2.42).

Increase in number of primary branches was observed at 60 DAT and was ranged from 4.96 to 10.87. The cultivar PAU-B-107 recorded the maximum number of primary branches (10.87) followed by cv.Co-3 (9.40), cv.Geethanjali (7.70), which is statistically on par with cv.Pusa Semidouble (7.53) whereas cv.Yellow Double recorded minimum number of primary branches (4.96).

The increasing trends of number of primary branches continued even 90 DAT. The number of primary branches ranged from 7.23 to 14.97. Maximum number of primary branches was recorded with cv.PAU-B-107 (14.97) followed by cv.Chandini (12.86), cv.Geethanjali (12.68), cv.Co-3 (12.67), cv.Rekha (12.14) and minimum number of primary branches was recorded with cv.Yellow Double (7.23).

At 120 DAT the number of primary branches ranged from 8.85 to 16.30. The linear increasing trend of number of primary branches continued with cv.PAU-B-107 (16.30) and recorded maximum number of primary branches followed by cv.Co-3 (14.30), cv.Chandini (13.67), cv.Pusa Semidouble (13.50), and the minimum number of primary branches was recorded with cv.Yellow Double (8.85).

Number of primary branches plant^{-1} showed significant variation for the cultivars evaluated and the cv.PAU-B-107 recorded maximum number of branches and maintained its superiority over other varieties until the final stage of growth. Such differences observed in production of branches among the varieties might be due to inherent genetic factor (Hemalata *et al.*, 1992 and Behera *et al.*, 2002). Accordingly variations in production of branches among the chrysanthemum cultivars were also reported by Kanamadi and Patil, (1993) and Vasanthachari, (2003).

4.1.4 Number of suckers plant^{-1}

Significant differences were observed among the cultivars for number of suckers per plant and presented in Table 4.6.

Number of suckers plant^{-1} was ranged from 2.00 to 21.50. The maximum number of suckers (21.50) plant^{-1} was recorded in cv.PAU-B-107 followed by cv.Pusa Anmol

(20.00), cv.Rajamundry (20.00), cv.Geethanjali (18.00) and cv.Yellow Double produced minimum number of suckers (2.00) plant^{-1}.

The similar findings were reported by Bhaskaran (2001), Jayanthi and Vasanthachari (2003) for suckering capacity of chrysanthemum varieties and they reported that sucker production for the chrysanthemum plants is a varietal character associated with leaf number and area.

4.2 FLOWER AND YIELD CHARACTERS

4.2.1 Days taken to first flower bud initiation

Data for this attribute revealed that the days taken to first flower bud initiation showed significant differences among the cultivars tested and presented in Table 4.5.

Days taken to first flower bud initiation ranged from 63.33 to 97.00. The cv.Co-3(63.3 days) recorded minimum number of days followed by cv.Pusa Anmol (65.00 days) and cv.Yellow Double (70.33 days). However, the cv.PAU-B-107 recorded more number of days (97.00 days) for flower bud initiation.

Early flowering habit was observed with cv.Co-3 and found significantly superior to all other varieties tested. This signifies the earliness of a cultivar as reported by Heidmans and Stalk (1984), Negi *et al*. (1988), Behera *et al*. (2002) and Vasanthachari (2003) in chrysanthemum, where the varietal genetic character play an important role.

4.2.2 Days taken to 50% flowering

Significant differences were observed among chrysanthemum cultivars with respect to number of days taken to 50% flowering and it ranged between 93.00 to 133.00 days (Table 4.5.)

The cv.Co-3 recorded significantly less number of days (93.00 days) to produce 50% flowers and was found significantly superior to all other cultivars tested followed by cv. Pusa Anmol (95.00) and cv. Yellow Double (102.67). However, the cv.PAU-B-107 (133.00 days) taken more number of days to 50% flowering.

The inherent early flower bud initiation factor in cv.Co-3 significantly influenced the days to 50% flowering. The variation for early or late bloom seems to be the varietal character (Kanamadi and Patil, 1993; Behera *et al.,* 2002 and Manohar Rao and Pratap, 2003).

4.2.3 Days taken to first harvest

Significant differences were observed among the cultivars with respect to days taken to first harvest and it ranged 90.67 to 130.33 days (Table 4.6).

The minimum number of days taken to first harvest was recorded in cv.Co-3 (90.67 days) which was on par with cv.Pusa Anmol (93.00 days) and followed by cv.White Double (98.33 days). The cv. PAU-B-107(130.33 days) recorded the maximum number of days to first harvest.

The cultivar which is recorded early bloom it also reaches early to harvest and the number of days taken to first harvest is depends upon varietal character (Peddi Laxmi *et al.,* 2008 and Kishan Swaroop *et al.,* 2008)

4.2.4 Number of flowers spray^{-1}

The data for number of flowers spray^{-1} in different cultivars of chrysanthemum are presented in Table 4.7.

The significant differences were observed among the chrysanthemum cultivars with respect to number of flowers spray^{-1} ranged from 5.60 to 16.50. The on par results were observed for number of flowers spray^{-1} where maximum number of flowers

spray^{-1} with cv.PAU-B-107 (16.50) followed by cv.Pusa Semidouble (15.67), cv.Chandini (14.33) and cv.Rekha (14.00). Minimum number of flowers spray^{-1} (5.60) was recorded by cv.Yellow Double.

Cultivar PAU-B-107, cv.Pusa Semidouble and cv.Rekha were significantly superior over the other cultivars for number of flowers spray^{-1} is in accordance to the reports of Peddi Laxmi *et al.*, 2006, where the number of flowers produced spray^{-1} ultimately determines the vigour of the genotype or variety for the flower production (Anonymous, 1991).

4.2.5 Number of flowers plant^{-1}

Significant results were found among the cultivars evaluated with respect to number of flowers plant^{-1} and ranged from 61.13 to 169.33 (table 4.7). Highest number of flowers (169.33) was recorded in cv.PAU-B-107 followed by cv.Pusa Anmol (146.00) and cv.Co-3 (141.00). Cultivar White Double (61.13) recorded lowest number of flowers plant^{-1}.

Number of flowers produced plant^{-1} ultimately determines the vigour of the genotype or variety for the flower production (Anonymous, 1991). The cv.PAU-B-107 was significantly superior over the other cultivars for maximum number of flowers plant^{-1} followed by cv.Pusa Anmol and cv.Co-3. Similar trend was observed by Bhaskaran (2001) and Vasanthachari (2003) in chrysanthemum.

4.2.6 Spray length (cm)

Significant differences were observed among the cultivars for spray length and it ranged from 6.63 to 25.23 cm (table 4.7). Cultivar Geethanjali (25.23 cm) recorded maximum spray length followed by cv.Raichur (25.10 cm), cv.Rekha (23.67 cm) and cv.Silper (22.83 cm). Minimum spray length was recorded by cv.white Double (6.63 cm). These results are in accordance with the findings as reported by Manohar Rao and Pratap (2003).

4.2.7 Flower diameter (cm)

Significant differences were observed among the chrysanthemum cultivars with respect to flower diameter and it ranged from 2.40 cm and 5.90 cm (table 4.8.). Significantly maximum flower diameter (5.90 cm) was recorded by cv.CO-3 followed by cv.PAU-B-107 (5.73 cm), cv.Geethanjali (4.83 cm) and cv.Pusa Anmol (4.83 cm). The minimum flower diameter (2.40 cm) was recorded by cv.Pusa Semidouble.

Largest flower diameter was registered with cv.Co-3 which was followed by cv.PAU-B-107. Probably variation in flower diameter might be due to variation in the genetic makeup of varieties (Kanamadi and Patil, 1993 and Mishra, 1999). Similar variations for the chrysanthemum cultivars were also reported by Manohar Rao and Pratap (2003) where the maximum and minimum flower diameter was recorded with the cv.Ravikiran and cv.Basanthi respectively.

4.2.8 Flower weight (g)

Significant differences were observed among the cultivars evaluated for flower weight and presented in Table 4.8. The data collected for individual flower weight ranged from 1.30 g and 5.40 g and maximum flower weight (5.40 g) was recorded by cv.PAU-B-107 followed by cv.Co-3 (5.18 g), cv.Rajmundry (4.37 g) and cv.Pusa Anmol (3.80 g). While the minimum flower weight (1.30 g) was recorded by cv.Pusa Semidouble.

Probably variation in flower weight is depends on varietal character. Similar variations for the chrysanthemum cultivars were also reported by Dhahiya *et al.*, (2003) where the maximum and minimum flower weight was recorded with the cv.Basanthi and cv.Gauri respectively.

4.2.9 Flower colour

Flower colour of different chrysanthemum cultivars was observed and recorded as per the R.H.S.C chart and presented in Table 4.9.

Out of thirteen cultivars, seven cultivars *viz.*, Rekha, Raichur, Silper, Pusa Semidouble, Yellow Double and Chandini were yellow in colour. Three cultivars *viz*., PAU-B-107, Pusa Anmol and Rajmundry were white in colour. The cv.Co-3 was yellowish brown in colour, Shanthi was Pinkish cream in colour and Geethanjali was lemon yellow colour.

Wide ranges of flower colour were observed among thirteen cultivars of chrysanthemum which were categorized as per colour codes described in R.H.S.C.C, London (Table 9). Similar observations were also recorded by various workers on varietal evaluation of chrysanthemum cultivars on the basis of colour of the flower (Wilfert and Harbaugh 1980, Chaudhary 1997 and Simrat Singh *et al.,* 2008).

4.2.10 Duration of flowering

Significant differences were observed in duration of flowering among the cultivars evaluated and ranged from 39.00 to 71.83 days (Table 4.5.). The maximum flower duration showed by cv.Co-3 (71.83 days) followed by cv.Pusa Anmol (68.98 days) and minimum for cv.Pusa Semidouble (39.00 days).

Chrysanthemum is a short day plant and commonly transplanted during June-July months. Hence forth, the flowers harvested from September to November. Preference for selecting the cultivars for early and extended period of blooming is the utmost criteria to have continued supply of flowers to the market. In the present study considerable variation was recorded for the duration of flowering and it was minimum with cv.Pusa Semidouble while the flowering period was significantly more with cv.Co-3. These variations have the commercial advantage for selecting cultivars to have continuity of flower supply for longer period which will help in earning profitable returns. The variation in duration of flowering among the varieties can be

attributed to differences in genetic makeup of the plant (Gaikwad and Dumbre Patil 2001 and Kavita Kand Pal *et al*., 2003).

4.2.11 Flower yield plant^{-1} (g)

Flower yield plant^{-1} showed significant differences among thirteen cultivars and presented in Table 4.10.

The data for flower yield plant^{-1} ranged from 96.67 g to 293.33 g. The maximum was recorded by cv.PAU-B-107 (293.33 g) followed by cv.Co-3 (276.00 g), cv.Pusa Anmol (238.33g) and cv.Chandini (236.67 g) were found on par with one another. The lowest flower yield plant^{-1} was recorded by cv.Yellow Double (96.67.g).

4.2.12 Flower yield plot^{-1} (kg)

The flower yield plot^{-1} (2 x 2 m) showed significant differences among the thirteen chrysanthemum cultivars (Table 10) and ranged from 3.48 to 10.56 kg. The maximum flower yield plot^{-1} recorded in cv. PAU-B-107 (10.56 kg) followed by cv.Co-3 (9.93 kg), cv.Pusa Anmol (8.58 kg) and cv.Chandini (8.52 kg). Whereas, the cv. Yellow Double (3.48 kg) recorded minimum flower yield plot^{-1}.

4.2.13 Flower yield hectare^{-1} (q)

The significant results were obtained among the cultivars for flower yield per plant ranged from 86.92 q to 264 q (Table 4.10.).

Maximum flower yield hectare^{-1} was recorded by the cv.PAU-B-107 (264 q) followed by cv.Co-3 (248.33 q), cv.Pusa Anmol (214.50q) and cv.Chandini (213.00 q) were found on par with one another. Whereas the lowest flower yield was recorded by cv.Yellow Double (86.92 q).

The average flower yield plant^{-1}, plot^{-1} and hectare^{-1} also differed with the cultivars. The cultivar PAU-B-107 yielded significantly higher than all the other cultivars tested which is in accordance with the reports of Hemalatha *et al.* (1992) and Behera *et al.* (2002) where the varietal difference for yield potential may be attributed to additive gene effect.

4.3 INCIDENCE OF PESTS AND DISEASES

No serious incidence of pests and diseases was observed. Among pests and diseases of chrysanthemum, the Bud borer (*Spodoptera litura*) and Leaf blight (*Alternaria alternate*) with low incidence, were observed.

4.3.1 Incidence of Bud borer (*Spodoptera litura*)

The data recorded for number of larvae plant^{-1} presented in table 11. Significant differences observed among the chrysanthemum cultivars.

At the vegetative stage, there was no incidence of *S.litura* but the infestation was observed at flower bud stage. The number of larvae plant^{-1} ranged from 0.67 to 2.17. The maximum number of larvae plant^{-1} recorded by cv.Co-3 (2.17) followed by cv.Geethanjali (2.13) indicating susceptible reaction. Whereas minimum was observed in cv.PAU-B-107 (0.67) followed by cv.Rajmundry (0.93), cv.Raichur (0.97) and Pusa Semidouble (0.97) showing resistance against the pest, comparatively. Probably the variation with incidence of pest might be due to variation in the genetic makeup of varieties (Reddy *et al.,* 2004 and Pal *et al*., 2009).

4.3.2 Incidence of Leaf blight (*Alternaria alternata*)

The data for the Percent disease index (PDI) of Alternaria leaf blight in different chrysanthemum cultivars are presented in Table 4.11.

There were significant differences among the chrysanthemum cultivars, the percent disease index ranged from 5.00 to 38.00. The maximum PDI was recorded cv.Silper (38.00) followed by cv.Raichur (34.00), cv.Co-3 (30.00) and cv.Chandini (21.00). The minimum PDI was recorded by cv.PAU-B-107 (5.00) indicating the resistance against the disease among the chrysanthemum varieties studied.

This variation in different response to the Alternaria blight infection might be due to their genetic makeup. The severity of disease was also dependent on cultivar,

inoculum load, agro-climatological situations prevailing in different localities. This is in agreement with the reports of Arunkumar *et al.* (2011).

4.4 ECONOMICS

There was a significant difference among thirteen chrysanthemum cultivars evaluated with respect B:C ratio, which are presented in Table 4.12. and details of cost of cultivation in Appendix II.

Among the different cultivars, the higher flower yield was recorded by cv.PAU-B-107(264 q ha^{-1}) which resulted into maximum net returns (Rs 2,67,510 ha^{-1}) and B:C ratio (2.08) followed by cv.CO-3 (248.33q ha^{-1}) with net returns (Rs 2,44,005 ha^{-1}) and B:C ratio (1.90). The minimum flower yield (86.92 q ha^{-1}), net returns (Rs 1,890) and B:C ratio (0.01) was recorded by cv.Yellow Double.

Recognizing the study further identifies that lack of alternative marketing channels and wide fluctuations in prices in flower markets are the major problems in the case of Chrysanthemum cultivation. Kumari (1992), Subramanyam and Sudha (1992), Chengappa (1998), Mysore (2005) also opined the same on notable price variation in different markets throughout india.

4.5 STORAGE LIFE OF FLOWERS WITH DIFFERENT PACKING MATERIALS (DAYS)

4.5.1 Days taken to 50% flowers wilt

4.5.1.1 Days taken to 50% flowers wilt in gunny bags

The data for the days taken to 50% flowers wilt in gunny bags of different chrysanthemum cultivars are presented in Table 4.13.

Significant difference was observed among the chrysanthemum cultivars with respect to storage life and ranged from 2.00 to 3.33 days. Some of the cultivars showed better

storage life compared to local check (cv.Chandini). The maximum storage life was recorded by cv.PAU-B-107 (3.33 days) followed by cv.Rajamundry (3.00 days) which was on par with cv.Chandini (3.00 days) and cv.Co-3 (2.67 days). The minimum storage life was recorded by cv.Yellow Double (1.67 days).

Among all cultivars the cv.PAU-B-107 had taken maximum days to 50% flowers wilt in Gunny bags storage. The minimum days were recorded by cv.Yellow Double. These results are in accordance with the findings of Karuppaiah *et al.* (2006) in Jasmine.

4.5.2.2 Days taken to 50% flowers wilt in bamboo baskets

The data for the days taken to 50% flowers wilt in bamboo baskets of different chrysanthemum cultivars are presented in Table 4.13.

Significant differences were observed among the chrysanthemum cultivars with respect to storage life and ranged from 2.30 to 4.33 days. When compared to cv.Chandini (local check) the maximum Storage life with bamboo baskets was recorded by cv. PAU-B-107 (4.33 days) followed by cv.Co-3 (4.33 days) and cv.Geethanjali (3.33 days) which was on par with cv.Pusa Anmol (3.33 days). The minimum Storage life was recorded by cv.Yellow Double (2.30 days).

Significantly, it was observed that the cv.PAU-B-107 had taken maximum number of days to 50% flowers wilting while packing with bamboo baskets and the minimum number of days was recorded by cv.Yellow Double. These results are in accordance with the findings reported by Karuppaiah *et al.* (2006) in jasmine.

4.5.1.3 Days taken to 50% flowers wilt in 200 gauge polyethylene bag

The data for the days taken to 50% flower wilt in 200 gauge polyethylene bag of different chrysanthemum cultivars are presented in Table 4.13.

Significant differences were observed among the chrysanthemum cultivars with respect to storage life and ranged from 3.33 to 5.87 days. Some of the cultivars showed better storage life compared to local check (cv.Chandini). The maximum storage life with 200 gauge polyethylene bag was recorded by cv.PAU-B-107 (6.67 days), followed by cv.Chandini (6.00 days), which was on par with cv.Rajamundry (5.87 days) cv.Co-3 (5.67 days) and cv.Pusa Anmol (5.67 days). The minimum storage life with 200 gauge polyethylene bag was recorded by cv.Yellow Double (3.33 days).

Among the packing materials tried to assess the storage life 200 gauge polyethylene bags found better to enhance the life of flowers and cv.PAU-B-107 recorded maximum number (6.67 days) of days. Madaiah and Venkatesh Reddy (1994) reported that polyethylene films of 200 gauges are capable of modifying the atmosphere in the packs and thus allowing the flowers to be stored for several days without affecting freshness.

4.5.2 Physiological loss in weight (%)

4.5.2.1 PLW (%) in gunny bags

The data for the PLW (%) in gunny bags of different chrysanthemum cultivars are presented in Table 4.14.

Significant differences were observed among the chrysanthemum cultivars with respect to PLW (%) in gunny bags. The PLW (%) increased from day1 to day 3. By the day three the minimum PLW (%) was observed in cv.PAU-B-107 (11.95%) followed by cv.Co-3 (12.33%), cv.Chandini (12.70%) and cv.Rajamundry (13.20%). The maximum PLW (%) in gunny bags was recorded by cv.Yellow Double (17.80%).

Among all cultivars the cv.PAU-B-107 showed the minimum weight loss when the flowers attain 50% flowers wilting while packing with bamboo baskets. The maximum was in cv.Yellow Double. These results are in accordance with the findings reported by Karuppaiah *et al.* (2006) in Jasmine.

4.5.2.2 PLW (%) in bamboo baskets

The data for the PLW (%) in bamboo baskets of different chrysanthemum cultivars are presented in Table 4.15.

Significant differences were observed among the chrysanthemum cultivars with respect to PLW (%) in bamboo baskets. The PLW (%) increased from day1 to day 4. By the day three the minimum PLW (%) was recorded by cv.PAU-B-107 (6.40%) followed by cv.Co-3 (7.2%), cv.Chandini (7.20%) and cv.Rajamundry (7.20%). The maximum PLW (%) in bamboo baskets was recorded by cv.Yellow Double (11.60%).

