EFFECT OF TIME OF PLANTING AND SPACING ON GROWTH, FLOWERING AND YIELD OF ANNUAL CHRYSANTHEMUM

BY

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

Master of Science

In

Horticulture

COLLEGE OF AGRICULTURE
CCS HARYANA AGRICULTURAL UNIVERSITY
HISAR - 125004 (HARYANA)

2006


Dedicated
To
My Beloved Parents

CERTIFICATE - I

This is to certify that this thesis entitled, "**Effect of time of planting and spacing on growth, flowering and yield of annual chrysanthemum"** submitted for the degree of **Master of Science** in the subject of **Horticulture** to the CCS Haryana Agricultural University, Hisar, is a bonafide research work carried out by **Ankush Joshi** under my supervision and that no part of this thesis has been submitted for any other degree.

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

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CERTIFICATE – II

This is to certify that this thesis entitled, "**Effect of time of planting and spacing on growth, flowering and yield of annual chrysanthemum"** submitted by **Ankush Joshi** to the CCS Haryana Agricultural University, Hisar, in partial fulfilment of the requirements for the degree of **Master of Science** in the subject of **Horticulture** has been approved by the Student's Advisory Committee after an oral examination on the same.

MAJOR ADVISOR

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Acknowledgment

Gratitude cannot be seen or expressed, it can only be felt in the heart and is beyond description. Although thanks are poor expressions of deep debt of gratitude one feels, yet there is no better way to express it.

It is a matter of immense pleasure for me to express my profound regards and deep sense of gratitude to my esteemed Major Advisor, Dr. D.S. Dahiya, Associate Professor, Department of Horticulture, for his able and sustaining guidance, continuous encouragement, keen interest, constructive criticism, pleasant discussion and untiring supervision during the entire period of the study, whose enthusiastic cooperation and sustained interest made me possible to accomplish this manuscript of scientific utility.

I am greatly indebted to worthy members of my advisory committee Dr. S.K. Sehrawat, Associate Professor, Department of Horticulture, Dr. B.K. Hooda, Associate Professor, Department of Mathematics and Statistics, Dr. Saleem Sidiqui, Professor, Department of Food Science and Technology, and Dr. V.K. Kalra, Professor, Department of Entomology for their valuable suggestion, insightful guidance and cooperation during the course of present investigation.

I am thankful to Dr. M.S. Joon, Professor and Head, Department of Horticulture for extending all possible help and support during the course of my study.

It is my privilege to express my sincere gratitude to Dr. A.L. Patel, Dr. I.S. Yadav and Dr. Anil Godara, for their cooperation at various stages during course of this investigation.

I shall be failing in duty, if I do not express my cordial thanks to my friends Dr. Vikas Bhardwaj, Dr. Rajesh Kathwal, Dr. Satpal Yadav, Dr. Bijender Yadav, Dr. Rajesh Malik, Manoj Kundu, Ajit Malik, Manoj Sharma,

Narender and specially for '**Naresh Sharma**' who all gave me their valuable time, generous help and moral support at various stages of work.

I wish to put on records my gratitude to my brothers Sanjeev, Rajan and Bhabhijis Anju, Lata and gudiya, isha, khushi and neetu for their silent good wishes, deep affection and everlasting inspiration.

I am also thankful to all non-teaching staff who provided timely help at various stages of study. I am especially thankful to Sh. Ashwani Kumar and Miss Varsha.

Feeling which cannot be molded into words, from the core of my heart, I truly express my sincere gratitude to my affectionate grand parents and my parents whose consistent encouragement and blessings are beyond my expression, that brought here up to the dream without which it could not have been sketched.

Last but not least, my earnest gratitude is due to the Almight God whose showers of blessing could make it possible to fulfill this challenging venture.

Place: Hisar

December, 2006 **(Ankush Joshi)**

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LIST OF ABBREVIATIONS

@	at the rate of
C.D.	critical difference
cm	centimeter
cv.	cultivar
et al.	*et al*ii
g	gram
ha	hectare
kg	kilogram
m^{-2}	per meter square
N	nitrogen
P_2O_5	phosphorus
/	per
%	per cent
q	quintal
t	tonne
mm	millimeter

CHAPTER-I

Introduction

Floriculture is emerging as major enterprise in world trade due to tremendous surge in the demand of floricultural products with increasing expandable income and globalization of economy. Its expansion as a trade in domestic market got the boost in last two decades. With the implementation of world trade organization provisions, the floriculture industry has also received an impetus in recent years. Globally, floriculture generates more than US $65 billion and has been growing at the rate of 19 percent per annum (Anonymous, 2002). The major flower growing countries are Holland, Columbia, Italy, Israel, Germany and Mexico.

The total area under floriculture in India is approximately 98 thousand hectares (Negi *et al.,* 2002). The major flower growing states in India are Karnataka, Andhra Pradesh, Tamil Nadu, West Bengal, Maharashtra and Uttar Pradesh. In Haryana, area under flower cultivation is 4810 hectares with a production of 55583.0 tones of loose flower and 508.0 lakhs of cut flower. The important floral crops of Haryana are marigold, gladiolus and tuberose and the area under their cultivation is 411, 350 and 105 hectares, respectively (Anonymous, 2006).

The genus chrysanthemum belongs to the family Compositae and the number of species under the genus

chrysanthemum varies from 100 to 200 (Carter, 1980). It has two main commercial species viz., *Chrysanthemum morifolium* and *Chrysanthemum coronarium* commonly known as guldaudi and market, respectively. Some species of this genus are also cultivated as a source of pyrethrum, an important insecticide (Reimherr and Gradner, 1987).

Annual chrysanthemum is a tall, winter season annual flowering crop. It has earned tremendous popularity for the garden display and garland making. Its flowers are also used for decoration purposes. These are available from February to April, when the market is deficient in other flowers. So, its flower can fetch good market price. The rate of traditional flowers in Delhi market ranged between Rs. 2.0 and Rs. 20 per kg. depending upon the season and demand in the market (Sindhu and Mishra, 1997). It normally forms flower buds when the day length exceeds 14.5 hrs.

The demand of flowers is increasing particularly in big cities and to meet this ever-increasing demand the need of the hour is to increase the production of the flowers. The various factors responsible for increasing the production are selection of variety, planting material, time of planting, spacing and other cultural operations. Till now very less work has been reported on these aspects in annual chrysanthemum in this part of country. The production technology of annual chrysanthemum in agro climatic condition of Haryana has not been standardized so far.

Therefore, it is very much essential to find out the best planting time and proper spacing to expose the crop for better environment for maximum productivity. The present studies were planned keeping in view the following objectives:

1. To find out the optimum time to planting and spacing for better growth, flowering and yield of annual chrysanthemum.

CHAPTER-II

Review of Literature

A comprehensive review of the available literature indicates that very less work has been done on agronomic aspects of annual chrysanthemum. The time of planting and spacing plays a key role in affecting the yield and quality of every crop. The relevant literature on the time of planting and spacing is discussed under the following heading and sub-headings.

2.1 EFFECT OF TIME OF PLANTING ON GROWTH, FLOWERING AND YIELD OF ANNUAL CHRYSANTHEMUM

Selection of good planting material is not only necessary for obtaining optimum vegetative growth but also flower production. The appropriate time of planting is also important for better vegetative growth and flowering in annual chrysanthemum.