Among the all cultivars the cv.PAU-B-107 had taken minimum weight loss while packing with bamboo baskets. The maximum loss was in cv.Yellow Double. When compared to gunny bag packing the bamboo baskets maintained low PLW (%). These results are in accordance with the findings reported by Karuppaiah *et. al* (2006) and Nirmala and Reddy (1993) in Jasmine.

4.5.2.3 PLW (%) in 200 gauge polyethylene bag

The data for the PLW (%) in 200 gauge polyethylene bag of different chrysanthemum cultivars are presented in Table 4.16.

Significant differences were observed among the chrysanthemum cultivars with respect to PLW (%) in 200 gauge polyethylene bag. The PLW (%) increased from

day1 to day 7. By the day seven the minimum PLW (%) was recorded by cv. PAU-B-107 (2.00%) followed by cv.Chandini (2.20%), cv.Rajamundry (2.40%) and cv.Pusa Anmol (2.60%). The maximum PLW (%) in 200 gauge polyethylene bag was recorded by cv.Yellow Double (11.60%).

Among the all cultivars the cv.PAU-B-107 showed the minimum weight loss when the flowers attain 50% flower wilting while packing with 200 gauge polyethylene bag. The maximum was in cv.Yellow Double.

Among three packing materials, polyethylene bag of 200 gauge was significantly superior to maintained lower PLW (%) and freshness of flowers at higher level for long time. Packaging maintains higher humidity which in turns, slows down the proper moisture loss and proper balance of carbon dioxide and oxygen concentration which slows down the process of respiration (Anzueto and Rizvi,1985; Bhowmik and Hulbert, 1989). Karuppaiah *et al.* (2006) and Nirmala and Reddy et al. (1993) reported that packing of J. sambac flowers in 200 gauge polyethylene bags proved effective in extending the post-harvest life. These results are in accordance with the findings reported by Suresh kumar (2011) and Anil kumar (2012) in Chrysanthemum, Madaiah and Reddy (1994) in Tuberose.

4.6 GENETIC VARIABILITY, HERITABILITY, CORRELATION STUDIES AND PATH COEFFICIENT ANALYSIS

4.6.1 Variability, Heritability and Genetic advance as per cent of mean

Critical estimates of genetic parameters *viz.*, PCV, GCV, heritability and Genetic advance as per cent of mean are important for initiating an appropriate breeding procedure in crop improvement program. Similar analysis of variability studies were carried out in the present study of investigation “Evaluation of Chrysanthemum

(*Dendranthema grandiflora* Tzvelev.) cultivars for growth, yield and storage life under open field conditions". Heritability gives information on the magnitude and extent of inheritance of quantitative characters while, genetic advance is helpful in formulating suitable selection procedure.

The phenotypic and genotypic coefficient of variation, heritability in broad sense and Genetic advance as per cent of mean were computed for eighteen characters (all vegetative, flower, yield and incidence of pests and disease characters) in thirteen cultivars of chrysanthemum and were presented in Table 4.17.

4.6.1.1 Genotypic co-efficient of variation (GCV)

The genotypic coefficient of variation (GCV) values ranged from 9.22 to 57.07 % for the characters under study.

The high values of GCV were observed for characters *viz.*, number of suckers plant^{-1} (57.07%), flower weight (48.15%), Incidence of Disease (36.29%), spray length (35.51%), Incidence of pest (34.74%), flower yield plant^{-1} (34.44%), flower yield plot^{-1} (34.45%), flower yield hectare^{-1} (34.45%), number of flowers plant^{-1} (30.97%), number of flower spray^{-1} (28.76%). The moderate values of GCV were observed for duration of flowering (19.89%), plant spread at 120 DAT (14.78%), days taken to first flower bud initiation (13.07%), number of branches plant^{-1} at 120 DAT (12.18%), days taken to first harvest (11.92%), days taken to 50% flowering (11.55%) and the low values of GCV was observed for plant height at 120 DAT (9.22%).

4.6.1.2 Phenotypic coefficient of variation (PCV)

The phenotypic coefficient of variation (PCV) values ranged from 12.43 to 57.6 % for the characters under study.

The high values of PCV were observed for number of suckers plant^{-1} (57.68%), flower weight (49.34%), incidence of pest (39.28%), incidence of disease (37.26%), spray length (36.82%), flower yield plot^{-1} (37.21%), flower yield hectare^{-1} (37.21%), flower yield plant^{-1} (37.20%), number of flowers spray^{-1} (32.45%), number of flowers plant^{-1} (32.03%), duration of flowering (21.51%). The moderate values of PCV were observed for plant spread at 120 DAT (16.81%), days taken to first flower bud initiation (15.33%), number of branches plant^{-1} at 120 DAT (14.71%), days taken to first harvest (14.40%), days taken to 50% flowering (14.14%) and plant height at 120 DAT (12.43%).

4.6.1.2 Heritability estimates in broad sense

Heritability estimates in broad sense ranged from 54.94 to 97.88 % for the characters under study. The high heritability was recorded for the character *viz.*, number of

suckers plant^{-1} (97.88%), flower weight (95.22%), incidence of Disease (95.90%), number of flowers plant^{-1} (93.52%), spray length (92.99%), flower diameter (89.11%), flower yield plant^{-1} (85.73%), flower yield hectare^{-1} (85.72%), duration of flowering (85.50%), flower yield plot^{-1} (85.07%), number of flowers spray^{-1} (78.55%),incidence of pest (78.23%), plant spread at 120 DAT (77.27%), days taken to first flower bud initiation (72.27%), number of branches plant^{-1} at 120 DAT (68.56%), days taken to first harvest (68.50%), days taken to 50% flowering (66.66%). The moderate value of heritability was observed for plant height at 120 DAT (54.94%).

4.6.1.4 Genetic advance as per cent of mean

Genetic advance as per cent of mean was estimated for different characters and results were presented in table 4.17. and ranged from 14.07 to 116.31%.

The genetic advance as per cent of mean high for number of suckers plant^{-1} (116.31%), flower weight (96.78%), incidence of disease (72.84%), spray length (70.54%), flower yield plot^{-1} (65.71%), flower yield plant^{-1} (65.69%), flower yield hectare^{-1} (65.61%), incidence of pest (63.30%), number of flowers per plant (61.50%), number of flowers spray^{-1} (52.51%), flower diameter (45.61%), duration of flowering (37.89%), plant spread at 120 DAT (26.76%), days taken to first flower bud initiation (22.95%), number of branches plant^{-1} at 120 DAT (20.78%), days taken to first harvest (20.32%). The moderate value of genetic advance as percent of mean was observed for characters days taken to 50% flowering (19.42%) and plant height at 120 DAT (14.07%).

The high PCV and GCV were recorded for the number of suckers plant^{-1}, spray length, number of flowers spray^{-1}, flower diameter, flower weight, incidence of disease, incidence of pest and flower yield plant^{-1}. Moderate PCV and GCV were observed for the plant height at 120 DAT, plant spread at 120 DAT, number of primary branches at 120 DAT, days taken to first flower bud initiation, days taken to 50% flowering and days taken to first harvest. Days taken to 50% flowering showed high PCV and moderate GCV. Similar observations were made by Raghava *et al.* (1992), Sirohi and Behera (2000), Bhaskaran (2001) and Talukdar *et al.* (2003).

High values of genotypic variances alone are not the determining factors of expected progress that can be made in respect of quantitative traits (Falconer, 1964). Hence, high genotypic coefficients of variation along with high heritability estimates would give true picture of the extent of genetic advance under selection.

In present study, high heritability noted for the characters plant spread at 120 DAT, number of primary branches at 120 DAT, days taken to first flower bud initiation, days taken to 50% flowering, days taken to first harvest of flowers, number of suckers plant^{-1}, spray length, number of flowers spray^{-1}, flower diameter, flower weight,

incidence of disease, incidence of pest and flower yield plant^{-1}, whereas, it was moderate for plant height at 120 DAT. Similar results were reported by Ponnuswamy *et al.* (1985), Raghava *et al.* (1992), Bhaskaran (2001) and Sirohi and Behera (2000). High values of heritability indicate that there was very good scope for the improvement of clones for these traits through direct selection. Low and moderate heritability values suggest the involvement of environmental component in the expression of the character, there by direct selection of a particular character would be a futile exercise. Hence, indirect selection needs to be adopted. Heritability estimates along with genetic gain will be of more useful than heritability alone to know the ultimate effect of selection (Johnson *et al.,* 1955).

High Genetic advance as per cent of mean coupled with high heritability was noticed in plant spread at 120 DAT, number of primary branches at 120 DAT, days taken to first flower bud initiation, days taken to 50% flowering and days taken to first harvest, number of suckers plant^{-1}, spray length, number of flowers spray^{-1}, flower diameter, flower weight, incidence of disease, incidence of pest and flower yield plant^{-1}. Hence, these traits were appear to be controlled by additive gene action and selection for such character will be very effective (Panse, 1957). Similar results of high genetic advance with high heritability for above characters were reported by Chaugule (1985) and Bhaskaran (2001). Whereas, high heritability estimates accompanied with moderate Genetic advance as per cent of mean was recorded for days taken to 50% flowering and moderate heritability with moderate genetic advance as percent of mean was recorded in plant height indicating less influence of environment but prevalence of non-additive gene action for which selection will not be effective.

To sum up from the variability studies, number of suckers plant^{-1}, spray length, number of flowers spray^{-1}, flower diameter, flower weight, incidence of disease, incidence of pest and flower yield plant^{-1} had high PCV, high GCV, high heritability and genetic advance as percent of mean. Hence, improvement in these characters can be brought through simple selection process.

4.6.2 Correlation studies

In order to find out the degree and direction of association between flower yield per plant and yield contributing characters and between yield contributing characters among themselves, genotypic and phenotypic correlation coefficients are worked out on the basis of their respective variances and covariance which were presented in the table 4.18a. and 4.18b.

4.6.2.1 Genotypic correlation

Plant height at 120 DAT exhibited highly significant and positive genotypic correlation with spray length (r = 0.8823) and moderately significant association with

flower diameter (r = 0.3838). Whereas it exhibited positive but non-significant association with incidence of pest, number of primary branches plant^{-1} at 120 DAT, incidence of disease, days taken to first flower bud initiation, plant spread at 120 DAT, number of suckers plant^{-1}, number of flowers spray^{-1}, flower weight. Similarly plant height exhibited negative and non-significant association with flower yield plant^{-1}, days to 50% flowering, duration of flowering, number of flowers plant^{-1}, days taken to first harvest.

Plant spread at 120 DAT exhibited highly significant and positive genotypic correlation with number of suckers plant^{-1} (r = 0.8587), number of primary branches plant^{-1} at 120 DAT (r = 0.7423), number of flowers plant^{-1} (r = 0.6917), number of flowers spray^{-1} (r = 1.0020) and moderately significant association with days taken to 50% flowering (r = 0.4606) and flower weight (r = 0.4091). Whereas it exhibited positive but non-significant association with flower yield plant^{-1}, days taken to first harvest, flower diameter, days taken to first flower bud initiation, spray length, duration of flowering and it exhibited negative and significant association with disease incidence (r = -0.6626), negative and non-significant association with incidence of pest.

Number of primary branches plant^{-1} at 120 DAT exhibited high significant and positive genotypic correlation with number of flowers spray^{-1} (r = 0.8120), number of flowers plant^{-1} (r = 0.7911), spray length (r = 0.6274), flower diameter (r = 0.6033), number of suckers plant^{-1} (r = 0.5344) and moderately significant association with days taken to first flower bud initiation (r = 0.4420) and days taken to first harvest (r = 0.2952). Whereas it exhibited positive but non-significant association with flower yield plant^{-1}, flower weight, days taken to 50% flowering, duration of flowering. Similarly number of primary branches plant^{-1} at 120 DAT exhibited negative and non-significant association with incidence of pest, incidence of disease.

Number of suckers plant^{-1} exhibited high significant and positive genotypic correlation with number of flowers spray^{-1} (r = 0.7991), number of flowers plant^{-1} (r = 0.5961), flower diameter (r = 0.4340), spray length (r = 0.4287) and moderately significant association with days taken to 50% flowering (r = 0.4711) and days taken to first harvest (r = 0.4469). Similarly number of suckers plant^{-1} exhibited negative and significant association with incidence of disease (r = -0.4965). Whereas it exhibited positive but non-significant association with flower yield plant^{-1}, flower weight, duration of flowering, negative and non-significant association with incidence of pest.

Days taken to first flower bud initiation showed high significant and positive genotypic correlation with days taken to 50% flowering (r = 0.9786), days taken to first harvest (r = 0.8772), number of flowers spray^{-1} (r = 0.6191), and moderately

significant association with spray length (r = 0.4120). Similarly days taken to first flower bud initiation exhibited negative and significant association with incidence of pest (r = -0.5021). Whereas it exhibited positive but non-significant association with number of flowers plant^{-1}, flower yield plant^{-1}, negative non-significant association with flower weight, incidence of disease and flower diameter.

Days taken to 50% flowering exhibited high significant and positive genotypic correlation with days taken to first harvest (r = 1.1148) and number of flowers per spray (r = 0.6624). Similarly days taken to 50% flowering exhibited negative and highly significant association with duration of flowering (r = -0.5786), negative and moderately significant association with incidence of disease (r = -0.3969), incidence of pest (r = -0.5980). It exhibited positive but non-significant association with number of flowers plant^{-1}, spray length, flower yield plant^{-1}. Negative non-significant association with flower diameter and flower weight.

Days taken to first harvest exhibited high significant and positive genotypic correlation with number of flowers spray^{-1} (r = 0.6803). Similarly days taken to first harvest exhibited negative and highly significant association with duration of flowering (r = -0.5997), incidence of pest (r = -0.6131), negative and moderately significant with spray length (r = -0.0019). whereas it exhibited positive but non-significant association with number of flowers plant^{-1}, flower yield plant^{-1}, flower weight. Negative non-significant association with flower diameter and incidence of disease.

Number of flowers spray^{-1} exhibited high significant and positive genotypic correlation with number of flowers plant^{-1} (r = 0.6884). Whereas, it exhibited negative highly significant association with incidence of disease (r = -0.4796). Positive but non-significant association with flower yield plant^{-1}, spray length, flower weight, flower diameter. Negative and non-significant association with duration of flowering and incidence of pest.

Number of flowers plant^{-1} exhibited high significant and positive genotypic correlation with flower diameter (r = 0.5697) and duration of flowering (r = 0.5053). Positive but non-significant association with flower yield plant^{-1}, flower weight and spray length. whereas it exhibited negative non-significant association with incidence of pest, incidence of disease.

Spray length exhibited high significant and positive genotypic correlation with flower diameter (r = 0.4419), positive and moderately significant association with incidence of disease (r = 0.3604). Whereas it exhibited positive and non-significant association with flower yield plant^{-1}, incidence of pest, flower weight and duration of flowering.

Flower diameter exhibited high significant and positive genotypic correlation with duration of flowering (r = 0.5524) and it exhibited positive and non-significant association with flower weight, flower yield plant^{-1}, incidence of pest. Similarly flower diameter exhibited negative and non-significant association with incidence of disease.

Flower weight exhibited high significant and positive genotypic correlation with duration of flowering (r = 0.5427). It exhibited positive and non-significant association with flower yield per plant, incidence of pest and negative non-significant association with incidence of disease.

Duration of flowering exhibited non-significant and positive genotypic correlation with flower yield plant^{-1} (r = 0.6505), incidence of pest (r = 0.2898) and incidence of disease (r = 0.0428).

Incidence of pest exhibited negative and non-significant genotypic correlation with flower yield plant^{-1} (r = -0.0586).

Incidence of disease exhibited positive and moderately significant genotypic correlation with incidence of pest (r = 0.4347) and negative non-significant association with flower yield plant^{-1} (r = -0.2212).

4.6.2.2 Phenotypic correlation

Plant height at 120 DAT exhibited high significant and positive phenotypic correlation with spray length (r = 0.6301) and moderately significant association with flower diameter (r = 0.3206). Whereas it exhibited positive but non-significant association with incidence of pest, number of primary branches plant^{-1} at 120 DAT, incidence of disease, days taken to first flower bud initiation, number of flowers spray^{-1}, number of suckers plant^{-1}, flower yield plant^{-1}, plant spread at 120 DAT, flower weight. Similarly plant height exhibited negative and non-significant association with duration of flowering, days taken to first harvest, days taken to 50% flowering , number of flowers plant^{-1}.

Plant spread at 120 DAT exhibited high significant and positive phenotypic correlation with number of suckers plant^{-1} (r = 0.7258), number of flowers spray^{-1} (r = 0.6943), number of flowers plant^{-1} (r = 0.5987), number of primary branches plant^{-1} at 120 DAT (r = 0.5869), flower yield plant^{-1} (r = 0.4911) and moderately significant association with flower weight (r = 0.3591) and days taken to 50% flowering (r = 0.3248). Similarly plant height at 120 DAT exhibited negative and highly significant association with disease incidence (r = -0.5333). Similarly plant spread at 120 DAT exhibited negative and significant association with disease incidence (r = -0.6626). Whereas it exhibited positive but non-significant association with, days taken to first

harvest, flower diameter, days taken to first flower bud initiation, spray length, duration of flowering and negative non-significant association with incidence of pest.

Number of primary branches plant^{-1} at 120 DAT exhibited high significant and positive phenotypic correlation with number of flowers plant^{-1} (r = 0.6979), flower yield plant^{-1} (r = 0.5926), number of flowers spray^{-1} (r = 0.5538), spray length (r = 0.5417), flower diameter (r = 0.5147), number of suckers plant^{-1} (r = 0.4726) and moderately significant association with days taken to first flower bud initiation (r = 0.3838) and days taken to first harvest (r = 0.3184). Whereas it exhibited positive but non-significant association with flower weight, days taken to 50% flowering, duration of flowering, incidence of pest. Similarly it exhibited negative and non-significant association with incidence of disease.

Number of suckers plant^{-1} exhibited high significant and positive phenotypic correlation with number of flowers spray^{-1} (r = 0.6916), number of flowers plant^{-1} (r = 0.5832), flower yield plant^{-1} (r = 0.5679), flower weight (r = 0.4734), flower diameter (r = 0.4281), spray length (r = 0.4108) and moderately significant association with days taken to 50% flowering (r = 0.3795) and days taken to first harvest (r = 0.3756). Similarly number of suckers plant^{-1} exhibited negative and significant association with incidence of disease (r = -0.4828). Whereas it exhibited positive but non-significant association with duration of flowering and negative non-significant association with incidence of pest.

Days taken to first flower bud initiation exhibited high significant and positive phenotypic correlation with days taken to 50% flowering (r = 0.7235), days taken to first harvest (r = 0.7644), number of flowers spray^{-1} (r = 0.4951), and moderately significant association with spray length (r = 0.4000). Similarly days taken to first flower bud initiation exhibited negative and significant association with incidence of pest (r = -0.4433) and duration of flowering (r = 0.5173). Whereas it exhibited positive but non-significant association with number of flowers plant^{-1}, flower yield plant^{-1}. Negative and non-significant association with incidence of disease, flower weight and flower diameter.

Days taken to 50% flowering exhibited high significant and positive phenotypic correlation with days taken to first harvest (r = 0.7791) and number of flowers spray^{-1} (r = 0.5540) Similarly days taken to 50% flowering exhibited negative and highly significant association with duration of flowering (r = -0.4397), negative and moderately significant association with incidence of disease (r = -0.3286) and incidence of pest (r = -0.4031). It exhibited positive but non-significant association with number of flowers plant^{-1}, flower yield plant^{-1}, spray length. Negative non-significant association with flower weight and flower diameter.