2.1.1 Growth parameters

Krijer (1985) conducted a trial on chrysanthemum and revealed that the planting which was done on mid November produced plants with the maximum vegetative growth in terms of number of branches per plant and plant spread.

Jane *et al.* (2001) conducted a field experiment on annual chrysanthemum and reported that maximum plant height

(110.20 cm) and spread (76.19 cm) was observed in the plants transplanted between 5th and 15th October.

Reimherr and Gradner (1987) revealed that the sowing of *Chrysanthemum parthenium* from 29th January to 3rd April recorded maximum number of branches per plant.

Hong and Jeong (1988) conducted a trial on *Chrysanthemum morifolium* in which sowing was done at monthly intervals from February to July. The maximum vegetative growth was observed by the later planting dates.

An experiment was conducted on *Chrysanthemum coronarium* in which planting was done on four dates from 10th September to 15th October and reported that maximum plant height (115.8 cm) and spread (76.8 cm) was observed in October plantings (Yang *et al.*, 1989).

A trial was conducted on planting time of tuberose at Akola, and concluded that planting bulbs at early date (10th April) significantly improved the vegetative growth and bulb production (Khobragade *et al.*, 1997).

Meher *et al.* (1999) reported that plant height, spread, internode length, stem circumference and number of branches were assessed at 30, 50, 70 and 90 days after planting in chrysanthemum. Planting in May produced the tallest and most spreading plants.

Mishra (1999) investigated the effect of planting date (February – May) on growth of *P. tuberosa* and revealed that planting bulbs on 7th March followed by 22nd March produced plants with a high number of spikes/clump.

A field experiment was conducted on rooted cuttings of chrysanthemum cv. Flirt (Singh *et al.*, 2004). The rooted cuttings were transplanted in the 1st week of July or the second week of August. The cuttings planted in the first week of July gave the maximum plant height (49.09cm) and number of branches per plant (6.10).

2.1.2 Floral parameters

In southern parts of India, Nambisan and Krishnan (1983) suggested to plant the bulbs of tuberose in the month of July-August for better flowering.

Zalewska (1986) reported that the first half of February was the best time for planting of chrysanthemum to obtain longer duration of flowering whereas planting in March had a beneficial effect on flower weight and size.

A field experiment was conducted on *chrysanthemum coronarium* (Jane *et al.* 2001) and revealed that minimum number of days were taken to bud appearance, first flowering and 50% flowering when the transplanting was done between 5th and 15th October.

Deotale *et al.* (1994) conducted a field experiment on chrysanthemum with four planting dates (15th May, 4th and 24th June and 14th July) aimed to produce early flowers and higher returns. Time to bud initiation and flower opening and the difference between the two were reduced with both later planting dates. The number of flowers per plant tended to increase with later plating dates and maximum flowering was obtained from planting on 14th July, which resulted in 256 flowers per plant. Flower yield per plant increased with both the later planting dates, up to 24th June planting which gave the highest flower yield of 474.0 g per plant.

Shin *et al.* (1996) studied the effect of planting time (December, February, April and June) on the days to bud appearance and development of lateral shoots in three chrysanthemum cultivars. The minimum days to bud appearance were taken by the rooted cutting planted in December.

According to Biswas (2000), March planting of tuberose bulbs was found to be better than other planting time which recorded longest duration of flowering (17.00 days).

A field experiment was done on the rooted cuttings of chrysanthemum and it was reported that non-significant differences in the number of flowers per plant were observed in cuttings planted on the first week of July than those planted on the second week of August (Grewal *et al.,* 2004).

In an field experiment on chrysanthemum it was reported that the plants which had longest duration of flowering were those planted between February and September (Bres and Jerzy, 2004).

2.1.3 Yield parameters

Gill *et al.* (1985) studied the effect of time of planting on flower quality and yield of chrysanthemum and reported that with every planting from October onwards, the quality and yield of blooms was affected to a great extent.

A trial was conducted on tuberose, planted in a green house and open in Italy and mentioned that good flower yield of cv. 'La Florentina' was obtained in the open from July and August plantings Zizoo *et al.* (1986).

In an another trial at Meerut, Singh and Kumar (1999) reported that the longest flower spikes and highest number of spikes per clump resulted from October planting in tuberose cv. 'Double'.

Meher *et al.* (1999) studied the effect of planting time on flowering and yield of chrysanthemum and concluded that cut flower yield was highest from May planting.

In an experiment on tuberose, it was reported that April planting was found to be better than other planting time in respect of number of spikes per bulb (1.33), number of florets per spike (34.26) and yield of spike (9.26/m^2) (Datta, 2000).

2.2 EFFECT OF SPACING ON GROWTH, FLOWERING AND YIELD OF ANNUAL CHRYSANTHEMUM

2.2.1 Growth parameters

A two year experiment was conducted on the effect of spacing in chrysanthemum cv. Co-1 (Chezhiyan *et al.*, 1986) and observed more plant height (49.52 cm and 38.86 cm) and number of branches (14.43 and 15.83) at a closer spacing of 20 cm x 30 cm as compared to 30 cm x 30 cm and 40 cm x 30 cm spacing during both the years, respectively.

Farina and Paterniani (1986) conducted a trial on planting density and growing system for single bloom chrysanthemum cv 'Yellow Turner'. When this cultivar was planted in field with 12, 15 and 18 plants m^{-2}, they observed that stem length increased with increasing planting density.

Another trial was conducted with three levels of spacing (30 cm x 30 cm, 45 cm x 30 cm and 60 cm x 30 cm) on local cultivar of African marigold to find its optimum spacing (Ravindran *et al.,* 1986) and they revealed that number of primary branches per plant significantly increased in wider spacings (45 cm x 30 cm and 60 cm x 30 cm) as compared to closer spacing (30 cm x 30 cm).

The effect of spacing was studied on growth and flowering of chrysanthemum cv. 'Local White'. More plant height and less spread, was observed at 20 cm x 30 cm than 30 cm x 30 cm and 40 cm x 30 cm (Gowda and Jayanthi, 1988).

A significant increase in plant canopy volume observed with increase in intra-row spacing from 15 cm to 30 cm (Rao *et al.*,

1992), however, number of shoots per plant were not affected by increase in spacing.

A field experiment was conducted on annual chrysanthemum at Nagpur and reported that the tallest plant (109.6 cm) and maximum primary and secondary branches (31.62 and 169.47) were found at a spacing of 45 cm x 45 cm as compared to 30 cm x 45 cm and 60 cm x 45 cm spacings (Belgaonkar *et al.*, 1996).

Mildernberger and Hendriks (1996) observed that plants at the closest spacing had more height and few lateral shoots in chrysanthemum.

An experiment was conducted with four levels of spacing (30 cm x 30 cm, 40 cm x 20, 30 cm x 30 cm, 40 cm x 30 cm) in chrysanthemum and they observed that spacing had no significant effect on growth parameters like plant height and number of primary branches (Mohanty *et al.*, 1997).

A two year field experiment conducted with three levels of spacing (40 cm x 40 cm, 40 cm x 30 cm and 30 cm x 30 cm) for cut chrysanthemum cv. 'Chandrama' production and reported that closer spacing 30 cm x 30 cm increased plant height and stalk length (Barman and Pal, 1999).

A field experiment was conducted to determine the effect of spacing on *Chrysanthemum coronarium* cv. 'Local White' (Karvadia and Dhaduk, 2002). The treatments comprised of three spacings (30 cm x 20 cm, 30 cm x 30 cm and 30 cm x 40 cm) and they revealed

that number of branches per plant and plant spread were significantly highest in the widest spacing (30 cm x 40 cm).

A field experiment was conducted to determine the optimum plant spacing in chrysanthemum (*Dendranthema morifolium*). Three spacing 20 cm x 20 cm, 20 cm x 30 cm and 20 cm x 40 cm were used. The plant height and number of branches per plant were highest at the closer spacing of 20 cm x 30 cm. (Beniwal *et al.*, 2003).

A trial was conducted to evaluate the effects of spacing on the growth, flowering and yield of annual chrysanthemum (Dixit, 2004). The treatments consisted of three levels of spacing (30 cm x 20 cm, 30 cm x 30 cm and 40 cm x 30 cm). The various growth parameters, such as number of branches, plant spread, main stem diameter were significantly higher in wider spacing (40 cm x 30 cm).

2.2.2 Floral parameters

A trial was conducted on several spray cultivars of chrysanthemum to compare the effect of six plant densities between 40 and 80 m^{-2} and they observe longer duration of flowering at wider spacing (Glas and Breedveld, 1984).

Farina and Paterniani (1986) observed that bloom weight and diameter fell with increasing plant density in chrysanthemum.

Gowda and Jayanthi (1988) reported that chrysanthemum cv. 'Local White' produced maximum flower diameter and flower weight was highest in the spacing of 20 cm x 30 cm when grown for cut flowers.

A field experiment was conducted with three plant spacing (30 cm x 30 cm, 45 cm x 30 cm and 60 cm x 30 cm) (Belorkar *et al.,* 1992) and they found the maximum flower size and longer duration of flowering with a spacing of 45 cm x 30 cm.

John and Paul (1995) studied the effect of three spacings (20 cm x 30 cm, 30 cm x 30 cm and 40 cm x 30 cm) on growth and flower production of chrysanthemum cv. 'Flirt'. The pooled data indicated that at widest spacing minimum number of days were taken to bud appearance and first flowering.

Belgaonkar *et al.* (1997) conducted an experiment on annual chrysanthemum and observed more diameter of flowers with 45 cm x 45 cm spacing as compared to 30 cm x 45 cm and 60 cm x 45 cm spacing.

Beniwal *et al.* (2005) found early bud initiation, flowering, and maximum flower size and weight of flowers at closer spacing (20 cm x 20 cm) while the maximum number of buds and flowers were observed 20 cm x 30 cm spacing in *Chrysanthemum morifolium* was sown in three different spacings (20 cm x 20 cm, 20 cm x 30 cm, 20 cm x 40 cm).

2.2.3 Yield parameter

Rao and Singh (1982) reported that when plants of *chrysanthemum cinerarifolium* grown at 45, 60 or 75 cm between rows and 30, 45, or 60 cm within rows, then yield was highest (6.64 kg/ha) from plants spaced at 60 cm x 30 cm and lowest (2.84 kg/ha) spaced at 75 cm x 60 cm.

In an experiment, cut flower chrysanthemum were grown at wider spacing than usual 12.7 cm x 12.7 cm during the winter season in an attempt to reduce losses and improve flower quality (Machin and Potter, 1983). Diagrams of planting systems show arrangement for reducing populations by 16.6 per cent and 15.38 per cent. Yields are tabulated for the cv. Pink Gin and Yellow Snowdon compared at a normal density of 64 plants m^{-2} and at a reduced density (16.6 per cent) achieved by omitting one diagonal row in four, but the planting system might prove complicated for commercial use.

Ravindran *et al.* (1986) conducted an experiment to find out optimum spacing on local cultivar of African marigold with three levels of spacing and they observed that per cent flower yield both by number and fresh weight increased in the medium spacing (40 cm x 30 cm) however flower yield per hectare was maximum in closer (30 cm x 30 cm) and medium spacing (45 cm x 30 cm).

Sastry *et al.* (1989) conducted a trial on chrysanthemum and reported that the plant spacing of 60 cm x 45 cm gave higher yield than different combinations of 30, 45 and 60 cm as inter and intra row spacing. The high yield was attributed to both increased number of flowers per plant and dry matter production efficiency.

Yang *et al.* (1989) conducted a trial on *Chrysanthemum coronarium*, sown in rows 15, 20 and 25, 30 cm apart. The yield was maximum in the plant spacing of 15 cm.

An experiment was conducted with the three plant spacings and maximum flower yield (83.92 q/ha) was recorded with a spacing of 45 cm x 30 cm (Belorkar *et al.,* 1992.

Rao *et al.* (1992) observed that when *Chrysanthemum indicum* cv. 'Kasthi' was grown at four intra-row spacings (15, 20, 25 or 30 cm) with a 40 cm inter-row spacing, than plant growth and flower yield per plant in terms of flower number and weight increased with increasing intra-row spacing. However, flower yield per hectare increased with decreasing intra-row spacing. The highest cut flower yield (12.19 t/ha) was obtained at a 15 cm intra-row spacing.

Mohanty *et al.* (1997) reported that with the increase in spacing, the fresh weight of individual flower and flower yield per plant increased significantly.

A trial was conducted on chrysanthemum and they reported that closer spacing (30 cm x 30 cm) increased the number of flowers per unit area (Barman and Pal 1999).

Nardi *et al.* (2001) observed that when *Chrysanthemum morifolium* cv. 'Snowdon' was sown in different plant densities (40, 48, 56, 64, 72, 80, 88, 104 plants m^{-2}) than yield of class A stems were highest with 40-56 plants m^{-2}. For high yield of good quality stems, planting density should not exceed 72 plants m^{-2}.

CHAPTER-III

Material and Methods

The present investigations entitled, “Effect of time of planting and spacing on growth, flowering and yield of annual chrysanthemum (*Chrysanthemum coronarium*) cv. Local White Double” were carried out during 2004-05 at the Experimental Orchard, Department of Horticulture, Chaudhary Charan Singh Haryana Agricultural University, Hisar. The details with reference to the site, location and materials and methods used for this experiment are described briefly.

1.1 Geographical location and climate of the experimental site

Hisar is situated in sub-tropics at 29^0 10' north altitude and 75^0 46' east longitude with an elevation of 215.2 meters above mean sea level. The soil of the experimental site was sandy loam. The average rainfall of the location is about 450 mm which is unevenly distributed with peak rainfall occurring during the months of July and August. It experiences extreme climate with very hot summer from May to July, humid warm monsoon season and extreme cold winter. The mean and maximum temperatures show a wide range of fluctuations during summer and winter.

The meteorological data for the experimental period recorded at the meteorological observatory of the university are presented in the Annexure-I.

1.2 Planting material

The seed of annual chrysanthemum cv. Local White Double was procured from the Division of Floriculture and Landscaping, IARI, New Delhi. The nursery was raised for different planting times and three weeks old seedlings were used for each transplanting.