Days taken to first harvest exhibited high significant and positive phenotypic correlation with number of flowers spray^{-1} (r = 0.4127). Similarly days taken to first harvest exhibited negative and highly significant association with incidence of pest (r = -0.4529) and duration of flowering (r = -0.4584) and exhibited positive but non-significant association with number of flowers plant^{-1}. Negative non-significant association with flower weight, flower diameter and incidence of disease.

Number of flowers spray^{-1} exhibited high significant and positive phenotypic correlation with number of flowers plant^{-1} (r = 0.5534), flower yield plant^{-1} (r = 0.4475) and it exhibited positive and moderately significant association with spray length (r = 0.3611). Whereas negative and high significant association with incidence of disease (r = -0.4139). Positive but non-significant association with flower weight, flower diameter, duration of flowering and negative non-significant association with incidence of pest.

Number of flowers plant^{-1} exhibited highly significant and positive phenotypic correlation with flower yield plant^{-1} (r = 0.8736), flower weight (r = 0.6965), flower diameter (r = 0.5307), duration of flowering (r = 0.4502). whereas it exhibited positive but non-significant association with spray length and negative non-significant association with incidence of pest and incidence of disease.

Spray length exhibited highly significant and positive phenotypic correlation with flower diameter (r = 0.4240), positive and moderately significant association with incidence of disease (r = 0.3409). Whereas it exhibited positive and non-significant association with flower yield plant^{-1}, incidence of pest, flower weight and duration of flowering.

Flower diameter exhibited highly significant and positive phenotypic correlation with flower weight (r = 0.8488), flower yield plant^{-1} (r = 0.7331), duration of flowering (r = 0.4891) and it exhibited positive and non-significant association with incidence of pest. Similarly it showed negative and non-significant association with incidence of disease.

Flower weight exhibited highly significant and positive phenotypic correlation with flower yield plant^{-1} (r = 0.8416), duration of flowering (r = 0.4615). It exhibited positive and non-significant association with incidence of pest and negative non-significant association with incidence of disease.

Duration of flowering exhibited highly significant and positive phenotypic correlation with flower yield plant^{-1} (r = 0.5524).

Incidence of disease exhibited moderately significant and positive phenotypic correlation with incidence of pest (r = 0.3745) and it exhibited negative and non-significant association with flower yield plant^{-1}.

Incidence of pest exhibited negative and non-significant phenotypic correlation with flower yield plant^{-1}.

In any breeding program improving in yield is one of the major objective but yield is a complex character and is being influenced by number of components, hence direct selection for yield is not effective. The characters which are having high heritability and are less influenced by environment could be useful for improving flower yield if they are correlated with yield. It has been generally accepted that the correlation between different characters represent coordination of physiological process which is often achieved through gene linkage (Mather and Jinks, 1971). While formulating breeding programme, knowledge on the strength and type of such association between characters is very important prerequisite (Breese and Haywards, 1972) from this it would be possible to bring about genetic up gradation in one character by selection of the other.

In general, genotypic correlation were of higher magnitude than phenotypic correlation in present study indicating strong inherent associations between various traits studied, but it was lessened in the phenotypic expression under the influence of environment which indicates the usefulness of genotypic estimates.

Plant spread at 120 DAT, number of primary branches at 120 DAT, number of suckers plant^{-1}, number of flowers spray^{-1}, number of flowers plant^{-1}, flower diameter, flower weight and flowering duration showed significant positive correlation with yield both at phenotypic and genotypic level indicating the importance of these traits in selection for yield and are identified as yield attributing characters on which selection can be relied upon for the genetic improvement of yield of chrysanthemum. This is in line with the earlier reports of Raghava *et al.* (1992), Sirohi and Behera (1999), Deka and Paswan (2002), Pal and George (2002), Bhaskaran *et al.* (2004), Gantajt and Pal (2009) and Kumar *et al.* (2012).

4.6.3 Path coefficient analysis

Upon the assessment of apparent relationship between yield and yield components, it was necessary to partition the direct and indirect effects of each character on yield to understand the nature of association at genotypic and phenotypic level. In order to fulfill the requirement, the path coefficient analysis was computed and direct and indirect effects of different characters on flower yield per plant are presented in the Table 4.19a. and 4.19b.

The flower yield plant^{-1} was considered as effect dependent on 15 independent variables, which are considered as cause. The independent characters were plant height at 120 DAT, plant spread at 120 DAT, number of primary branches plant^{-1} at 120 DAT, number of suckers plant^{-1}, days taken to first flower bud initiation, days taken to 50% flowering, days taken to first harvest, number of flowers spray^{-1}, number of flowers plant^{-1}, spray length, flower diameter, flower weight, duration of flowering, incidence of pest and incidence of disease.

DIRECT EFFECTS

4.6.3.1 Plant height at 120 DAT

This trait showed direct positive low phenotypic path coefficient (0.1677) and direct positive high genotypic path coefficient (0.7427) on flower yield plant^{-1}.

4.6.3.2 Plant spread at 120 DAT

Plant spread have direct negative negligible phenotypic path coefficient (-0.0200) and direct positive high genotypic path coefficient (0.9237) on flower yield plant^{-1}.

4.6.3.3 Number of primary branches plant^{-1} at 120 DAT

Number of primary branches plant^{-1} at 120 DAT showed direct negative moderate phenotypic and direct positive low genotypic path coefficient (-0.2780, 0.0540) on flower yield plant^{-1}.

4.6.3.3 Number of suckers plant^{-1}

Number of suckers plant^{-1} showed direct negative low phenotypic and direct negative high genotypic path coefficient (-0.0468, -0.5672) on flower yield plant^{-1}.

4.6.3.4 Days taken to first flower bud initiation

This trait showed direct negative negligible phenotypic path coefficient (-0.0468) and direct negative low genotypic path coefficient (-01376.) on flower yield plant^{-1}.

4.6.3.5 Days taken to 50% flowering

Days taken to 50% flowering registered direct positive high phenotypic path coefficient (0.3050) and direct positive very high genotypic path coefficient (1.2942) on flower yield plant^{-1}.

4.6.3.7 Days taken to first harvest

Days taken to first harvest showed direct negative negligible phenotypic path coefficient (-0.0398) and direct negative negligible genotypic path coefficient (-0.0016) on flower plant^{-1}.

4.6.3.5 Number of flowers spray^{-1}

This trait showed direct positive low phenotypic (0.1504) and direct negative low genotypic path coefficients (-0.1866) on flower yield plant^{-1}.

4.6.3.6 Number of flowers plant^{-1}

This character had direct positive high phenotypic and direct negative high genotypic path coefficients (0.8297, -0.6323) on flower yield plant^{-1}.

4.6.3.7 Spray length (cm)

Spray length exhibited negligible direct negative phenotypic path coefficient (-0.0523) and high direct negative genotypic path coefficient (-0.5869) on flower yield plant^{-1}.

4.6.3.10 Flower diameter (cm)

Flower diameter exerted direct positive high phenotypic path coefficient (0.3231) and direct positive high genotypic path coefficient (0.4030) on flower yield plant^{-1}.

4.6.3.11 Flower weight (g)

Flower weight showed direct positive low phenotypic path coefficient (0.1600) and direct positive high genotypic path coefficient (0.6178) on flower yield plant^{-1}.

4.6.3.12 Duration of flowering

Duration of flowering had direct negative negligible phenotypic and direct positive very high genotypic path coefficients (-0.0137, 1.2704) on flower yield plant^{-1}.

4.6.3.12 Incidence of Disease

Incidence of disease had direct positive low phenotypic path coefficient (0.1125) and direct positive high genotypic path coefficient (0.7421) on flower yield plant^{-1}.

4.6.3.13 Incidence of pest

Incidence of pest showed direct positive low phenotypic path coefficient (0.1047) and direct negative high genotypic path coefficient (-0.6394) on flower yield plant^{-1}.

INDIRECT EFFECTS

Plant height at 120 DAT had high positive genotypic indirect effect on flower yield plant^{-1} through number of primary branches plant^{-1} at 120 DAT (0.3062), spray length

(0.6553), incidence of pest (0.3804). Moderate positive genotypic effect through flower diameter (0.2851) and negative through days taken to first harvest (-0.2410).Indirect low positive genotypic through plant spread at 120 DAT (0.1020), days taken to first flower bud initiation (0.1554), incidence of disease (0.1680) and negative through days taken to 50% flowering (-0.1242), number of flowers plant^{-1} (-0.1404) and flowering duration (-0.1262). While it exerted low positive indirect effects through spray length (0.1056) and showed negligible indirect effects through all other characters at phenotypic level.

Plant spread at 120 DAT imparted high positive indirect genotypic effect on flower yield plant^{-1} through number of primary branches plant^{-1} at 120 DAT (0.6856), number of suckers plant^{-1} (0.793) days taken to 50% flowering (0.4255), days taken to first harvest (0.3764), number of flowers spray^{-1} (0.9255), number of flowers plant^{-1} (0.6389), flower diameter (0.3276), flower weight (0.3779) and negative through disease incidence (-0.6120). Moderate positive genotypic effects through days taken to first flower bud initiation (0.2600), spray length (0.2241) and low positive genotypic effect through plant height at 120 DAT(0.1268), flowering duration (0.1962) and negative through incidence of pest (-0.1451). Whereas indirect effects through all other characters were negligible at phenotypic level.

Number of primary branches plant^{-1} at 120 DAT recorded low negative indirect phenotypic effect on flower yield plant^{-1} through plant spread at 120 DAT (-0.1631), number of suckers plant^{-1} (-0.1314), days taken to first flower bud initiation (-0.1067), number of flowers plant^{-1} (-0.1940), spray length (-0.1506), flower diameter (-0.1431), flower weight (-0.1459). Its indirect effect through all characters was negligible at genotypic level.

It was observed that number of suckers per plant had high negative indirect genotypic effect on flower yield plant^{-1} via plant spread at 120 DAT(-0.3031), number of primary branches plant^{-1} at 120 DAT (-0.3031), number of flowers spray^{-1} (-0.4553), number of flowers plant^{-1} (-0.3381). Moderate negative genotypic effect through days taken to first flower bud initiation (-0.2134), days taken to 50% flowering (-0.2672), days taken to first harvest (-0.2335), flower diameter (-0.2462), flower weight (-0.2836) and its indirect low negative genotypic effect through flowering duration (-0.1252).

Days taken to first flower bud initiation showed low negative indirect effect on flower yield plant^{-1} through days taken to 50% flowering (-0.1321,-0.1346), days taken to first harvest (-0.1396,-0.1207) both at phenotypic and genotypic level.

At genotypic level high positive and negative effects shown by days taken to 50% flowering on flower yield per plant through plant spread at 120DAT (0.5962), number

of primary branches at 120 DAT (0.4418), number of suckers plant^{-1} (0.6097), number of flowers spray^{-1} (0.8572), number of flowers plant^{-1} (0.3443), flower diameter (-0.3711), flowering duration (-0.7488), incidence of disease (-0.5136) and incidence of pest (-0.7739). Indirect low negative genotypic effect observed through flower weight (-0.1174). Whereas it is showed indirect moderate phenotypic effect on flower yield plant^{-1} through days taken to first flower bud initiation (0.2207), days taken to first harvest (0.2376). Indirect low positive and negative phenotypic observed through number of suckers plant^{-1} (0.1158), number of flowers spray^{-1} (0.16900) and flowering duration (-0.1341), disease incidence (-0.1002), pest incidence (-0.1229).

Days taken to first harvest showed indirect effect on flower yield plant^{-1} through all other characters were negligible both at genotypic and phenotypic level.

Number of flowers spray^{-1} imparted low negative indirect genotypic effect on flower yield per plant through plant spread at 120 DAT (-0.1870), number of primary branches at 120 DAT (-0.1515) number of suckers plant^{-1} (-0.1491), days taken to first flower bud initiation (-0.1155), days taken to 50% flowering (-0.1236), days taken to first harvest (-0.1269) and number of flowers plant^{-1} (-0.1284). Indirect low phenotypic effects were observed through plant spread at 120 DAT (0.1045) and number of suckers plant^{-1}(0.1040).

Highest negative indirect genotypic effect was shown by number of flowers plant^{-1} on flower yield plant^{-1} observed through number of primary branches plant^{-1} at 120 DAT (-0.5002), plant spread at 120DAT (-0.4374), number of suckers plant^{-1} (-0.3769), number of flowers spray^{-1} (-0.4352), flower diameter (-0.3602), flower weight (-0.4779) and flowering duration (-0.3195). Moderate positive genotypic effect was observed through incidence of pest (0.2062) and low negative through days taken to first harvest (-0.1851). Indirect negative genotypic effects was observed with days taken to first flower bud initiation (-0.1409), days taken to 50% flowering (-0.1682) and low positive genotypic effect through plant height at 120 DAT (0.1196).

Spray length showed high negative indirect genotypic effect on flower yield plant^{-1} through plant height at 120DAT (-0.5718), number of primary branches plant^{-1} at 120 DAT (-0.3682). Moderate negative genotypic effects through number of suckers plant^{-1} (-0.2516), days taken to first flower bud initiation (-0.2418), number of flowers spray^{-1} (-0.2365) and disease incidence (-0.2115).

Highest positive indirect genotypic effect was shown by flower diameter on flower yield per plant via flower weight (0.3888). Indirect moderate positive genotypic effect was observed through number of primary branches plant^{-1} (0.2342), number of flowers plant^{-1} (0.2296) and flowering duration (0.226). Indirect positive low genotypic effect through plant height at 120 DAT (0.1547), plant spread at 120 DAT

(0.1429), number of suckers plant^{-1} (0.1749) and negative through days taken to 50% flowering (-0.1156).

At genotypic level flower weight showed high positive indirect effect on flower yield plant^{-1} through number of primary branches plant^{-1} (0.3954), number of suckers plant^{-1} (0.3089), number of flowers plant^{-1} (0.4670), spray length (0.1576), flower diameter (0.5960), flowering duration (0.3353) and moderate positive effect through plant spread at 120 DAT (0.2527), low positive effect through number of flowers spray^{-1} (0.1156) and low negative effect observed through incidence of disease (-0.1170).

Duration of flowering exhibited high positive indirect genotypic effect on flower yield plant^{-1} through flower diameter (0.7018), flower weight (0.6895) and high negative effect through days taken to first flower bud initiation(-0.8445), days to 50% lowering(-0.7351), days taken to first harvest(-0.7619). Moderate positive effect recorded through plant spread at 120DAT (0.2699), number of suckers plant^{-1} (0.2805) and moderate negative effect through plant height at 120DAT (-0.2159) at genotypic level. Whereas indirect low positive genotypic effect through number of primary branches plant^{-1} at 120 DAT (0.1339).

Incidence of disease showed high positive indirect effect on flower yield plant^{-1} through incidence of pest (0.3226) and high negative effect through plant spread at 120 DAT (-0.4917), number of suckers plant^{-1}(-0.3684), days taken to first harvest (-0.3331), flowers per spray (-0.3559) and moderate positive and negative effect through spray length (0.2675) and days taken to 50% flowering (-0.2945), flowers per plant (-0.2293) at genotypic level. Low positive indirect genotypic effect observed through plant height at 120 DAT (0.1679) and negative low genotypic effect through days taken to first flower bud initiation (-0.1178) and flower weight (-0.1405).

At genotypic level incidence of pest showed high positive indirect effect on flower yield per plant through days taken to first flower bud initiation (0.03210), days to 50% flowering (0.3823), days taken to first harvest (0.3920) and high negative effect through plant height at 120 DAT (-0.3275). Moderate positive genotypic effect was observed through number of flowers spray^{-1} (0.2011), number of flowers plant^{-1} (0.2086) and moderate negative genotypic effect through incidence of disease (-0.2779). Whereas low negative genotypic effect was observed through duration of flowering (-0.1853) and low positive effect through plant spread at 120 DAT (0.1004), number of suckers plant^{-1} (0.1007).

The path analysis unravels whether the association of the component characters with yield is due to their direct effect on yield, or is a consequence of their indirect effect via some other trait(s). Thus path analysis helps in partitioning the genotypic correlation coefficient into direct and indirect effects of the component characters on

the yield on the basis of which improvement programs can be devised effectively. If the correlation between yield and any of its components is due to the direct effect, it reflects a true relation between them and selection can be practiced for such a character in order to improve yield. But if the correlation is mainly due to indirect effect of the character another component trait, the breeder has to select the latter trait through which the indirect effect is exerted.

The study of direct effect showed that number of flowers plant^{-1}, flower diameter, and flower weight exhibited considerable positive effects on flower yield plant^{-1} whereas negative effects on flower yield were observed with plant height at 120 DAT, number of primary branches plant^{-1}, number of suckers plant^{-1}, days taken to first flower bud initiation, days taken to first harvest, spray length, flowering duration. At genotypic level flowering duration and at phenotypic level number of flowers plant^{-1} recorded highest positive direct effect with yield, whereas duration of flowering recorded highest indirect negative genotypic path coefficient with yield.

Results indicated that the first ranking components of flower yield in chrysanthemum were number flowers plant^{-1}, duration of flowering, flower weight as these characters directly influenced flower yield. Similar observations were reported in chrysanthemum by Sirohi and Behera (1999), Deka and Paswan (2002), Pal and George (2002), Bhaskaran *et al.* (2004) and Kumar *et al.* (2012).

Chapter-V

Summary and Conclusions

CHAPTER V

SUMMARY AND CONCLUSIONS

The present investigation entitled **"Evaluation of Chrysanthemum (*Dendranthema grandiflora* Tzvelev.) cultivars for growth, yield and storage life under open field conditions"** was undertaken to find out suitable cultivar along with better storage life for Anantharajupet conditions.

The experiment was carried out in a Randomized Block Design with 3 replications in Kharif season of 2012 at Horticulture College and Research institute, Anantharajupet, Dr. Y.S.R. Horticultural University, Andhra Pradesh, comprising 12 cultivars along with one check (Chandini) obtained from different sources. Observations were

recorded for various growth yield and storage characters. Data was subjected to standard statistical analysis and the results obtained are summarized in the present chapter.

Plant height of the cultivars varied significantly in at all the stages of crop growth *i.e.* at 30, 60, 90 and 120 DAT, the plants of Geethanjali recorded maximum plant height (26.07, 42.28, 53.63, 58.31cm).

All the cultivars varied significantly with respect to plant spread and number of primary branches. Maximum plant spread (8.73, 17.20, 28.08, 29.99 cm) and numbers of primary branches plant^{-1} (5.96, 10.87, 14.97, 16.30) was observed in the cultivar PAU-B-107 at all the stages of the crop growth *i.e.* at 30, 60, 90 and 120 DAT and maximum number of suckers plant^{-1} observed in cv.PAU-B-107 (21.50) and minimum with cv.Yellow Double (2.00).

Significant variations were observed for floral characters, among cultivars the cv.Co-3 was early to first flower bud initiation (63.33 days) and days taken to 50% flowering (93.00 days) whereas cv.PAU-B-107 was late to flower (97.00) and cv.Shanthi has taken more number of days taken to 50% flowering (136.00 days). Duration of flowering was maximum for cv.Co-3 (71.83 days) and minimum for cv.Pusa Semidouble (39.00 days).

The cv.Co-3 recorded lowest number of days taken to first harvest (112.33 days). Maximum number of flowers spray^{-1} (16.50) and number of flowers plant^{-1} (169.33) were recorded by the cultivar PAU-B-107. The minimum number of flowers spray^{-1} and number of flowersplant^{-1} was recorded by cv.Yellow Double (5.60) and cv.White Double (61.13). Spray length was maximum in cv.Geethanjali (25.23 cm) followed by cv.Raichur (25.10 cm). Maximum flower diameter was observed with the cultivars Co-3 (5.90 cm), PAU-B-107 (5.73 cm) and minimum with cv.Pusa Semidouble (2.40 cm). Maximum flower weight was recorded in cv.PAU-B-107 (5.40 g) followed by cv.Co-3 (5.18 g).