3.3 Experiment

"Effect of time of planting and spacing on growth, flowering and yield of annual chrysanthemum (*Chrysanthemum coronarium* L.) cv. Local White Double.

Treatments

Time of planting (6)	:	The transplanting was done at fortnight intervals starting from mid September to December
Spacing (4) (R-R x P-P)		S_1= 30 cm x 30 cm S_2 = 30 cm x 45 cm S_3 = 45 cm x 45 cm S_4 = 45 cm x 60 cm
Replication	:	Three
Experimental design	:	Split Plot Design
Plot size	:	1.8 m x 1.8 m
Number of plots	:	72
Number of plants per replication	:	S_1 = 36 S_2 = 24

$S_3 = 16$

$S_4 = 12$

3.4 Preparation of field and fertilizer application

The experimental area was ploughed well by disc plough and tilled several times to bring the soil to fine tilth by cultivator. The plots measuring 1.8 m x 1.8 m were prepared. A basal dose of well rotten farm yard manure @ 5 kg m^{-2} along with full dose of phosphorus (20 gm^{-2}) and potassium (10 g m^{-2}) was mixed in the soil 15 days before transplanting. Half dose of nitrogen (10 g m^{-2}) was applied after 10 days of transplanting and remaining half dose (10 g m^{-2}) was applied one month after the application of first dose.

3.5 Transplanting and establishment of seedlings

The three weeks old seedlings of almost equal size and vigour were transplanted in the plots at different spacing up to a depth of first leaf node from below. Soil was firmly pressed around the base. After transplanting, light irrigation was applied. The seedlings which could not survive were replaced immediately by healthy seedlings.

3.6 Cultural operations

The field was irrigated once at an interval of 7-10 days till mid November and after that it was irrigated at an interval of 10-15 days. Weeding and hoeing was done, wherever it was required. No insecticide or pesticide was sprayed as the crop did not show any incidence of pests or diseases.

3.7 Collection of data from the field experiments

For the collection of data from the field experiment, six plants were selected randomly and tagged in each plot. Data was collected from these plants for vegetative, flowering and yield characters.

3.8 Observations recorded

The following observations were recorded during the experiment.

(A) Growth parameters

(i) Plant height (cm)

Six plants were tagged in each plot and plant height was recorded in centimeter with the help of a meter rod from base of the plant up to the tip of apical shoot and final height was recorded at full bloom stage. The plant height was taken at different intervals of 30, 45, 60 and 90 days after transplanting.

(ii) Plant spread (cm)

The plant spread was recorded at full bloom stage by measuring the spread in east to west and north to south directions and taking mean of sum for representative plants in each plot.

(iii) Number of branches per plant

Number of branches per plant was counted at the time of full bloom for representative plants in each plot.

(B) Floral parameters

(i) Days to bud appearance

The days taken for initiation of floral buds were recorded from the date of transplanting up to the appearance of bud for representative plants in each plot.

(ii) Days to first flowering

The number of days to first flowering were recorded from the time of transplanting to the opening of first flower bud for representative plants in each plot.

(iii) Days to 50% flowering

The number of days to 50 per cent flowering were recorded from the time of transplanting to the opening of 50 per cent flower buds.

(iv) Duration of flowering

The number of days taken from the date of first flower opening to the last flower senescence constituted the duration of flowering and was recorded for representative plants in each plot.

(v) Size of flower (cm)

The size of flowers were recorded at full bloom stage by digital vernier caliper by measuring the diameter between the apices of ray florets in east to west and north to south directions and taking the mean of sum for representative plants in each plot.

(C) Yield parameters

(i) Average weight of flowers (g)

The average weight of ten flowers was recorded in grams for the representative plants in each plot.

(ii) Number of flowers per plant

The total number of flowers per plant were counted for the representative plants in each plot.

(iii) Yield per plant (g)

Flower yield per plant was recorded in grams by multiplication of average weight of flowers and number of flowers per plant.

(iv) Yield per acre (q)

The flower yield per acre was calculated by multiplication of yield per plant and the number of plants accommodated in one acre in different spacings.

CHAPTER-IV

Experimental Results

The findings of the present investigations entitled "Effect of time of planting and spacing on growth, flowering and yield of annual chrysanthemum (*Chrysanthemum coronarium L.*) cv. 'Local White Double' are presented in this chapter.

4.1 GROWTH PARAMETERS

4.1.1 Plant height

4.1.1.1 Plant height at 30 days after transplanting

The perusal of data in Table 1 revealed that the time of planting and spacing significantly influenced the plant height. The planting which was done on 15th October produced plants with the maximum height (64.58 cm) followed by 1st November planting (63.54 cm) and the minimum height (35.07 cm) was observed in 1st December planting.

It is evident from the data that increase in plant spacing decreased the plant height significantly upto 45 cm x 45 cm. The maximum plant height (54.97 cm) was recorded at the closer spacing of 30 cm × 30 cm followed by 30 cm x45 cm spacing (51.20 cm) and the minimum plant height (48.31 cm) was recorded at the wider

spacing of 45 cm × 60 cm. which was at par with 45 cm × 45 cm spacing.

Table 1: Effect of time of planting and spacing on plant height (cm) after 30 days of transplanting in annual chrysanthemum

Time of Planting	Spacing (cm)				
	S_1 (30x30cm)	S_2 (30x45cm)	S_3 (45x45cm)	S_4 (45x60cm)	Mean
T_1 15 Sept.	48.42	44.34	40.63	40.95	**43.58**
T_2 1 Oct.	58.96	53.30	51.41	51.02	**53.67**
T_3 15 Oct.	69.40	65.34	62.23	61.37	**64.58**
T_4 1 Nov.	66.87	63.76	63.06	60.50	**63.54**
T_5 15 Nov.	47.85	44.94	43.31	43.50	**44.90**
T_6 1 Dec.	38.73	35.56	33.87	32.51	**35.07**
Mean	**54.97**	**51.20**	**49.08**	**48.31**	

CD at 5% level

T = 0.71
S = 0.87

T x S = NS

The interaction between time of planting and spacing on plant height was found to be non significant.

4.1.1.2 Plant height at 45 days after transplanting

The data presented in table 2 revealed that the time of planting and spacing had significant effect on plant height. The maximum plant height (81.98 cm) was observed at 15th October planting followed by 1st November planting (79.41 cm) and the minimum height (50.11 cm) was recorded at 1st December planting.

It is explicit from the data that spacing had a significant effect on plant height. As the spacing increased, the plant height decreased significantly. The maximum plant height of 70.54 cm was observed at the spacing of 30 cm x 30 cm and the minimum plant height of 62.64 cm was observed at the widest spacing of 45 cm x 60 cm.

The effect of interaction between the time of planting and spacing on plant height was found to be non-significant.

4.1.1.3 Plant height at 60 days after transplanting

A perusal of data presented in Table 3 indicated that the planting which was done on 15th October resulted in maximum plant height (94.92 cm) followed by 1st November planting (92.61 cm) and minimum plant height (54.47 cm) was observed in 1st December planting.

A review of the data revealed that increase in plant spacing decreased the plant height significantly. The plants

Table 2: Effect of time of planting and spacing on plant height (cm) after 45 days of transplanting in annual chrysanthemum

Time of Planting	Spacing (cm)				
	S_1 (30x30cm)	**S_2 (30x45cm)**	**S_3 (45x45cm)**	**S_4 (45x60cm)**	**Mean**
T_1 15 Sept.	57.57	54.21	53.09	50.43	**53.82**
T_2 1 Oct.	76.27	72.03	71.29	68.73	**72.08**
T_3 15 Oct.	86.07	81.86	81.96	78.03	**81.98**
T_4 1 Nov.	83.90	81.06	77.95	74.73	**79.41**
T_5 15 Nov.	66.69	63.83	60.28	56.51	**61.83**
T_6 1 Dec.	52.73	50.75	49.53	47.43	**50.11**
Mean	**70.54**	**67.29**	**65.68**	**62.64**	

CD at 5% level

T = 1.95
S = 0.90

T x S = N.S

Table 3: Effect of time of planting and spacing on plant height (cm) after 60 days of transplanting in annual chrysanthemum

Time of Planting	Spacings (cm)				
	S_1 (30x30cm)	**S_2 (30x45cm)**	**S_3 (45x45cm)**	**S_4 (45x60cm)**	**Mean**
T_1 15 Sept.	66.43	64.16	60.62	58.34	**62.39**
T_2 1 Oct.	85.16	83.10	79.33	78.55	**81.54**
T_3 15 Oct.	99.36	95.96	93.15	91.22	**94.92**
T_4 1 Nov.	96.77	94.52	91.10	88.05	**92.61**
T_5 15 Nov.	73.42	71.49	69.33	66.38	**70.15**
T_6 1 Dec.	59.01	55.40	51.56	51.90	**54.47**
Mean	**80.02**	**77.44**	**74.18**	**72.40**	

CD at 5% level

T = 1.53
S = 1.00
T x S = N.S.

which were closely planted attained the maximum height of 80.02 cm where as the plants which were planted at the wider spacing of 45 cm x 60 cm recorded minimum height of 72.40 cm.

The interaction between the time of planting and spacing on plant height was non-significant.

4.1.1.4 Plant height at 90 days after transplanting

A perusal of the data presented in Table 4 shows that the time of planting and spacing had significant effect on plant height. The maximum plant height (102.50 cm) was recorded in 15th October planting followed by 1st November (99.16 cm) and the minimum height (60.51 cm) was observed at 1st December planting.

It is explicit from the data that increase in plant spacing decreased the plant height significantly. The closer spacing of 30cm x 30cm produced plants with the maximum height of 86.83 where as the wider spacing of 45cm x 60cm recorded minimum height of 77.39 cm.

The interaction between time of planting and spacing in plant height after 90 days of transplanting was found to be significant. Maximum plant height of 108.27cm was observed in 15th October planting and 30 cm x 30 cm spacing followed by 105.51 cm height in 15th October planting and 30 cm x 45 cm spacing where as minimum plant height of 56.57 cm was recorded at 1st December planting and 45 cm x 60 cm spacing.

Table 4: Effect of time of planting and spacing on plant height (cm) after 90 days of transplanting in annual chrysanthemum

Time of Planting	Spacings (cm)				
	S_1 (30x30cm)	**S_2 (30x45cm)**	**S_3 (45x45cm)**	**S_4 (45x60cm)**	**Mean**
T_1 15 Sept.	74.15	70.78	66.54	62.44	**68.47**
T_2 1 Oct.	92.10	88.25	84.93	82.44	**86.93**
T_3 15 Oct.	108.27	105.51	100.10	96.15	**102.50**
T_4 1 Nov.	102.48	100.73	97.71	95.74	**99.16**
T_5 15 Nov.	79.63	76.58	73.89	71.00	**75.27**
T_6 1 Dec.	64.35	63.11	58.01	56.57	**60.51**
Mean	**86.83**	**84.16**	**80.19**	**77.39**	

CD at 5% level

T = 1.87
S = 0.80
S at T= 2.06

T at S= 2.53

4.1.2 Plant spread

A perusal of the data presented in Table 5 shows that the time of planting and spacing had significant effect on plant spread. The planting which was done on 15th October produced plants with the maximum plant spread of 84.85cm followed by 1st November planting with 79.77 cm spread and the planting which was done on 1st December recorded minimum plant spread of 44.36cm.

The increase in plant spacing also increased the plant spread significantly. The maximum plant spread (70.48 cm) was recorded at the widest spacing of 45 cm x 60 cm and the minimum plant spread (62.94 cm) was recorded at the closest spacing of 30cm x 30cm.

The effect of interaction between time of planting and spacing on plant spread was found to be non-significant.

4.1.3 Number of branches/plant

It is explicit from the data (Table 6) that time of planting and spacing significantly effected the number of branches per plant. The planting which was done on 15th October resulted in maximum number of branches per plant (27.98) which were at par with 1st November planting (27.64) where as minimum branches (13.88) were recorded in 1st December planting.

It is also clear from the data that with the increase in plant spacing, the number of branches per plant also increased significantly. The maximum number of branches per

Table 5: Effect of time of planting and spacing on plant spread (cm) in annual chrysanthemum

Time of Planting	Spacings (cm)				
	S_1 (30x30cm)	**S_2 (30x45cm)**	**S_3 (45x45cm)**	**S_4 (45x60cm)**	**Mean**
T_1 15 Sept.	57.48	59.15	61.78	63.66	**60.51**
T_2 1 Oct.	71.65	73.28	74.74	76.99	**74.16**
T_3 15 Oct.	80.86	84.33	86.14	88.06	**84.85**
T_4 1 Nov.	75.27	78.75	80.78	84.28	**79.77**
T_5 15 Nov.	52.46	57.21	58.78	61.64	**57.52**
T_6 1 Dec.	39.91	42.97	46.27	48.29	**44.36**
Mean	**62.94**	**65.95**	**68.08**	**70.48**	

CD at 5% level

T = 3.00
S = 1.01
T x S = N.S.

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Table 6: Effect of time of planting and spacing on number of branches per plant in annual chrysanthemum

Time of Planting	Spacings (cm)				
	S_1 (30x30cm)	**S_2 (30x45cm)**	**S_3 (45x45cm)**	**S_4 (45x60cm)**	**Mean**
T_1 15 Sept.	11.50	13.37	15.16	16.16	**14.05**
T_2 1 Oct.	18.60	21.37	23.61	25.02	**22.15**
T_3 15 Oct.	25.77	27.60	28.57	30.00	**27.98**
T_4 1 Nov.	25.87	26.23	28.54	29.94	**27.64**
T_5 15 Nov.	14.27	15.90	17.94	19.58	**16.92**
T_6 1 Dec.	12.34	12.60	14.11	16.49	**13.88**
Mean	**18.06**	**19.51**	**21.32**	**22.86**	

CD at 5% level

T = 0.70
S = 0.53
T x S = N.S.

plant (22.86) were recorded at a spacing of 45 cm x 60 cm and the minimum number of branches per plant (18.06) were recorded at the closer spacing of 30 cm x 30 cm.