Among thirteen cultivars of chrysanthemum evaluated, seven were found yellow in colour, three were white in colour and remaining three are lemon yellow, pinkish cream and yellowish brown in colour.

Regarding the yield characters, cv.PAU-B-107 recorded maximum flower yield plant^{-1} (293.33 g) and yield plot^{-1} (10.56 kg) and yield hectare^{-1} (264 q) due to production of more number of flowers plant^{-1}.

All the cultivars tested had better storage life with three different packing materials viz., gunny bags, bamboo baskets and 200 gauge polyethylene bags. Among thirteen cultivars, cv.PAU-B-107 recorded maximum number of days taken to 50% flowers

wilting with gunny bag (3.33 days), bamboo basket (4.33 days) and 200 gauge polyethylene bag (6.67 days) followed by cv.Rajamundry (3.00 days, 3.67 days, 5.87 days) and minimum was in cv.Yellow Double (1.67 days, 2.30 days and 3.33 days).

Among thirteen cultivars, by the third day cv.PAU-B-107 was recorded minimum physiological weight with gunny bags (11.95 %), followed by Cultivars Co-3 (12.33 %), Chandini (12.70 %) and maximum was in cv.Yellow Double (17.80%). By fourth day cv.PAU-B-107 was recorded minimum physiological weight with bamboo baskets (6.40 %) followed by cv.Co-3 (7.20 %). With 200 gauge polyethylene bag, by the seventh day the minimum physiological weight was recorded by cv.PAU-B-107 (2.00 %), cv.Chandini (2.20 %) and cv.Rajamundry (2.40 %) .

Regarding the incidence of pests and diseases, minimum bud borer incidence was observed in cv.PAU-B-107 (0.67) followed by cv.Rajamundry (0.93). Similarly minimum leaf blight disease observed in cv.PAU-B-107 (5 %).

Among the different cultivars, significantly higher flower yield was recorded in cv.PAU-B-107 (264 q ha^{-1}) which resulted into maximum net returns (Rs 2,67,510 ha^{-1}) and B:C ratio (2.08) followed by cv.CO-3 (248.33 q ha^{-1}) with net returns of Rs 2,44,005 ha^{-1} and B:C ratio of 1.90. Flower yield (86.92 q ha^{-1}), net returns (Rs 1,890) and B:C ratio (0.01) was low in cv.Yellow Double.

Number of flowers $plant^{-1}$, spray length (cm), flower diameter (cm), number of flowers $spray^{-1}$, flower weight (g) and flower yield $plant^{-1}$ (g) had high PCV, GCV, heritability and genetic advance as percent of mean where in improvement in these characters can be brought through simple selection programme.

In correlation studies, for most of the characters genotypic correlation coefficients were higher than phenotypic correlation coefficients indicating lesser phenotypic expression under the influence of environment. Number of flowers $plant^{-1}$, flower diameter (cm), flower weight (g), flowering duration (days), number of flowers $spray^{-1}$, plant spread at 120 DAT, number of primary branches $plant^{-1}$ at 120 DAT and number of suckers $plant^{-1}$ showed significant positive correlation with yield both at phenotypic and genotypic level suggesting good scope for improvement of yield.

In Path coefficient analysis, the first ranking components of flower yield in chrysanthemum were flowering duration (days), number of flowers $plant^{-1}$ and flower weight (g) as these characters directly influenced the flower yield

From the present investigation it was concluded that the chrysanthemum cultivars PAU-B-107, Co-3 and Pusa Anmol were found to be promising regarding growth and yield characters while PAU-B-107 and Rajamundry lasts better storage in 200 gauge

polyethylene bag packing than the other cultivars and the same cultivars may be recommended for commercial cultivation under open field conditions of local region.

Further there is a need to standardize the necessary techniques to improve flower yield by adopting various improved agro techniques and postharvest management practices.

Table 4.17. Estimation of variability, heritability and genetic advance as percent of mean for different characters in cultivars of chrysanthemum

Characters	Range		Variance		Coefficient of variation (%)		Heritability (%)	Genetic Advance	Genetic Adavance as per cent of mean
	Minimum	Maximum	Phenotypic	Genotypic	PCV	GCV			
Plant height at 120 DAT (cm)	42.73	58.31	39.59	21.75	12.43	9.22	54.94	7.12	14.07
Plant spread at 120 DAT (cm)	19.20	29.99	12.73	8.72	14.71	12.18	68.56	5.04	20.78
No. of primary branches plant^{-1} at 120 DAT	8.85	16.30	4.45	3.44	16.81	14.78	77.27	3.36	26.76
No. of suckers plant^{-1}	2.00	21.50	48.88	47.84	57.68	57.07	97.88	14.10	116.31
Days to first flower bud initiation	63.33	97.00	162.19	117.91	15.33	13.07	72.27	19.07	22.95
Days to 50 % flowering	93.00	136.00	269.29	179.51	14.14	11.55	66.66	22.53	19.42
Days taken to first harvest	90.67	130.33	255.49	175.02	14.40	11.92	68.50	22.56	20.32
Number of flowers spray^{-1}	5.60	16.50	13.86	10.89	32.45	28.76	78.55	6.02	52.51
Number of flowers plant^{-1}	61.13	169.33	1267.66	1185.47	32.03	30.97	93.52	68.59	61.70
Spray length (cm)	6.63	25.23	42.40	39.43	36.82	35.51	92.99	12.47	70.54
Flower diameter (cm)	2.40	5.90	1.08	0.96	24.85	23.46	89.11	1.91	45.61
Flower weight (g)	1.30	5.40	2.06	1.96	49.34	48.15	95.22	2.8	96.78
Duration of flowering (days)	39.00	71.83	119.85	102.47	21.51	19.89	85.50	19.28	37.89
Disease incidence	5.00	38.00	71.31	67.68	37.26	36.29	94.90	16.51	72.84
Pest incidence	0.67	2.17	0.25	0.20	39.28	34.74	78.23	0.81	63.30
Flower yield plant^{-1} (g)	96.67	293.33	4806.46	4120.49	37.20	34.44	85.73	122.43	65.69
Flower yield plot^{-1} (kg)	3.48	10.56	6.23	5.34	37.21	34.45	85.07	4.41	65.71
Flower yield hectare^{-1} (q)	86.92	264.00	3894.81	3338.68	37.21	34.45	85.72	110.20	65.61

Character	Plant height at 120 DAT	Plant spread at 120DAT	Primary Branches At 120 DAT	Suckers plant^{-1}	First Flower Bud Initiation	Days to 50% Flowering	Days to 1st harvest	Flowers Spray^{-1}	Flowers Plant^{-1}	Spray Length	Flower Diameter	Flower Weight	Flowering Duration	Disease Incidence	Pest Incidence	Flower yield plant^{-1}

Table 4.18a. Genotypic correlation matrix among different characters in Cultivars of Chrysanthemum

Plant Height At 120 DAT	1.0000	0.1373	0.4123	0.1031	0.2092	-0.1672	-0.3244	0.0973	-0.1891	0.8823**	0.3838*	0.0644	-0.1700	0.2262	0.5122	-0.0088
Plant Spread At 120 DAT		1.0000	0.7423**	0.8587**	0.2815	0.4606*	0.4075	1.0020**	0.6917**	0.2426	0.3547	0.4091*	0.2125	-0.6626**	-0.1571	0.6430**
Primary Branches At 120 DAT			1.0000	0.5344**	0.4420*	0.3414	0.2952*	0.8120**	0.7911**	0.6274**	0.6033**	0.6400	0.1054	-0.0959	-0.0235	0.8196**
Suckers Plant^{-1}				1.0000	0.3762*	0.4711*	0.4469*	0.7991**	0.5961**	0.4287**	0.4340**	0.5000	0.2208	-0.4965**	-0.1575	0.6075**
First Flower Bud Initiation					1.0000	0.9786**	0.8772**	0.6191**	0.2228	0.4120*	-0.2188	-0.0406	-0.6648**	-0.1588	-0.5021**	0.1007
Days to 50% Flowering						1.0000	1.1148**	0.6624**	0.2661	0.0723	-0.2868	-0.0907	-0.5786**	-0.3969*	-0.5980*	0.0572
Days to 1st harvest							1.0000	0.6803**	0.2927	-0.0019*	-0.2435	0.0530	-0.5997**	-0.4488	-0.6131**	0.1391
Flowers Spray^{-1}								1.0000	0.6884**	0.4030	0.1142	0.1872	-0.0242	-0.4796**	-0.3146	0.4770**
Flowers Plant^{-1}									1.0000	0.2092	0.5697**	0.7559	0.5053**	-0.3090	-0.3262	0.9506**
Spray Length										1.0000	0.4419**	0.2551	0.0059	0.3604*	0.3011	0.3308
Flower Diameter											1.0000	0.9646	0.5524**	-0.0932	0.3413	0.8310**
Flower Weight												1.0000	0.5427**	-0.1893	0.0724	0.9114**
Flowering Duration													1.0000	0.0428	0.2898	0.6505**
Disease incidence														1.0000	0.4347*	-0.2212
Pest incidence															1.0000	- 0.0586

*Significant at 5 per cent level; ** Significant at 1 per cent level

Table 4.18b. Phenotypic correlation matrix among different characters in cultivars of chrysanthemum

Character	Plant height at 120 DAT	Plant spread at 120DAT	Primary Branches At 120 DAT	Suckers plant^{-1}	First Flower Bud Initiation	Days to 50% Flowering	Days to 1st harvest	Flowers Spray^{-1}	Flowers Plant^{-1}	Spray Length	Flower Diameter	Flower Weight	Flowering Duration	Disease Incidence	Pest Incidence	Flower yield plant^{-1}
Plant Height At 120 DAT	1.0000	0.0302	0.2427	0.0764	0.1312	-0.1482	-0.1743	0.0898	-0.1416	0.6301**	0.3206*	0.0269	-0.0288	0.1727	0.3093	0.0569
Plant Spread cm At 120 DAT		1.0000	0.5869**	0.7258**	0.2663	0.3248*	0.3014	0.6943**	0.5987**	0.2097	0.2758	0.3591*	0.1683	-0.5333**	-0.0927	0.4911**
Primary Branches At 120 DAT			1.0000	0.4726**	0.3838*	0.2234	0.3184*	0.5538**	0.6979**	0.5417**	0.5147**	0.5251	0.1314	-0.0703	0.0352	0.5926**
Suckers Plant^{-1}				1.0000	0.3261*	0.3795*	0.3756*	0.6916**	0.5832**	0.4108**	0.4281**	0.4734**	0.2082	-0.4828**	-0.1605	0.5679**
First Flower Bud Initiation					1.0000	0.7235**	0.7644**	0.4951**	0.1984	0.4000*	-0.0940	-0.0665	-0.5173**	-0.0617	-0.4433**	0.0332
Days to 50% Flowering						1.0000	0.7791**	0.5540**	0.1900	0.0733	-0.2476	-0.0227	-0.4397**	-0.3286*	-0.4031*	0.1110
Days to 1st harvest							1.0000	0.4127**	0.2446	0.0240	-0.1459	-0.0019	-0.4584**	-0.3153	-0.4529**	0.0566
Flowers Spray^{-1}								1.0000	0.5534**	0.3611*	0.0716	0.1950	0.0015	-0.4139**	-0.2675	0.4475**
Flowers Plant^{-1}									1.0000	0.2002	0.5307**	0.6965**	0.4502**	-0.2834	-0.2750	0.8736**
Spray Length										1.0000	0.4240**	0.2409	0.0240	0.3409*	0.2701	0.2900
Flower Diameter											1.0000	0.8488**	0.4891**	-0.0714	0.2610	0.7331**
Flower Weight												1.0000	0.4615**	-0.2009	0.0673	0.8416**
Flowering Duration													1.0000	0.0594	0.2948	0.5524**
Disease incidence														1.0000	0.3745*	-0.2142
Pest incidence															1.0000	-0.0172

*Significant at 5 per cent level; ** Significant at 1 per cent level

Table 4.19a. Genotypic path coefficient analysis among different characters in cultivars of chrysanthemum

	PHT 120 DAT	PS 120 DAT	NPB 120 DAT	SP	DFFB	DF 50%	DFH	FS	FP	SL	FD	FW	DUF	ID	IP	FYP
PHT 120 DAT	**0.7427**	0.1020	0.3062	0.0765	0.1554	-0.1242	-0.2410	0.0722	-0.1404	0.6553	0.2851	0.0478	-0.1262	0.1680	0.3804	**-0.0088**
PS 120 DAT	0.1268	**0.9237**	0.6856	0.7931	0.2600	0.4255	0.3764	0.9255	0.6389	0.2241	0.3276	0.3779	0.1962	-0.6120	-0.1451	**0.6430**
NPB 120 DAT	0.0222	0.0401	**0.0540**	0.0288	0.0238	0.0184	0.0159	0.0438	0.0427	0.0339	0.0326	0.0345	0.0057	-0.0052	-0.0013	**0.8196**
SP	-0.0585	-0.4871	-0.3031	**-0.5672**	-0.2134	-0.2672	-0.2535	-0.4533	-0.3381	-0.2432	-0.2462	-0.2836	-0.1252	0.2816	0.0893	**0.6075**
DFFB	-0.0288	-0.0387	-0.0608	-0.0518	**-0.1376**	-0.1346	-0.1207	-0.0852	-0.0307	-0.0567	0.0301	0.0056	0.0915	0.0218	0.0691	**0.1007**
DF 50%	-0.2164	0.5962	0.4418	0.6097	1.2666	**1.2942**	1.4428	0.8572	0.3443	0.0936	-0.3711	-0.1174	-0.7488	-0.5136	-0.7739	**0.0572**
DFH	0.0005	-0.0006	-0.0005	-0.0007	-0.0014	-0.0018	**-0.0016**	-0.0011	-0.0005	0.0000	0.0004	-0.0001	0.0009	0.0007	0.0010	**0.1391**
FS	-0.0181	-0.1870	-0.1515	-0.1491	-0.1155	-0.1236	-0.1269	**-0.1866**	-0.1284	-0.0752	-0.0213	-0.0349	0.0045	0.0895	0.0587	**0.4770**
FP	0.1196	-0.4374	-0.5002	-0.3769	-0.1409	-0.1682	-0.1851	-0.4352	**-0.6323**	-0.1323	-0.3602	-0.4779	-0.3195	0.1954	0.2062	**0.9506**
SL	-0.5178	-0.1424	-0.3682	-0.2516	-0.2418	-0.0424	0.0011	-0.2365	-0.1228	**-0.5869**	-0.2594	-0.1497	-0.0035	-0.2115	-0.1767	**0.3308**
FD	0.1547	0.1429	0.2432	0.1749	-0.0882	-0.1156	-0.0981	0.0460	0.2296	0.1781	**0.4030**	0.3888	0.2226	-0.0375	0.1376	**0.8310**
FW	0.0398	0.2527	0.3954	0.3089	-0.0251	-0.0560	0.0327	0.1156	0.4670	0.1576	0.5960	**0.6178**	0.3353	-0.1170	0.0447	**0.9114**
DUF	-0.2159	0.2699	0.1339	0.2805	-0.8445	-0.7351	-0.7619	-0.0308	0.6419	0.0075	0.7018	0.6895	**1.2704**	0.0544	0.3681	**0.6505**
ID	0.1679	-0.4917	-0.0712	-0.3684	-0.1178	-0.2945	-0.3331	-0.3559	-0.2293	0.2675	-0.0691	-0.1405	0.0318	**0.7421**	0.3226	**-0.2212**
IP	-0.3275	0.1004	0.0150	0.1007	0.3210	0.3823	0.3920	0.2011	0.2086	-0.1925	-0.2182	-0.0463	-0.1853	-0.2779	**-0.6394**	**-0.0586**

Genotypic Residual effect=-0.0605; Diagonal (under lined) values indicate direct effects; G: Genotypic

Table 4.19b. Phenotypic path coefficient analysis among different characters in cultivars of chrysanthemum

	PHT 120 DAT	PS 120 DAT	NPB 120 DAT	SP	DFFB	DF 50%	DFH	FS	FP	SL	FD	FW	DUF	ID	IP	FYP
PHT 120 DAT	**0.1677**	0.0051	0.0407	0.0128	0.0220	-0.0249	-0.0292	0.0151	-0.0237	0.1056	0.0537	0.0045	-0.0048	0.0289	0.0519	**0.0569**
PS 120 DAT	-0.0006	**-0.0200**	-0.0118	-0.0145	-0.0053	-0.0065	-0.0060	-0.0139	-0.0120	-0.0042	-0.0055	-0.0072	-0.0034	0.0107	0.0019	**0.4911**
NPB 120 DAT	-0.0675	-0.1631	**-0.2780**	-0.1314	-0.1067	-0.0621	-0.0885	-0.1539	-0.1940	-0.1506	-0.1431	-0.1459	-0.0365	0.0195	-0.0098	**0.5926**
SP	-0.0036	-0.0339	-0.0221	**-0.0468**	-0.0152	-0.0177	-0.0176	-0.0323	-0.0273	-0.0192	-0.0200	-0.0221	-0.0097	0.0226	0.0075	**0.5679**
DFFB	-0.0240	-0.0486	-0.0701	-0.0596	**-0.1826**	-0.1321	-0.1396	-0.0904	-0.0362	-0.0730	0.0172	0.0121	0.0945	0.0113	0.0810	**0.0332**
DF 50%	-0.0452	0.0991	0.0681	0.1158	0.2207	**0.3050**	0.2376	0.1690	0.0580	0.0223	-0.0755	-0.0069	-0.1341	-0.1002	-0.1229	**0.1110**
DFH	0.0069	-0.0120	-0.0127	-0.0149	-0.0304	-0.0310	**-0.0398**	-0.0164	-0.0097	-0.0010	0.0058	0.0001	0.0182	0.0125	0.0180	**0.0566**
FS	0.0135	0.1045	0.0833	0.1040	0.0745	0.0833	0.0621	**0.1504**	0.0833	0.0543	0.0108	0.0293	0.0002	-0.0623	-0.0402	**0.4475**
FP	-0.1175	0.4967	0.5790	0.4838	0.1646	0.1577	0.2029	0.4592	**0.8297**	0.1661	0.4403	0.5779	0.3735	-0.2351	-0.2282	**0.8736**
SL	-0.0329	-0.0110	-0.0283	-0.0215	-0.0209	-0.0038	-0.0013	-0.0189	-0.0105	**-0.0523**	-0.0222	-0.0126	-0.0013	-0.0178	-0.0141	**0.2900**
FD	0.1036	0.0891	0.1663	0.1383	-0.0304	-0.0800	-0.0471	0.0231	0.1715	0.1370	**0.3231**	0.2743	0.1580	-0.0231	0.0843	**0.7331**
FW	0.0043	0.0575	0.0840	0.0758	-0.0106	-0.0036	-0.0003	0.0312	0.1115	0.0386	0.1358	**0.1600**	0.0738	-0.0322	0.0108	**0.8416**
DUF	0.0004	-0.0023	-0.0018	-0.0029	0.0071	0.0060	0.0063	0.0000	-0.0062	-0.0003	-0.0067	-0.0063	**-0.0137**	-0.0008	-0.0040	**0.5524**
ID	0.0194	-0.0600	-0.0079	-0.0543	-0.0069	-0.0370	-0.0355	-0.0466	-0.0319	0.0384	-0.0080	-0.0226	0.0067	**0.1125**	0.0421	**-0.2142**
IP	0.0324	-0.0097	0.0037	-0.0168	-0.0464	-0.0422	-0.0474	-0.0280	-0.0288	0.0283	0.0273	0.0070	0.0309	0.0392	**0.1047**	**-0.0172**

Phenotypic Residual effect = 0.2258; Diagonal (under lined) values indicate direct effects, P: Phenotypic

Table 4.12. Economics of flower production of different chrysanthemum cultivars

Name of the cultivar	Flower yield hectare^{-1} (q)	Gross returns (Rs.)	Net returns (Rs.)	B:C ratio
Geethanjali	160.50	2,40,750	1,12,260	0.87
Rekha	106.50	1,59,750	31,260	0.24
Co-3	248.33	3,72,495	2,44,005	1.90
Raichur	127.50	1,91,250	62,760	0.49
Silper	146.83	2,20,245	91,755	0.71
PAU-B- 107	264.00	3,96,000	2,67,510	2.08
Pusa Anmol	214.50	3,21,750	1,93,260	1.50
Pusa Semidouble	121.67	1,82,505	54,015	0.42
Rajmundry	202.50	3,03,750	1,84,513	1.56
Shanthi	196.17	2,94,255	1,75,260	1.36
White Double	86.92	1,30,380	1,890	0.01
Yellow Double	91.83	1,37,745	9,255	0.07
Chandini	213.00	3,19,500	1,91,010	1.49

Table 4.13. Days taken to 50% flowers wilt in gunny bags, bamboo baskets, 200 gauge polyethylene bags in different chrysanthemum cultivars

Name of the cultivar	Days taken to 50% flower wilt in gunny bag	Days taken to 50% flowers wilt in bamboo basket	Days taken to 50% flowers wilt in 200 gauge polyethylene bag
Geethanjali	2.00	3.33	4.33
Rekha	2.67	3.00	3.67
CO-3	2.67	4.33	5.67
Raichur	2.33	3.33	4.67
Silper	2.33	3.33	4.67
PAU-B-107	3.33	4.33	6.67
Pusa Anmol	2.67	3.33	5.67
Pusa semiiDouble	2.33	2.33	3.67
Rajamundry	3.00	3.67	5.87
Shanthi	2.33	3.33	4.00
Yellow Double	1.67	2.30	3.33
White Double	2.00	2.33	3.67
Chandini	3.00	4.00	6.00
S.Em $\pm$	0.27	0.31	0.31
CD (P=0.05)	0.80	0.93	0.93

Table 4.14. PLW (%) in gunny bags at 1st day, 2nd day and 3rd day in different chrysanthemum cultivars

Name of the cultivar	PLW (%) in gunny bags		
	1st day	2nd day	3rd day
Geethanjali	6.00	16.00	16.00
Rekha	5.60	14.80	15.05
CO-3	4.80	9.00	12.33
Raichur	5.60	11.00	14.40
Silper	6.40	11.00	14.00
PAU-B-107	6.00	9.00	11.95
Pusa Anmol	5.60	12.00	13.95
Pusa Semidouble	6.00	15.00	17.00
Rajamundry	6.40	11.20	13.20
Shanthi	7.20	13.00	16.00
Yellow Double	6.40	15.40	17.80
White Double	7.40	15.00	17.50
Chandini	6.00	9.60	12.70
S.Em $\pm$	0.26	0.57	0.76
CD (P=0.05)	0.77	1.71	2.28

Table 4.15. PLW (%) in bamboo baskets at 1st day, 2nd day, 3rd day and 4th day in different chrysanthemum cultivars

Name of the cultivar	PLW (%) in bamboo baskets			
	1st day	2nd day	3rd day	4th day
Geethanjali	2.00	8.00	8.80	9.20
Rekha	2.40	8.00	10.40	11.00
CO-3	2.00	4.80	6.00	7.20
Raichur	2.80	8.00	10.00	10.80
Silper	2.80	7.60	9.60	8.40
PAU-B-107	2.00	4.00	6.00	6.40
Pusa Anmol	2.40	7.20	7.60	8.50
Pusa Semidouble	2.80	8.80	9.80	10.40
Rajamundry	2.40	4.80	6.00	7.20
Shanthi	2.00	7.20	9.20	9.80
Yellow Double	3.20	10.40	11.00	11.60
White Double	2.80	8.00	10.80	11.50
Chandini	2.00	4.80	6.00	7.20
S.Em $\pm$	0.26	0.36	0.42	0.40
CD (P=0.05)	0.79	1.18	1.25	1.30

Table 4.16. PLW (%) in 200 gauge Polyethylene bags at 1st day, 2nd day, 3rd day, 4th day, 5th day, 6th day and 7th day in different chrysanthemum cultivars

Name of the cultivar	PLW (%) in polyethylene bags						
	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day
Geethanjali	0.28	0.80	3.00	2.60	3.20	3.60	4.00
Rekha	0.40	1.20	2.40	3.20	3.60	4.00	4.40
CO-3	0.20	0.40	0.72	1.20	1.60	2.00	3.00
Raichur	0.36	0.44	1.32	2.40	2.80	3.00	3.40
Silper	0.72	0.96	1.92	2.40	3.00	3.20	3.60
PAU-B-107	0.32	0.80	1.20	1.52	1.60	1.90	2.00
Pusa Anmol	0.08	0.80	1.60	1.92	2.00	2.40	2.60
Pusa Semidouble	0.32	0.72	1.52	2.40	2.80	3.20	3.40
Rajamundry	0.64	1.86	2.40	2.80	1.68	2.00	2.40
Shanthi	0.40	0.68	1.12	1.40	2.40	2.60	3.00
Yellow Double	0.40	0.76	1.60	2.40	3.00	3.40	3.80
White Double	0.72	2.00	2.80	3.08	3.40	3.60	3.80
Chandini	0.40	1.12	1.44	1.60	1.64	1.98	2.20
S.Em ±	0.03	0.09	0.11	0.10	0.11	0.13	0.15
CD (P=0.05)	0.09	0.28	0.33	0.30	0.37	0.38	0.44

Table 4.2. Plant height (cm) in different chrysanthemum cultivars at different stages of growth

Name of the cultivar	Plant height (cm)			
	30 DAT	60 DAT	90 DAT	120 DAT
Geethanjali	26.07	42.28	53.63	58.31
Rekha	20.73	34.67	51.33	57.75
Co-3	16.92	31.14	48.74	51.67
Raichur	15.08	27.23	50.63	55.75
Silper	13.94	26.86	45.56	52.00
PAU-B-107	19.78	29.56	41.83	54.00
Pusa Anmol	16.00	25.09	31.12	46.00
Pusa Semidouble	12.82	22.30	28.50	42.73
Rajamundry	15.26	24.69	29.00	45.33
Shanthi	14.03	23.73	31.75	44.32
Yellow Double	11.70	22.31	29.34	47.00
White Double	13.31	22.96	31.36	48.73
Chandini	14.26	23.89	43.30	54.33
S.Em $\pm$	1.23	1.31	1.90	2.44
CD (P=0.05)	3.65	3.93	5.71	7.11

Table 4.3. Plant spread (cm) in different chrysanthemum cultivars at different stages of growth

Name of the cultivar	Plant spread (cm)			
	30 DAT	60 DAT	90 DAT	120 DAT
Geethanjali	18.38	35.76	42.33	45.12
Rekha	16.91	33.60	38.53	42.89
Co-3	15.68	30.64	35.63	38.16
Raichur	13.39	24.37	31.32	33.20
Silper	14.22	26.57	34.01	35.32
PAU-B-107	22.73	40.20	48.08	51.27
Pusa Anmol	17.39	35.12	45.76	47.39
Pusa Semidouble	19.53	37.07	46.99	48.33
Rajamundry	15.87	33.63	36.53	39.28
Shanthi	14.62	28.35	34.20	36.86
Yellow Double	10.86	23.67	29.58	30.99
White Double	11.50	25.98	30.08	32.73
Chandini	16.84	32.07	37.96	40.35
S.Em $\pm$	0.29	0.62	1.03	1.15
CD (P=0.05)	0.87	1.85	2.11	2.51

Table 4.4. Number of primary branches in different chrysanthemum cultivars at different stages of growth

Name of the cultivar	No. of primary branches plant^{-1}			
	30 DAT	60 DAT	90 DAT	120 DAT
Geethanjali	4.56	7.70	12.68	13.26
Rekha	4.35	7.30	12.14	13.00
Co-3	5.16	9.40	12.67	14.30
Raichur	3.33	6.16	10.00	12.83
Silper	3.03	6.67	10.64	12.83
PAU-B-107	5.96	10.87	14.97	16.30
Pusa Anmol	4.27	5.73	10.67	12.35
Pusa Semidouble	4.30	7.53	12.05	13.50
Rajamundry	4.23	5.40	10.56	11.59
Shanthi	3.90	5.67	11.30	12.33
Yellow Double	2.42	4.96	7.23	8.85
White Double	2.84	5.55	8.30	9.33
Chandini	4.20	6.93	12.86	13.67
S.Em $\pm$	0.29	0.34	0.53	0.58
CD (P=0.05)	0.87	1.02	1.60	1.74

Table 4.5. Days taken to first flower bud initiation, days taken to 50% flowering and duration of flowering (days) in different chrysanthemum cultivars

Name of the cultivar	Days taken to first flower bud initiation	Days taken to 50% flowering	Duration of flowering (days)
Geethanjali	83.33	112.67	48.00
Rekha	86.33	122.33	47.33
CO-3	63.33	93.00	71.83
Raichur	93.33	110.67	40.33
Silper	86.67	116.33	41.38
PAU-B-107	97.00	133.00	44.67
Pusa Anmol	65.00	95.00	68.98
Pusa Semidouble	91.00	132.67	39.00
Rajamundry	93.00	131.00	54.08
Shanthi	90.00	136.00	52.41
Yellow Double	70.33	102.67	45.88
White Double	71.33	106.33	47.75
Chandini	89.67	116.67	60.00
SEm $\pm$	3.84	5.47	2.41
CD (P=0.05)	11.53	16.41	7.02

Table 4.6. Days taken to first harvest and Number of suckers plant^{-1} in different chrysanthemum cultivars

Name of the cultivar	Days taken to first harvest	Number of suckers plant^{-1}
Geethanjali	106.33	18.00
Rekha	112.33	16.33
CO-3	90.67	6.60
Raichur	107.67	3.60
Silper	113.33	10.20
PAU-B-107	130.33	21.50
Pusa Anmol	93.00	20.00
Pusa Semidouble	129.33	10.00
Rajamundry	127.67	20.00
Shanthi	130.00	14.00
Yellow Double	100.00	2.00
White Double	98.33	2.33
Chandini	103.00	13.00
S.Em $\pm$	4.84	0.59
CD (P=0.05)	14.51	1.76

Table 4.7. Number of flowers spray^{-1}, Number of flowers plant^{-1} and Spray length (cm) in different chrysanthemum cultivars

Name of the cultivar	Number of flowers spray^{-1}	Number of flowers plant^{-1}	Spray length (cm)
Geethanjali	13.17	89.17	25.23
Rekha	14.00	75.00	23.67
CO-3	9.17	141.00	17.83
Raichur	10.00	98.83	25.10
Silper	7.93	85.00	22.83
PAU-B-107	16.50	169.33	19.80
Pusa Anmol	12.67	146.00	17.03
Pusa Semidouble	15.67	119.00	10.73
Rajamundry	11.67	131.33	16.00
Shanthi	13.27	129.33	15.33
Yellow Double	5.60	62.00	7.40
White Double	6.20	61.13	6.63
Chandini	14.33	138.00	22.30
S.Em $\pm$	1.06	5.23	1.00
CD (P=0.05)	3.17	15.70	2.99

Table 4.8. Flower diameter (cm) and Flower weight (g) in different chrysanthemum cultivars

Name of the cultivar	Flower diameter (cm)	Flower weight (g)
Geethanjali	4.83	2.75
Rekha	3.50	1.42
CO-3	5.90	5.18
Raichur	3.80	2.00
Silper	4.53	3.33
PAU-B-107	5.73	5.40
Pusa Anmol	4.83	3.80
Pusa Semidouble	2.40	1.30
Rajamundry	4.53	4.37
Shanthi	3.63	2.50
Yellow Double	3.30	1.67
White Double	3.37	1.50
Chandini	4.00	2.60
SEm $\pm$	0.20	0.18
CD (P=0.05)	0.59	0.54

Table 4.9. Flower colour as per R H S C C, London in different chrysanthemum cultivars

Name of the cultivar	Flower colour as per R H S C C London
Geethanjali	4D (Lemon Yellow)
Rekha	3C (Yellow)
CO-3	175 B (Yellowish brown)
Raichur	4A (Yellow)
Silper	4C (Yellow)
PAU-B-107	NN 155 B(White)
Pusa Anmol	NN 155 C (White)
Pusa Semidouble	12 B (Yellow)
Rajmundry	NN 155 A (White)
Shanthi	70C (Pinkish cream)
Yellow Double	1D (Yellow)
White Double	166C (Yellowish white)
Chandini	8C (Yellow)

Table 4.10. Flower yield plant^{-1} (g), Flower yield plot^{-1} (kg) and Flower yield ha^{-}(q) in different chrysanthemum cultivars

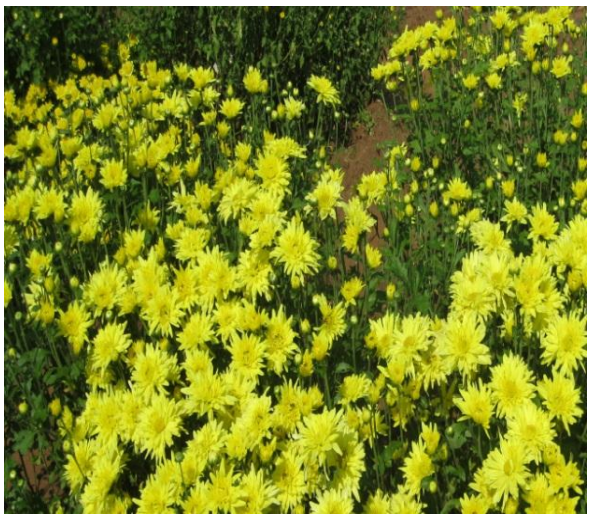
Name of the cultivar	Flower yield plant^{-1} (g)	Flower yield plot $^{-1}$(kg)	Flower yield ha^{-1} (q)
Geethanjali	178.33	6.42	160.50
Rekha	118.33	4.26	106.50
CO-3	276.00	9.93	248.33
Raichur	141.67	5.10	127.50
Silper	163.33	5.87	146.83
PAU-B-107	293.33	10.56	264.00
Pusa Anmol	238.33	8.58	214.50
Pusa semidouble	135.33	4.87	121.67
Rajamundry	225.00	8.10	202.50
Shanthi	218.00	7.85	196.17
Yellow Double	96.67	3.48	86.92
White Double	102.00	3.67	91.83
Chandini	236.67	8.52	213.00
S.Em $\pm$	15.12	0.54	13.62
CD (P=0.05)	45.36	1.63	40.85

Table 4.11. Number of larvae plant^{-1} (*Spodoptera litura*) and per cent disease index (*Alternaria alternata*) in different chrysanthemum cultivars

Name of the cultivar	Number of larvae plant^{-1}	Per cent disease index (%)
Geethanjali	2.13(1.73)	19.67(26.26)
Rekha	1.50(1.23)	22.00(27.95)
CO-3	2.17(1.83)	30.00(33.19)
Raichur	0.97(2.39)	34.00(35.65)
Silper	1.60(2.12)	38.00(38.04)
PAU-B-107	0.67(1.25)	5.00(12.74)
Pusa Anmol	1.07(1.00)	20.00(26.55)
Pusa Semidouble	0.97(1.68)	20.00(26.55)
Rajamundry	0.93(1.58)	18.00(25.08)
Shanthi	1.00(1.25)	21.00(27.23)
Yellow Double	1.47(1.10)	19.00(25.83)
White Double	1.00(1.25)	20.00(26.51)
Chandini	1.20(1.00)	28.00(31.93)
S.Em $\pm$	0.04	0.85
CD (P=0.05)	0.14	2.51

Figures in parentheses are square root transformed values (Number of larvae plant^{-1}) and Angular transformed values (PDI)

General view of experimental plot



cv.Geethanjali

cv.Rekha

cv.Co-3

cv.Raichur

2. Chrysanthemum cultivars used for the study

cv.Silper

cv.PAU-B-107

cv.Pusa Anmol

cv.Pusa Semidouble

3. Chrysanthemum cultivars used for the study

cv.Rajamundry

cv.Shanthi

cv.Yellow Double

cv.White Double

cv.Chandini

4. Chrysanthemum cultivars used for the study

Gunny bag packing

Bamboo basket packing

200 gauge Polyethylene bag packing

5. Storage study of cultivar PAU-B-107 flowers with different packing materials

cv. Geethanjali

cv. Rekha

cv. CO-3

cv. Raichur

cv. Silper

cv. PAUB-107

2. Chrysanthemum cultivars used for the study

cv. PusaAnmol

cv. PusaSemidouble

cv. Rajamundry

cv. Shanthi

cv. Yellow Double

cv. White Double

cv. Chandini

3.Chrysanthemum cultivars used for the study

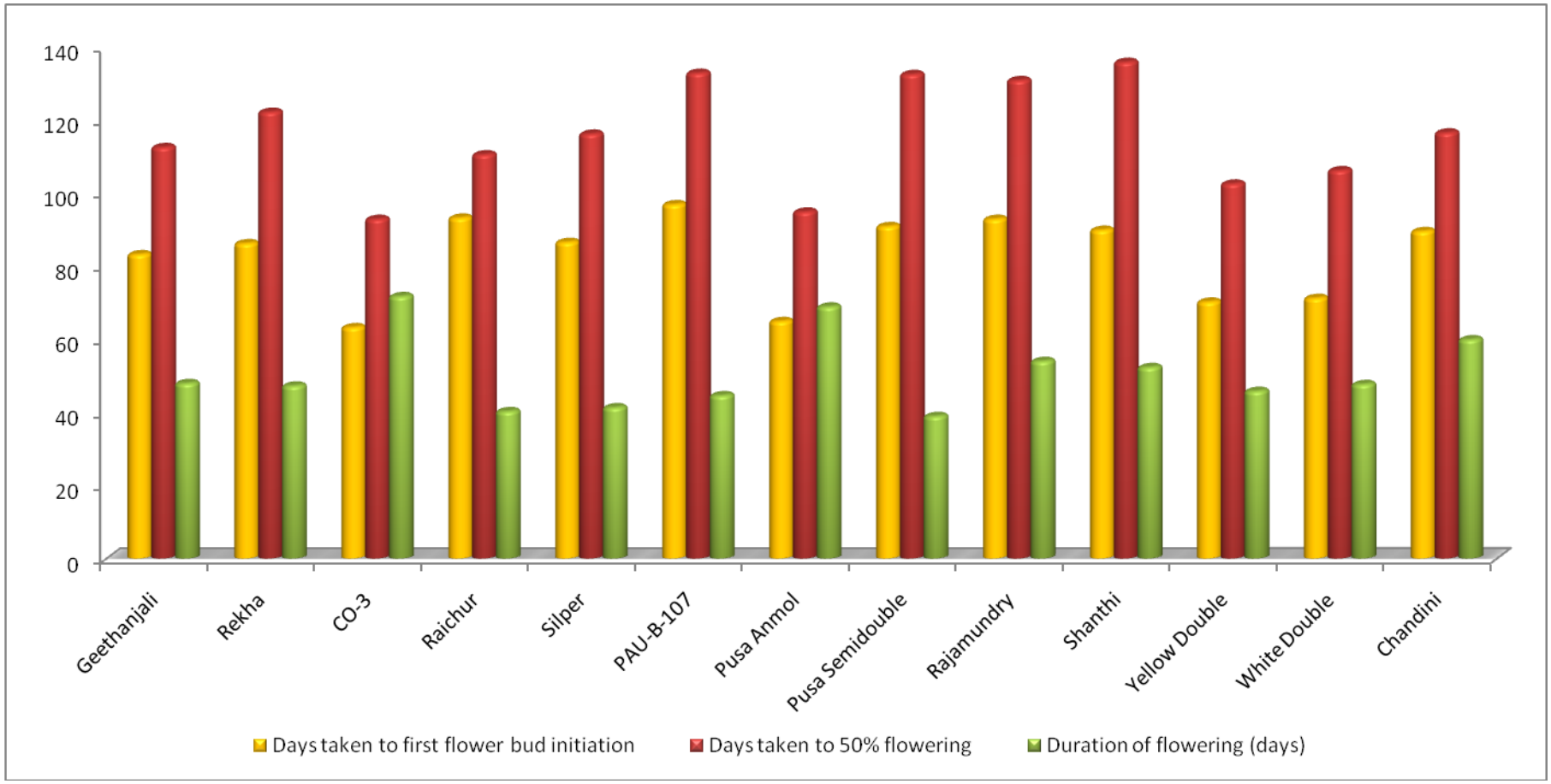


Fig. 4.5. Days taken to first flower bud initiation, days taken to 50% flowering and duration of flowering (days) in different chrysanthemum cultivars