The interaction between the time of planting and spacing on number of branches per plant was found to be non-significant.

4.2 FLORAL PARAMETERS

4.2.1 Days to bud appearance

A review of the data presented in Table 7 shows that the planting time, spacing and their interaction significantly effected the days to bud appearance. The minimum days to bud appearance were taken by 1st November planting (39.08) which were at par with 15th October planting (40.08) where as the maximum days to bud appearance were taken by 15th September planting (51.41).

It is evident from the data that increase in plant spacing decreased the days to bud appearance significantly. The minimum days to bud appearance were recorded at the wider spacing of 45 cm x 60 cm (43.05) and the maximum number of days to bud appearance (47.11) were recorded at the closer spacing of 30 cm x 30 cm.

The interaction between time of planting and spacing and days to bud appearance was found to be significant. The minimum days to bud appearance were observed in 1st November planting at the spacing of 45 cm x 60 cm (37.66) which were at par with 1st November and spacing of 45 cm x 45 cm (38.33) and

maximum in 15th September planting and spacing of 30 cm x 30 cm (53.66).

Table 7: Effect of time of planting and spacing on days to bud appearance in annual chrysanthemum

Time of Planting	Spacings (cm)				
	S_1 (30x30cm)	S_2 (30x45cm)	S_3 (45x45cm)	S_4 (45x60cm)	Mean
T_1 15 Sept.	53.66	52.00	51.00	49.00	**51.41**
T_2 1 Oct.	47.00	45.66	42.00	41.00	**43.91**
T_3 15 Oct.	41.33	40.33	39.66	39.00	**40.08**
T_4 1 Nov.	41.00	39.33	38.33	37.66	**39.08**
T_5 15 Nov.	48.00	46.33	44.66	43.66	**45.66**
T_6 1 Dec.	51.66	51.00	49.00	48.00	**49.91**
Mean	**47.11**	**45.77**	**44.11**	**43.05**	

CD at 5% level

T = 1.42
S = 0.52
S at T= 1.35
T at S= 1.80

4.2.2 Days to first flowering

The data pertaining to table 8 revealed that time of planting, spacing and their interaction significantly affected the days to first flowering. The planting which was done on 1st November took minimum days to first flowering (43.03) which was at par with 15th October planting (44.30) whereas the 15th September planting recorded the maximum days to first flowering (55.37).

A perusal of the data shows that increase in plant spacing decreased the days to first flowering. The plants which were widely planted at the spacing of 45 cm x 60 cm took the minimum days to first flowering (47.52) whereas maximum days to first flowering (52.06) were taken by 30 cm x 30 cm spacing.

The interaction between time of planting and spacing was found to be significant. The minimum days to first flowering were taken by 1st November planting at a spacing of 45 cm x 60 cm (42.33) which were at par with 1st November planting at a spacing of 45 cm x 45 cm and 15th October planting at a spacing of 45 cm x 60 cm whereas maximum days were recorded in 15th September planting at the spacing of 30 cm x 30 cm (58.23) and 1st December planting at a spacing of 30 cm x 30 cm (57.09).

4.2.3 Days to 50% flowering

It is obvious from the data presented in table 9 that the time of planting and spacing had significant effect on days to 50% flowering. The minimum days to 50% flowering were

Table 8: Effect of time of planting and spacing on days to first flowering in annual chrysanthemum

Time of Planting	Spacings (cm)				
	S_1 (30x30cm)	S_2 (30x45cm)	S_3 (45x45cm)	S_4 (45x60cm)	Mean
T_1 15 Sept.	58.23	55.63	54.40	53.24	**55.37**
T_2 1 Oct.	54.21	51.61	47.33	45.86	**49.75**
T_3 15 Oct.	45.53	44.87	43.87	42.95	**44.30**
T_4 1 Nov.	44.11	43.11	42.57	42.33	**43.03**
T_5 15 Nov.	53.20	51.85	49.49	47.92	**50.61**
T_6 1 Dec.	57.09	55.71	54.36	52.81	**54.99**
Mean	**52.06**	**50.46**	**48.67**	**47.52**	

CD at 5% level

T = 1.47
S = 0.51
S at T= 1.33

T at S= 1.83

Table 9: Effect of time of planting and spacing on days to 50% flowering in annual chrysanthemum

Time of Planting	Spacings (cm)				
	S_1 (30x30cm)	**S_2 (30x45cm)**	**S_3 (45x45cm)**	**S_4 (45x60cm)**	**Mean**
T_1 15 Sept.	73.89	73.20	72.46	71.68	**72.81**
T_2 1 Oct.	68.33	66.90	65.67	65.45	**66.59**
T_3 15 Oct.	62.78	62.11	60.62	61.03	**61.63**
T_4 1 Nov.	63.78	62.64	61.45	60.57	**62.11**
T_5 15 Nov.	73.50	71.55	70.91	69.75	**71.43**
T_6 1 Dec.	75.98	74.03	71.90	70.76	**73.17**
Mean	**69.71**	**68.40**	**67.17**	**66.54**	

CD at 5% level

T = 1.81
S = 0.56
T x S = N.S.

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taken by 15th October planting (61.63) which were par with 1st November planting (62.11) and the maximum days to 50% flowering were taken by 1st December planting (73.17) which were at par with 15th November planting (71.43) and 15th September planting (72.81).

It is apparent from the data that spacing had significant effect on days to 50% flowering. The minimum days to 50% flowering were recorded at the spacing of 45cm x 60 cm (66.54) and the maximum days to 50% flowering were recorded at the closer spacing of 30 cm x 30 cm (69.71),

The interaction between the time of planting and spacing was found to be non-significant.

4.2.4 Duration of flowering

A review of the data presented in Table 10 shows that time of planting, spacing and their interaction significantly influenced the duration of flowering. The maximum duration of flowering (55.69 days) was observed in 15th October planting which was at par with 1st November planting (54.73 days) whereas the planting which was done on 1st December recorded minimum duration of flowering (37.97 days).

It is explicit from the data that increase in plant spacing upto 45 cm x 45 cm, significantly increased the duration of flowering. The maximum duration of flowering was recorded at the

spacing of 45cm x 60 cm (48.71 days) which was at par with 45 cm x 45 cm spacing (47.87 days) and the

Table 10: Effect of time of planting and spacing on duration of flowering (days) in annual chrysanthemum

Time of Planting	Spacings (cm)				
	S_1 (30x30cm)	**S_2 (30x45cm)**	**S_3 (45x45cm)**	**S_4 (45x60cm)**	**Mean**
T_1 15 Sept.	41.53	42.58	44.85	43.98	**43.23**
T_2 1 Oct.	48.35	49.01	51.16	51.57	**50.02**
T_3 15 Oct.	54.25	55.70	55.96	56.84	**55.69**
T_4 1 Nov.	53.39	54.44	54.89	56.22	**54.73**
T_5 15 Nov.	41.02	42.19	41.95	43.85	**42.25**
T_6 1 Dec.	35.78	37.87	38.41	39.82	**37.97**
Mean	**45.72**	**46.96**	**47.87**	**48.71**	

CD at 5% level

T = 1.84
S = 0.37
S at T= 0.99

T at S= 2.01

minimum duration of flowering was recorded at the closest spacing of 30 cm x 30 cm (45.72 days).