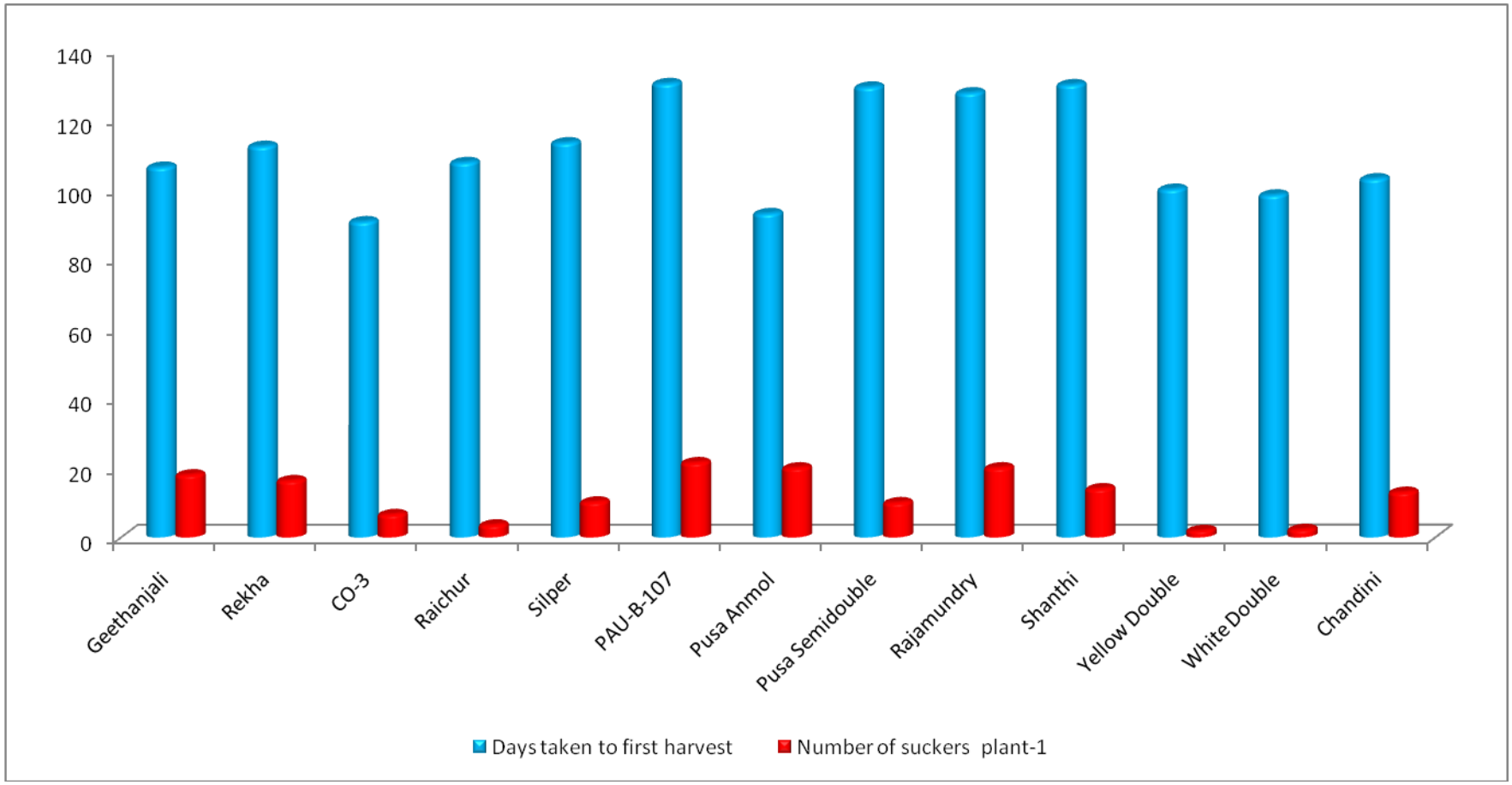


Fig. 4.6. Days taken to first harvest and number of suckers plant^{-1} in different chrysanthemum cultivars

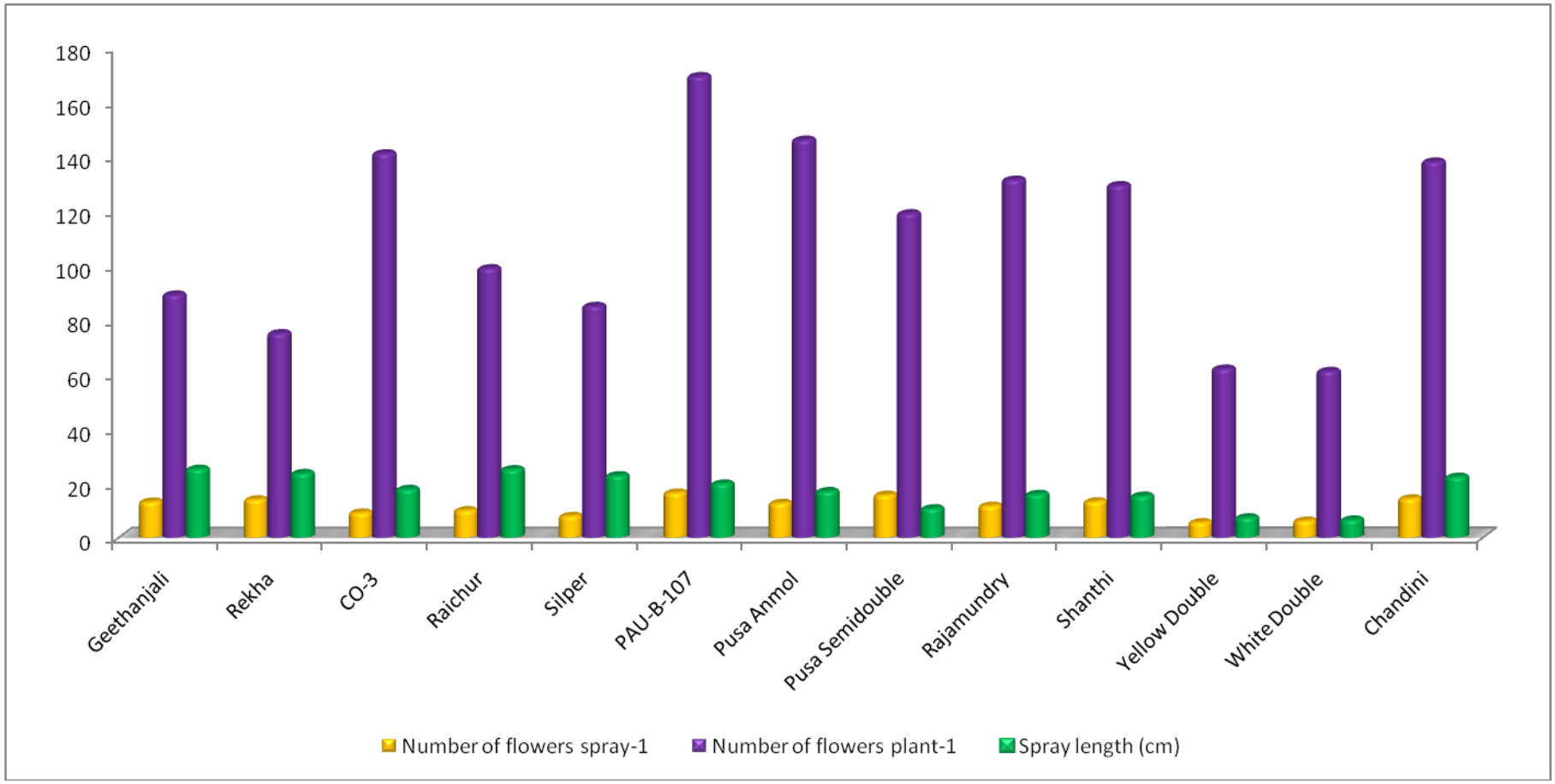


Fig.4.7. Number of flowers spray^{-1}, Number of flowers plant^{-1} and Spray length (cm) in different chrysanthemum cultivars

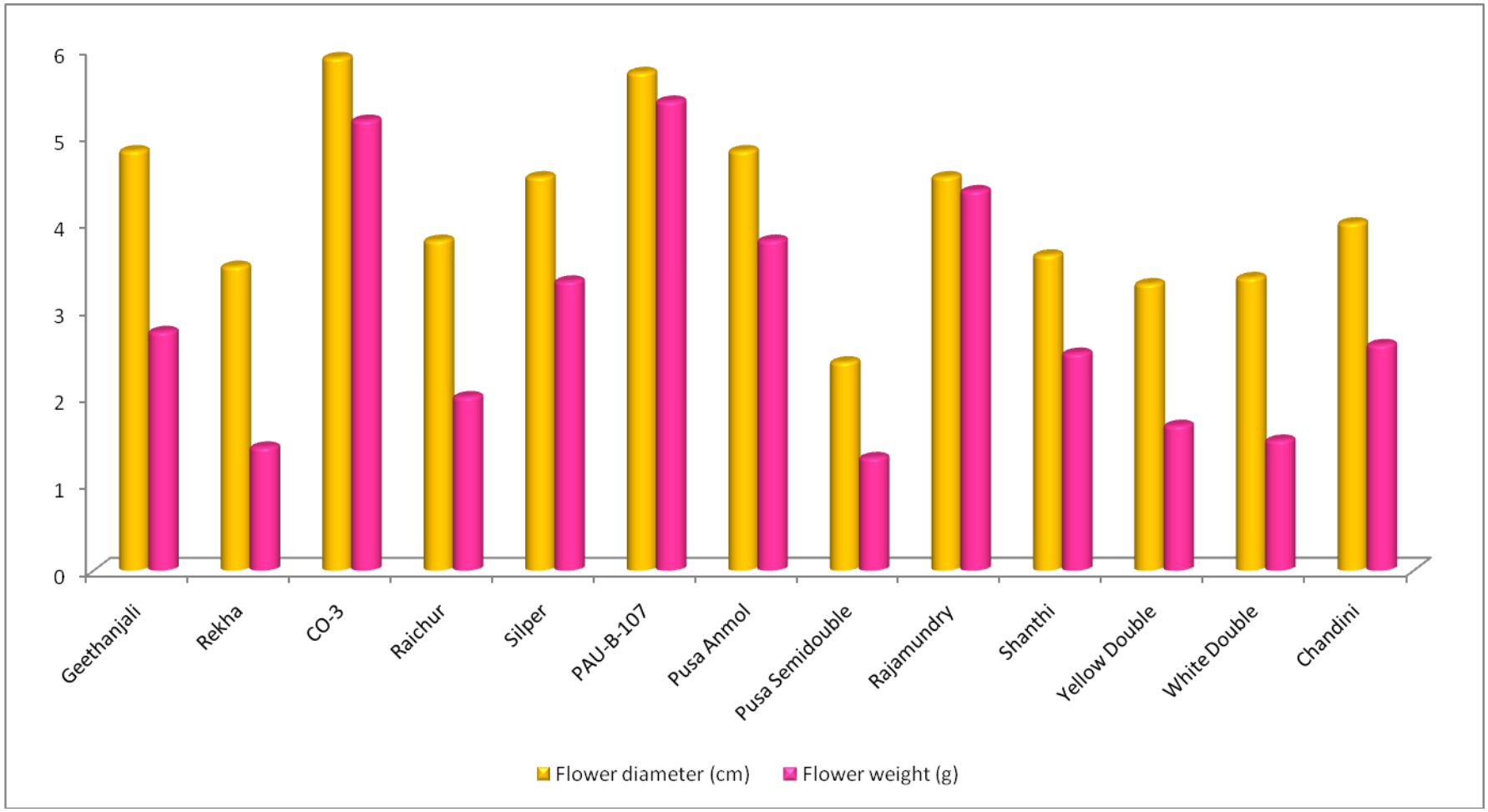


Fig. 4.8.Flower diameter (cm) and Flower weight (g) in different chrysanthemum cultivars

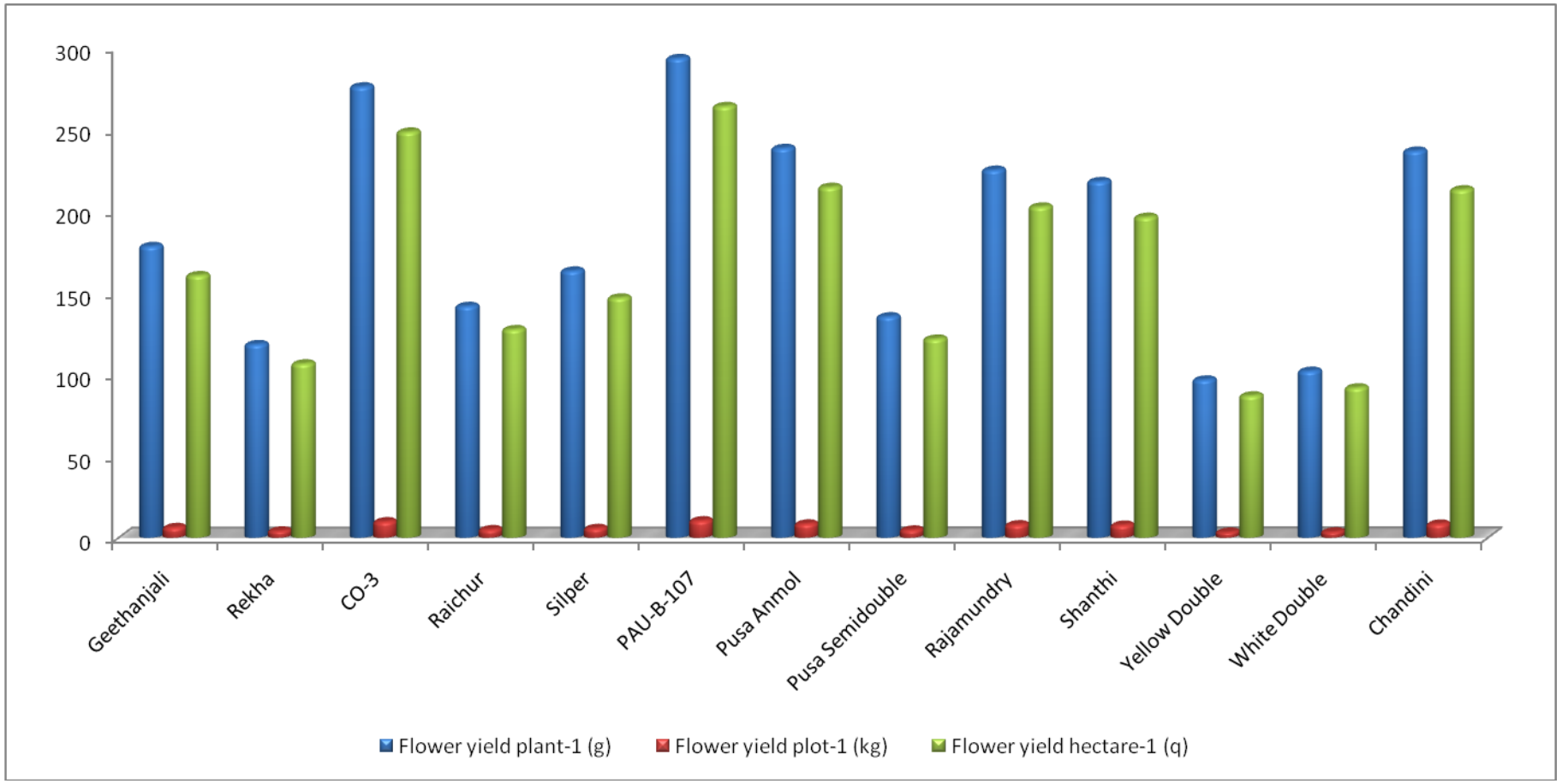


Fig. 4.9.Flower yield plant^{-1}, Flower yield plot^{-1}and Flower yield hectare^{-1} in different chrysanthemum cultivars

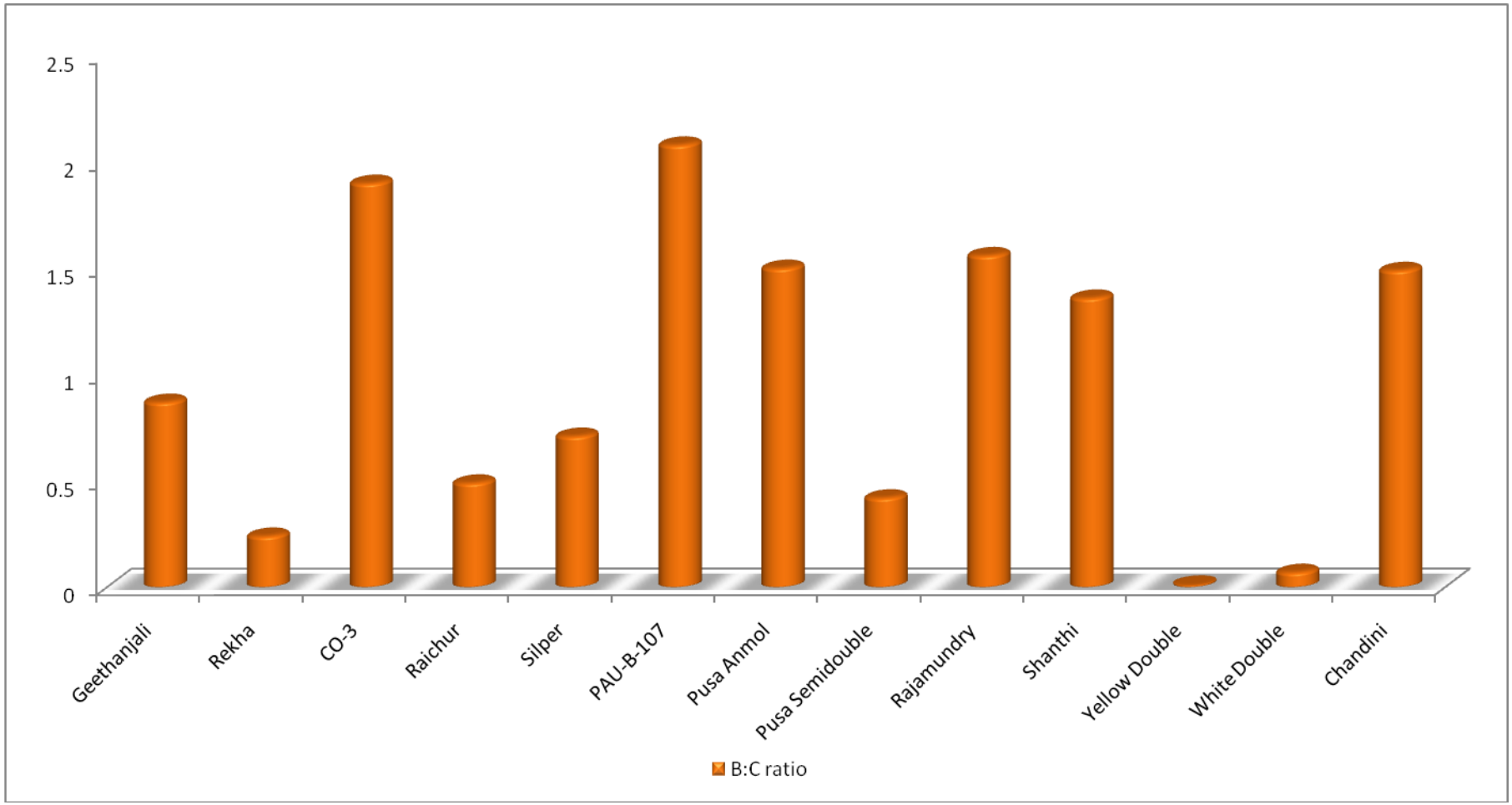


Fig. 4.10.Economics (Benefit cost ratio) of flower production of different chrysanthemum cultivars

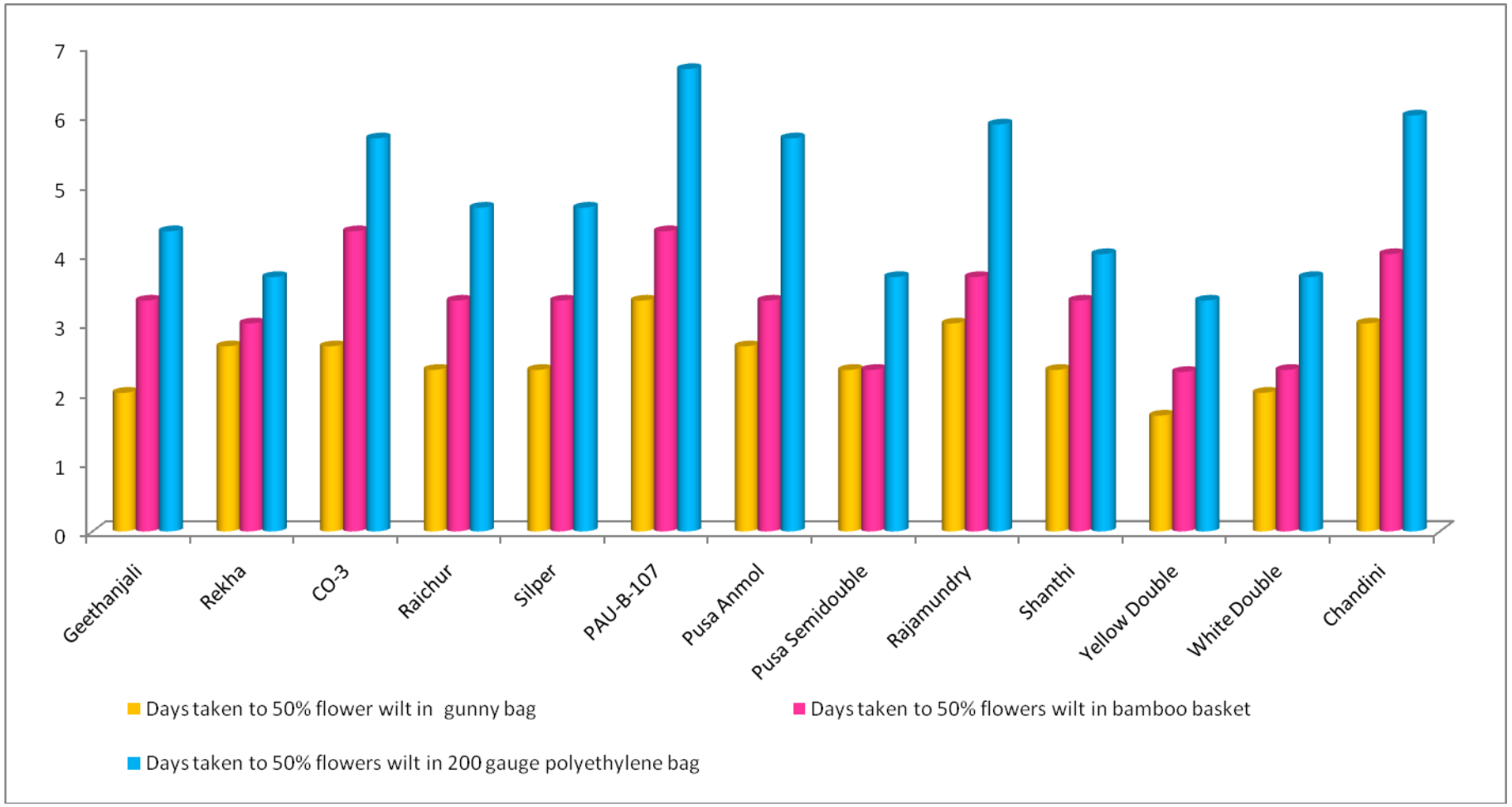


Fig. 4.11. Days taken to 50% flowers wilt in Gunny bags, Bamboo baskets and 200 gauge Polythene bags in different chrysanthemum cultivars

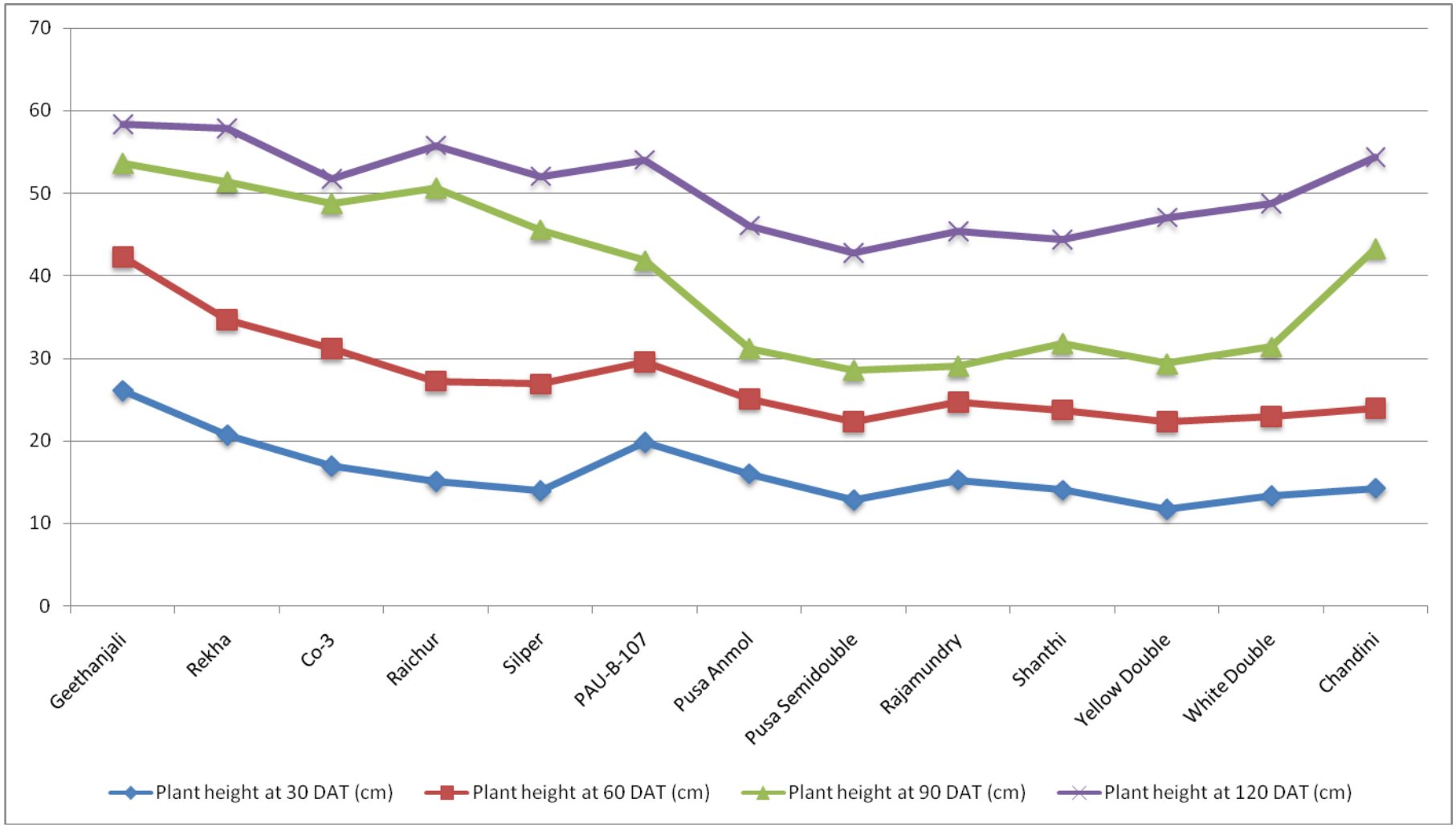


Fig. 4.2. Plant height (cm) in different chrysanthemum cultivars at different stages of growth

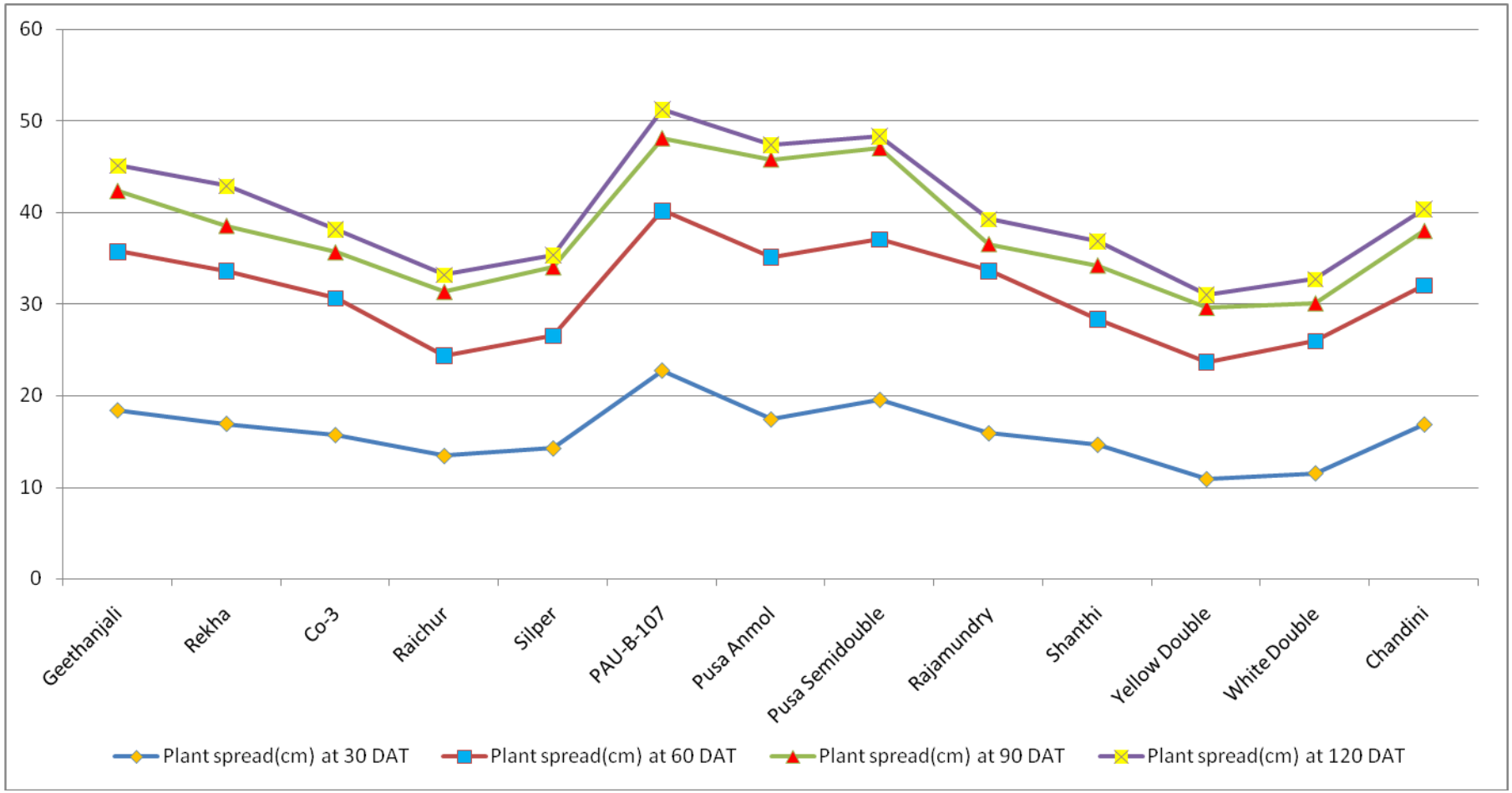


Fig. 4.3. Plant spread (cm) in different chrysanthemum cultivars at different stages of growth

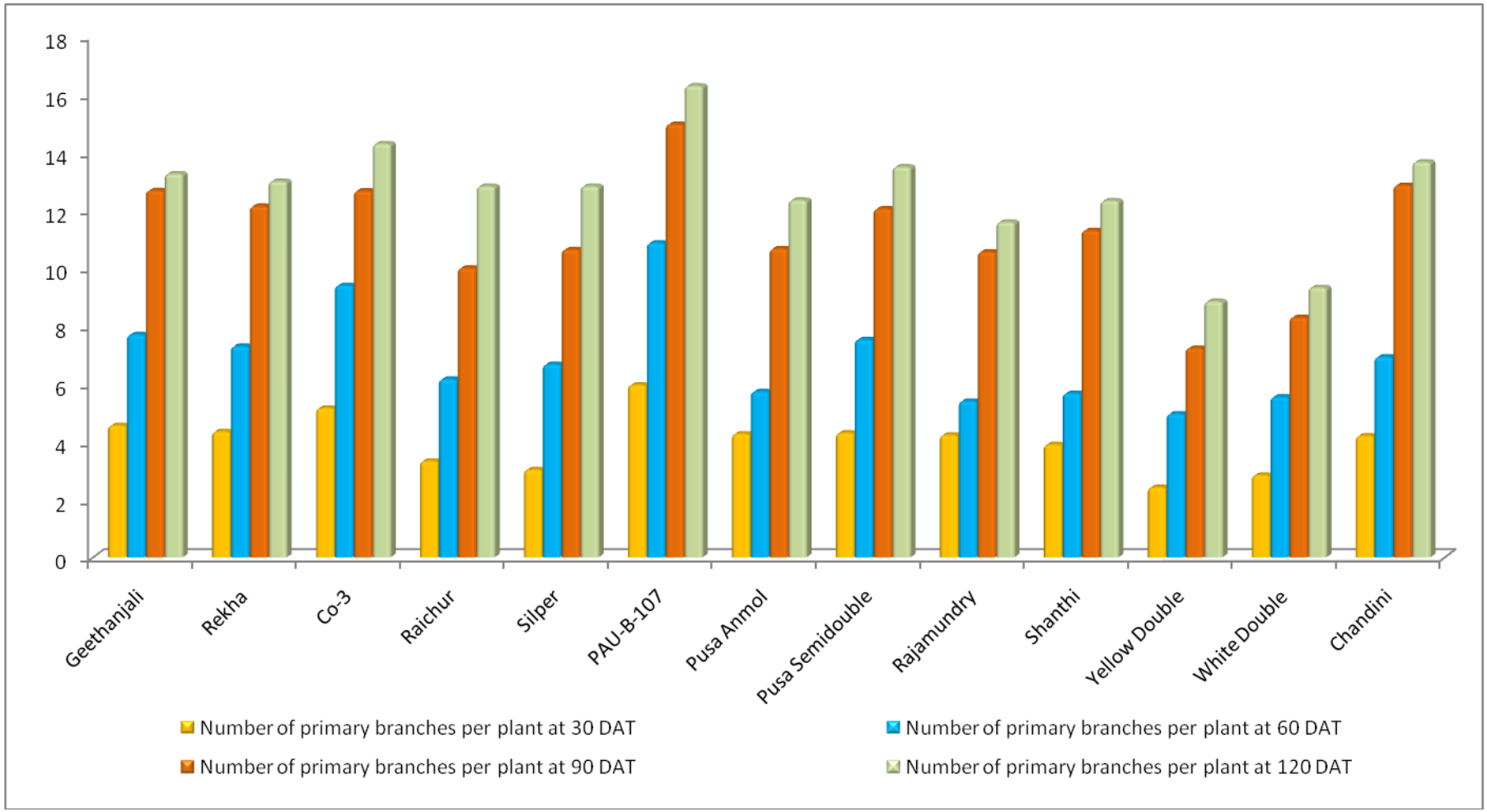


Fig. 4.4. Number of primary branches plant^{-1} in different chrysanthemum cultivars at different stages of growth

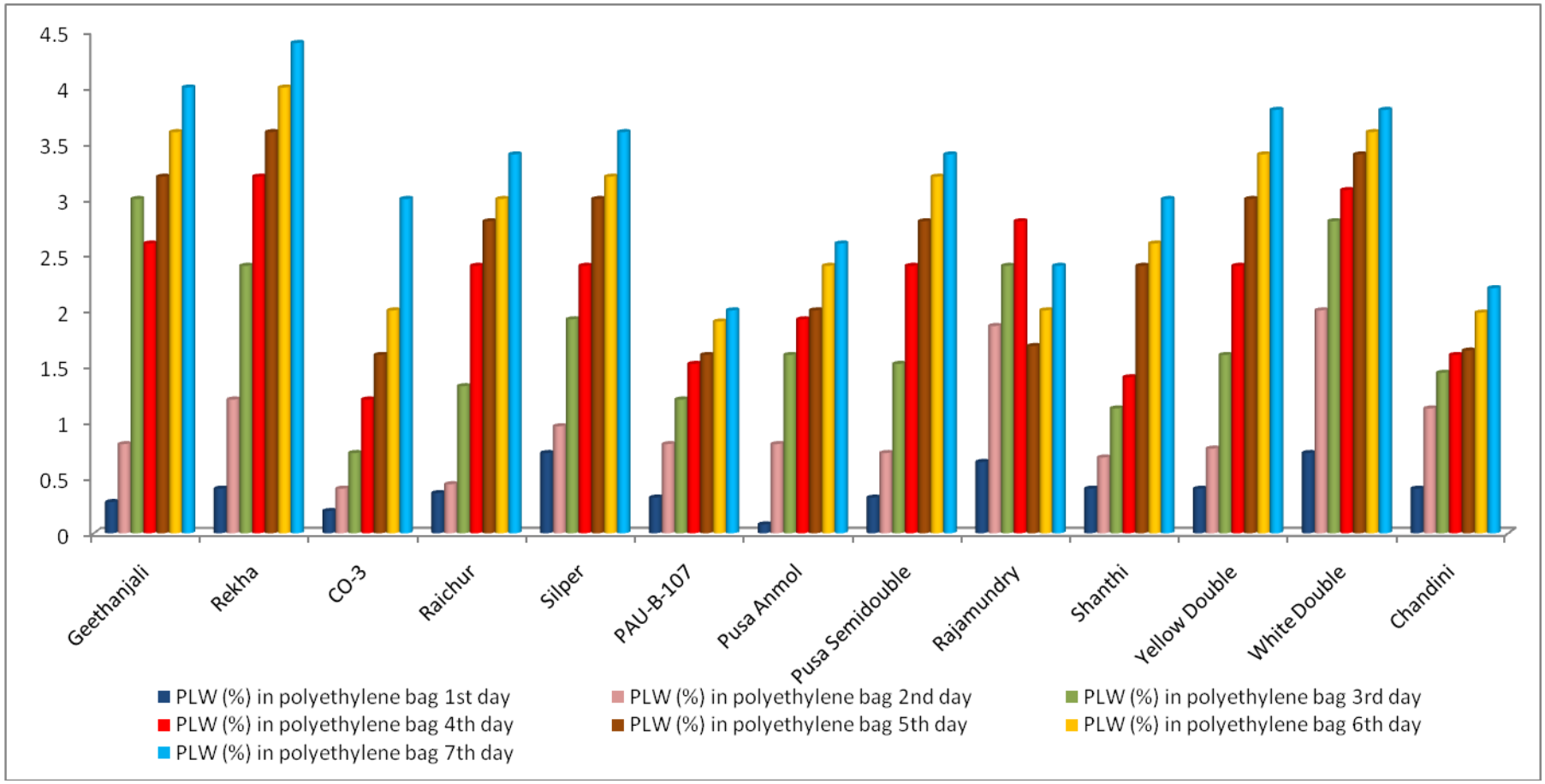


Fig. 4.12. PLW (%) in 200 gauge Polythene bags at 1st day, 2nd day, 3rd day, 4th day, 5th day, 6th day and 7th day in different chrysanthemum cultivars