The interaction between time of planting and spacing was found to be significant. The maximum duration of flowering (56.84) was recorded in the 15th October planting at the spacing of 45 cm x 60 cm which was at par with 15th October planting at a spacing of 45 cm x 45 cm (55.96 days) and 1st November planting at a spacing of 45 cm x 60 cm (56.22 days) whereas minimum (35.78 days) was recorded in 1st December planting at the closest spacing of 30 cm x 30 cm.

4.2.5 Size of flower

A perusal of the data shown in table 11 indicated that different planting dates and spacing affected the size of flower significantly. Among the various planting times, 15th October planting recorded the maximum size of flower (4.35 cm) followed by 1st November planting (4.31cm) whereas minimum size of flower (3.87cm) was recorded in 15th September planting.

It is explicit from the data that increases in plant spacing increased the size of flower significantly. The wider spacing of 45 cm x 60 cm recorded maximum size of flower (4.16 cm) and the closer spacing of 30 cm x 30 cm recorded minimum size of flower (3.99 cm).

The interaction between time of planting and spacing on size of flower was found to be non-significant.

Table 11: Effect of time of planting and spacing on size of flower (cm) in annual chrysanthemum

Time of Planting	Spacings (cm)				
	S_1 (30x30cm)	**S_2 (30x45cm)**	**S_3 (45x45cm)**	**S_4 (45x60cm)**	**Mean**
T_1 15 Sept.	3.80	3.83	3.91	3.96	**3.87**
T_2 1 Oct.	4.05	4.09	4.15	4.18	**4.12**
T_3 15 Oct.	4.24	4.30	4.38	4.47	**4.35**
T_4 1 Nov.	4.22	4.27	4.35	4.38	**4.31**
T_5 15 Nov.	3.81	3.88	3.99	4.04	**3.93**
T_6 1 Dec.	3.81	3.87	3.91	3.97	**3.89**
Mean	**3.99**	**4.04**	**4.11**	**4.16**	

CD at 5% level

T = 0.03
S = 0.01
T x S = N.S.

4.3 YIELD PARAMETERS

4.3.1 Number of flowers per plant

A review of the data presented in Table 12 shows that time of planting, spacing and their interaction had significant effect on number of flowers per plant. The planting which was done on 15th October recorded maximum number of flowers per plant (100.75) which was at par with 1st November planting (99.08) and minimum number of flowers per plant (57.91) were recorded in 1st December planting.

The data shows that spacing had significant effect on number of flowers per plant. Among the various spacing, the spacing of 45 cm x 60 cm resulted in maximum number of flowers per plant (84.72) whereas the spacing of 30 cm x 30 cm resulted in minimum number of flowers per plant (70.50).

The interaction between the time of planting and spacing on number of flowers per plant was found to be significant. The 15th October planting recorded maximum number of flowers per plant (108.66) at the spacing of 45 cm x 60 cm and minimum (51.33 and 52.66) were recorded in 1st December and 15th September planting at a spacing of 30 cm x 30 cm, respectively.

4.3.2 Average weight of flower

It is explicit from the data shown in Table 13 that time of planting, spacing and their interaction had significant effect on

average weight of flowers. The maximum average weight of flowers was recorded at 15th October planting (2.87g)

Table 12: Effect of time of planting and spacing on number of flowers per plant in annual chrysanthemum

Time of Planting	Spacings (cm)				
	S_1 (30x30cm)	**S_2 (30x45cm)**	**S_3 (45x45cm)**	**S_4 (45x60cm)**	**Mean**
T_1 15 Sept.	52.66	60.00	64.66	68.33	**61.41**
T_2 1 Oct.	74.33	79.33	82.33	84.00	**80.00**
T_3 15 Oct.	91.00	97.33	106.00	108.66	**100.75**
T_4 1 Nov.	90.66	96.33	103.33	106.00	**99.08**
T_5 15 Nov.	63.00	68.00	73.33	77.66	**70.50**
T_6 1 Dec.	51.33	56.66	60.00	63.66	**57.91**
Mean	**70.50**	**76.27**	**81.61**	**84.72**	

CD at 5% level

T = 2.75
S = 0.66
S at T= 1.74

T at S= 3.09

Table 13: Effect of time of planting and spacing on average weight of flowers (g) in annual chrysanthemum

Time of Planting	Spacings (cm)				
	S_1 (30x30cm)	**S_2 (30x45cm)**	**S_3 (45x45cm)**	**S_4 (45x60cm)**	**Mean**
T_1 15 Sept.	2.25	2.32	2.35	2.39	**2.32**
T_2 1 Oct.	2.46	2.51	2.57	2.65	**2.55**
T_3 15 Oct.	2.75	2.86	2.91	2.97	**2.87**
T_4 1 Nov.	2.74	2.85	2.91	2.94	**2.86**
T_5 15 Nov.	2.49	2.54	2.58	2.61	**2.55**
T_6 1 Dec.	2.21	2.26	2.31	2.36	**2.29**
Mean	**2.48**	**2.55**	**2.60**	**2.65**	

CD at 5% level

T = 0.06
S = 0.01

S at T= 0.33
T at S= 0.07

which was at par with 1st November planting (2.86 g) and the minimum observed in 1st December and 15th September planting (2.29g and 2.32 g).

It is also clear from the data that increase in plant spacing increased the average weight of flowers significantly. The plants which were planted at the spacing of 45 cm x 60 cm recorded maximum average weight of flowers (2.65g) whereas minimum at the spacing of 30 cm x 30 cm (2.48g).

The interaction between the time of planting and spacing was found to be statistically significant. The maximum average weight of flowers (2.97g) was recorded in 15th October planting at the spacing of 45cm x 60 cm and it was minimum (2.21g) 1st December planting a the spacing of 30 cm x 30 cm.

4.3.3 Yield per plant

It is revealed from the data shown in Table 14 that time of planting, spacing and their interaction had significant effect on yield per plant. The planting which was done at 15th October resulted in maximum yield per plant (290.26g) which was at par with 1st November planting (284.08g) whereas minimum yield per plant (132.91) was recorded at 1st December planting.

It is explicit from the data that increase in plant spacing significantly increased the yield per plant. The widest spacing of 45 cm x 60 cm resulted in maximum yield per plant (228.79g) and the

closest spacing of 30cm x 30 cm recorded minimum yield per plant (178.64g).

Table 14: Effect of time of planting and spacing on yield per plant (g) in annual chrysanthemum

Time of Planting	Spacings (cm)				
	S_1 (30x30cm)	**S_2 (30x45cm)**	**S_3 (45x45cm)**	**S_4 (45x60cm)**	**Mean**
T_1 15 Sept.	118.65	139.15	151.93	163.32	**143.26**
T_2 1 Oct.	182.88	199.42	212.19	222.59	**204.27**
T_3 15 Oct.	250.57	278.65	308.75	323.08	**290.26**
T_4 1 Nov.	248.72	274.91	301.06	311.63	**284.08**
T_5 15 Nov.	157.26	172.93	189.20	201.47	**180.21**
T_6 1 Dec.	113.79	128.23	138.98	150.66	**132.91**
Mean	**178.64**	**198.88**	**217.02**	**228.79**	

CD at 5% level

T = 8.31
S = 1.73
S at T= 4.59
T at S= 9.09

The effect of interaction between time of planting and spacing on yield per plant was found to be significant. The yield per plant was maximum in 15th September planting at the spacing of 45 cm x 60 cm (323.08g) followed by 1st November planting at a spacing of 45 cm x 60 cm (311.63 g) whereas minimum (113.79g) in 1st December planting at the spacing of 30 cm x 30 cm.