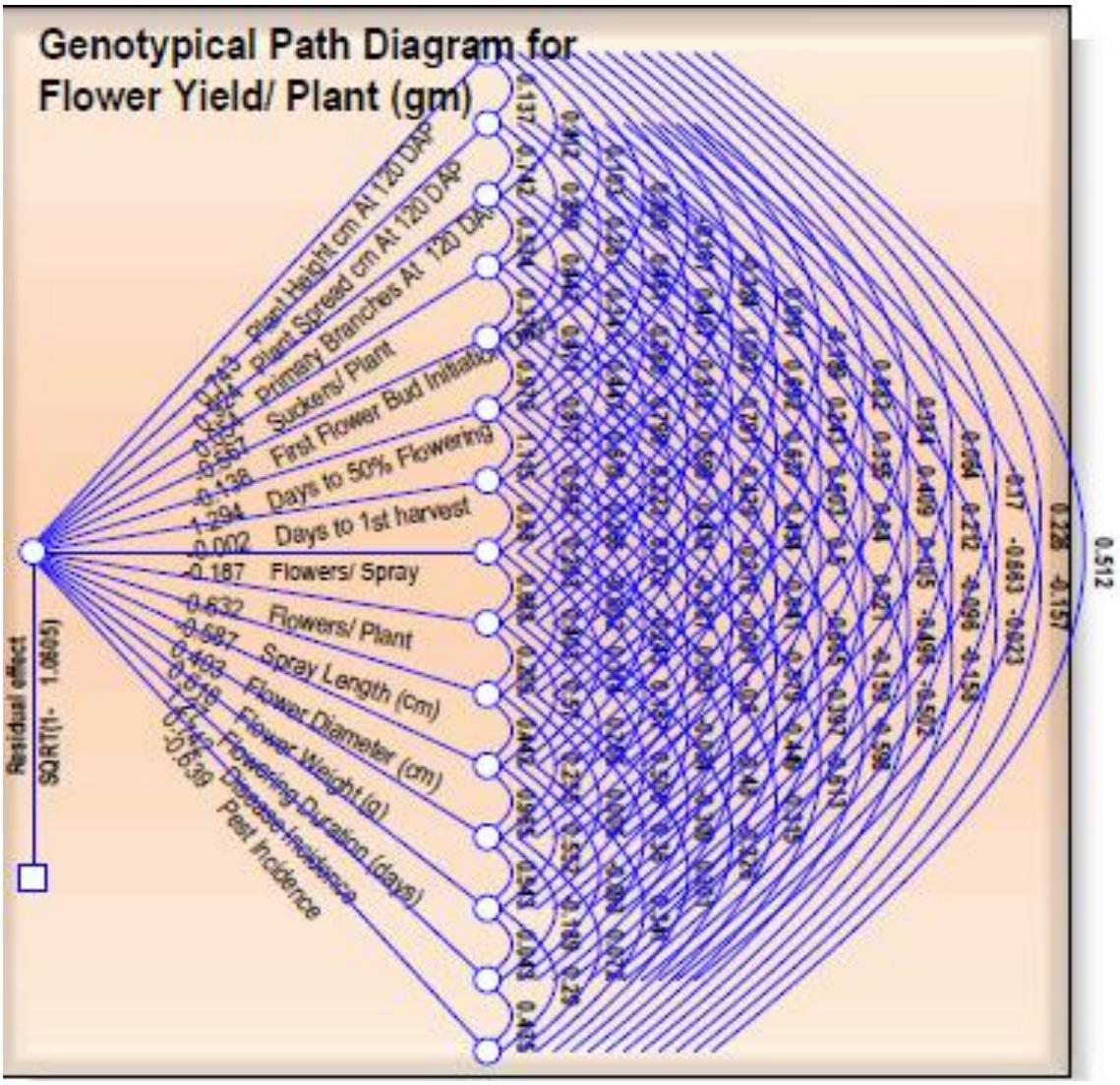


Fig. 4.15. Genotypic path diagram representing direct and indirect effects for flower yield plant^{-1} of chrysanthemum

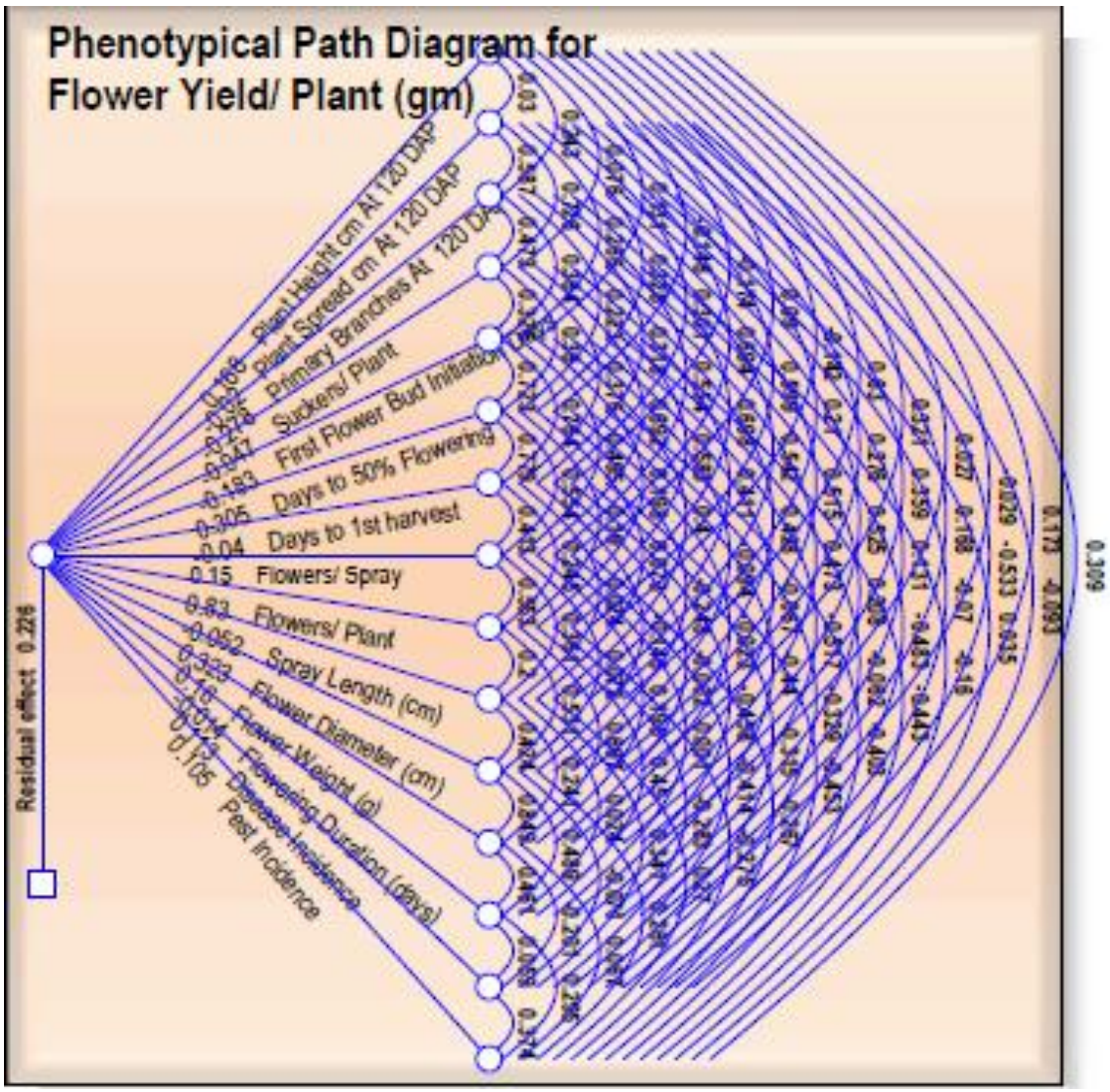


Fig. 4.16. Phenotypic path diagram representing direct and indirect effects for flower yield plant^{-1} of chrysanthemum

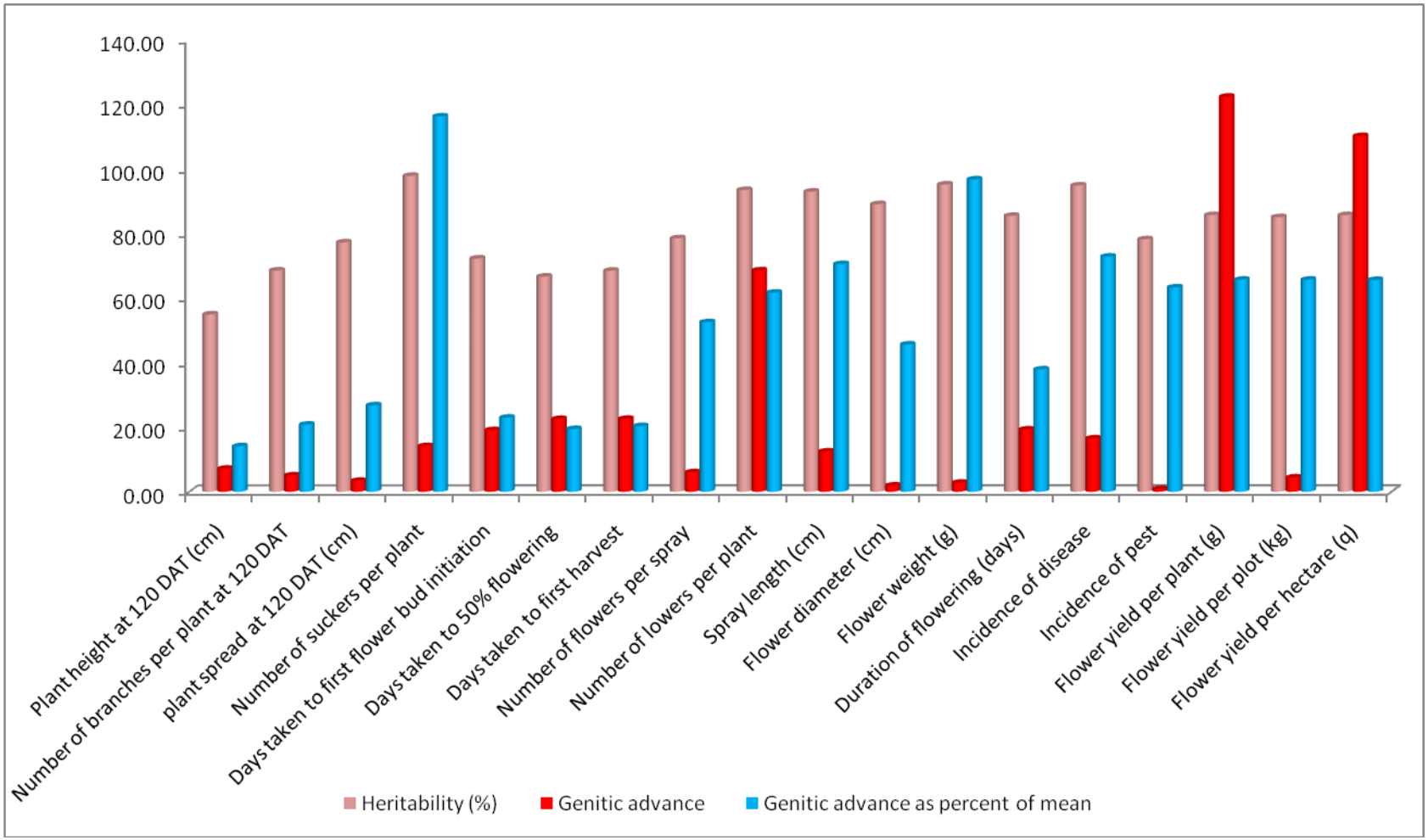


Fig. 4.14 Heritability (%), genetic advance and genetic advance as per cent of mean for different characters of chrysanthemum.

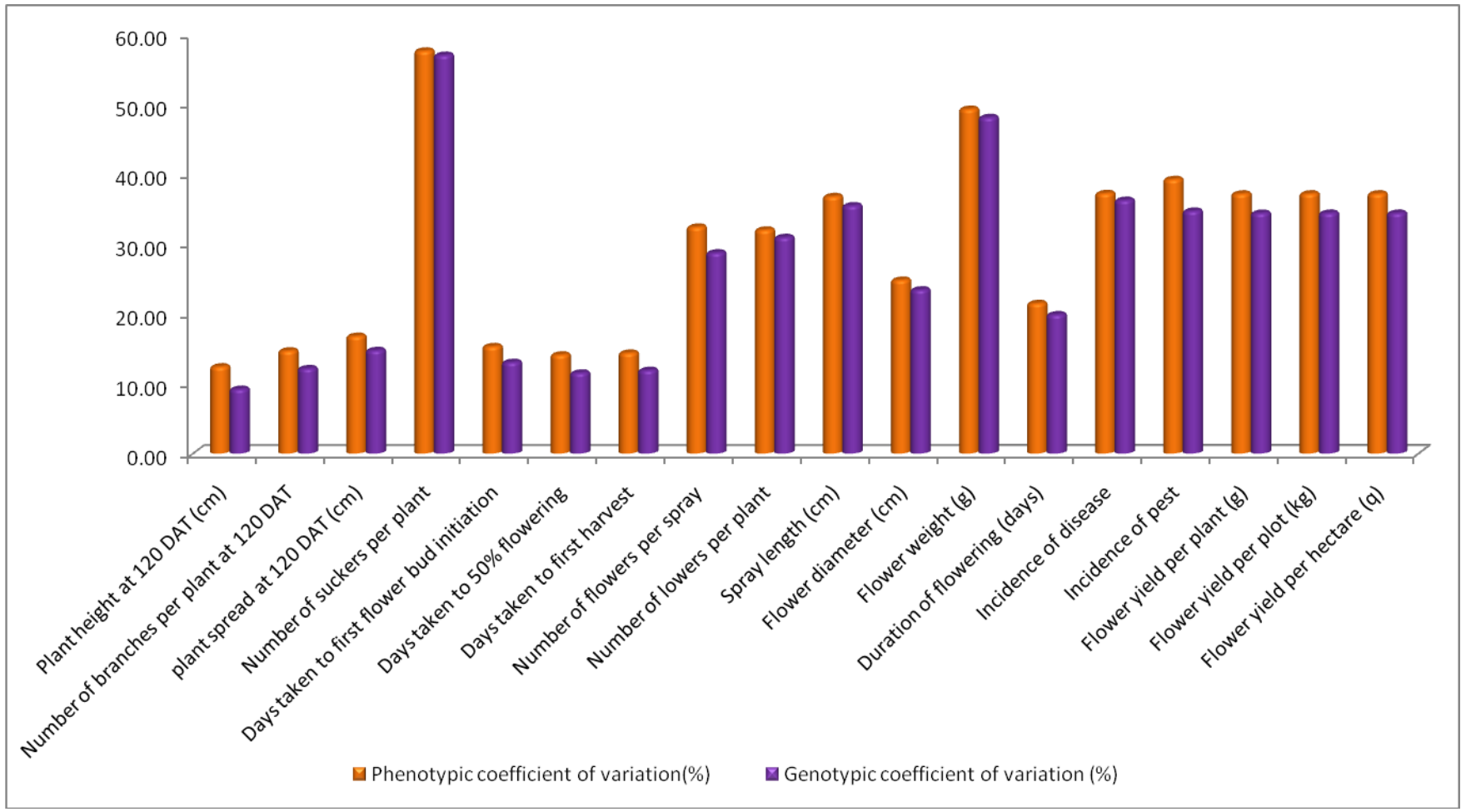


Fig. 4.13. Phenotypic and genotypic coefficient of variation for different characters of chrysanthemum

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* Original not seen

The pattern of "Literature cited" presented above is in accordance with the "Guidelines" for thesis presentation for Dr. Y.S.R. Horticultural University, Venkataramannagudem.

Appendices

APPENDIX - I

Monthly meteorological data recorded during the period of study

Month and Year	TEMPERATURE (^{o}C)		R.H. (%)		RAIN FALL (mm)	RAINY DAYS	SUN SHINE HOURS
	Maximum	Minimum	8.00 hrs Morning	14.00 hrs Evening			
July, 2012	30.70	25.90	82.80	36.10	137.4	7	4.8
Aug, 2012	30.20	25.00	84.20	38.00	123.6	10	4.6
Sept, 2012	30.47	26.30	86.40	38.2	61.6	8	5.5
Oct, 2012	31.00	23.99	84.00	37.3	152.6	7	5.8
Nov, 2012	27.60	22.90	86.70	36.80	70.8	2	4.6
Dec, 2012	22.90	19.20	82.50	36.20	152.6	6	4.2
Jan, 2013	25.70	18.80	87.00	36.20	0	0	9.3
Feb, 2013	28.90	19.30	83.00	36.10	40	1	10.2

APPENDIX - II

Cost of cultivation (hectare^{-1}) of chrysanthemum flowers production

Sl. No	Particulars	Unit	Quantity	Price unit^{-1}	Total
1.	Planting material	Plant^{-1}	30 x 30 spacing	0.45 plant^{-1}	50,000
2.	Manures - FYM	tonne	25	400	10,000
3.	Fertilizers Urea S.S.P M.O.P	 kg kg kg	 125 200 200	 282 50kg^{-1} 280 50kg^{-1} 594 50kg^{-1}	 846 3640 5940
4.	Plant protection chemicals Mancozeb Dimethoate	 kg l	 5 4	 500 kg^{-1} 516 l^{-1}	 2,500 2,064
Labour inputs (Man days)					
5.	Land preparation	MD	30	130	3,900
6.	Planting	MD	30	120	3600
7.	Manure application	MD	10	120	1,200
8.	Fertilization	MD	10x3	120	3,600
9.	Plant protection chemical application	MD	10x2	130	2,600
10.	Irrigation	MD	5x10	130	6,500
11.	Weeding	MD	15x6	120	10,800
12.	Harvesting	MD	17x8	120	16,320
13.	Transport and other expenses				5,000
	Total				**1,28,490**
	Price q^{-1} flowers	kg	100	15	1500