4.3.4 Yield per acre

It is explicit from the data (Table 15) that the time of planting had significant effect on yield per acre. The planting which was done on 15th September recorded maximum yield per acre (64.33q) which was at par with 1st November planting (63.24 q) whereas 1st December planting recorded minimum yield per acre (29.39q).

A review of the data shows that increase in plant spacing decreased the yield per acre significantly. The closed spacing of 30 cm x 30 cm resulted in maximum yield per acre (67.48q) and minimum yield per acre (28.80q) recorded at the spacing of 45cm x 60 cm.

The interaction between the time of planting and spacing was found to be significant. The maximum yield per acre (94.65 q) was recorded in 15th October planting at the closer spacing of 30 cm x 30 cm which was at par with 1st November planting at a spacing by 30 cm x 30 cm whereas minimum (18.96 q) was found in 1st December planting at the spacing of 45 cm x 60 cm.

Table 15: Effect of time of planting and spacing on yield per acre (q) in annual chrysanthemum

Time of Planting	Spacings (cm)				
	S_1 (30x30cm)	S_2 (30x45cm)	S_3 (45x45cm)	S_4 (45x60cm)	Mean
T_1 15 Sept.	44.81	35.04	25.50	20.56	**31.48**
T_2 1 Oct.	69.08	50.22	35.62	28.02	**45.73**
T_3 15 Oct.	94.65	70.17	51.83	40.68	**64.33**
T_4 1 Nov.	93.95	69.23	50.54	39.23	**63.24**
T_5 15 Nov.	59.40	43.54	31.76	25.36	**40.02**
T_6 1 Dec.	42.98	32.29	23.32	18.96	**29.39**
Mean	**67.48**	**50.08**	**36.43**	**28.80**	

CD at 5% level

T = 2.05
S = 0.60
S at T= 1.57
T at S= 2.42

CHAPTER-V

Discussion

The optimum time of planting and spacing are the important factors in determining the yield and quality of annual chrysanthemum. The yield of annual chrysanthemum can be increased to the optimum level by planting at appropriate time and spacing. In view of the above, the present investigations entitled "Effect of time of planting and spacing on growth, flowering and yield of annual chrysanthemum cv. Local White Double" were conducted under field conditions. The results obtained are discussed below:

5.1 GROWTH PARAMETERS

Growth parameters viz. plant height, spread and number of branches per plant were significantly highest in 15th October planting which were closely followed by 1st November planting. This might be attributed to the fact, that during this period the day and night temperature was very favourable for the vegetative growth resulting in higher plant height, spread and number of branches per plant. The plantings which were done before 15th October have less vegetative growth due to high temperature prevailing at that time. After 1st November planting, the plant height, spread and number of branches per plant decreased significantly due to prevailing low

temperature which dipped further during December and January. Similar results were obtained by Jane *et al.* (2001) in annual chrysanthemum and reported that the plants transplanted between 5th and 15th October recorded maximum plant height, spread and number of branches per plant. Yang *et al.* (1989) also reported that the plantings done in the month of October resulted in maximum plant height and spread in *Chrysanthemum coronarium*. Similar results were obtained by Bres and Jerzy (2004), Nardi *et al.* (2001) and Krijer (1985). Contrary results were reported by Meher *et al.* (1999) and Singh *et al.* (2004).

The results presented in Table 1-6 shows that different spacing proved effective in influencing the growth in terms of plant height, spread and number of branches per plant. The plant height was significantly highest in the closest spacing of 30 cm x 30 cm and minimum in the spacing of 45 cm x 60 cm. This might be ascribed to the fact that the plants which were closely planted does not have enough space to spread their branches, so they grow taller in height. Similar results were obtained by Rao and Singh (1982), Chezhiyan *et al.* (1986), Gowda and Jayanthi (1988), Mildernberger and Hendriks (1996), Singh and Kumar (1999) and Barman and Pal (1999) in chrysanthemum.

It is clear from the results that the plant spread and number of branches per plant were significantly maximum in the widest spacing of 45 cm x 60 cm. It was due to the fact that at wider spacing, there is less competition between the plants for food and

water. As a result more photosynthates synthesized in the plant resulting in more vegetative growth. Similar results were obtained by Dixit (2004), Karavadia and Dhaduk (2002) and Ravindran *et al.* (1986) in which they reported that the plant spread and number of branches per plant were significantly highest in the widest spacing. On contrary, Chezhiyan *et al.* (1986) reported higher number of branches per plant at a spacing of 20 cm x 30 cm as compared to 30 cm x 30 cm and 40 cm x 30 cm spacing.

5.2 FLORAL PARAMETERS

The results presented in Table 7-11 indicated that different planting times proved effective in influencing the floral development in terms of days to bud appearance, first flowering and 50% flowering, duration of flowering and size of flower. The days to bud appearance and first flowering were recorded minimum in 1st November planting whereas days to 50% flowering were recorded minimum in 15th October planting. Before 15th October and after 1st November plantings, the days to bud appearance, first flowering and 50% flowering, increased significantly, due to slow vegetative growth, thus entering late in reproductive phase. This might be ascribed to the fact that occurrence of favourable temperature around 15th October to 1st November resulted in optimum vegetative growth in short period, resulting in early flowering since it was possible to prepare enough photosynthates which is a prerequisite in many of the flowering plants to turn to reproductive phase. These results are in close conformity with those of Jane *et al.*

(2001) in which they reported minimum days were taken to bud appearance, first flowering and 50% flowering by the plants transplanted between 5th and 15th October. Grewal *et al.* (2004), Deotale *et al.* (1994) and Hong and Jeong (1998) also reported similar results. On contrary, Shin *et al.* (1986) reported that the rooted cutting planted in December recorded minimum days to bud appearance. Nambisan and Krishnan (1983) suggested to plant the bulbs of tuberose in the month of July-August for better flowering.

The minimum duration of flowering and size of flower was shown by the plantings which were done before 15th October and after 1st November. The duration of flowering and size of flowers were recorded maximum in 15th October planting which was at par with 1st November planting. It might be attributed to the fact that in these very plantings there is continuous and more formation of photosynthates due to favourable temperature, which resulted in longer duration of flowering and bigger flower size. Contrary to this, Zalewska (1986) reported that the first half of February was the best time for planting of chrysanthemum to obtain longer duration of flowering where as planting in March had a beneficial effect on flower size. Similarly, Biswas (2000) and Zizoo *et al.* (1986) reported that March planting of tuberose bulbs was found to be better than other planting time which recorded longest duration of flowering.

In case of spacing, the days to bud appearance, first flowering and 50% flowering were recorded minimum in the plant spacing of 45 cm x 60 cm. This may be due to the reason that in

wider spacing, the plants complete their vegetative growth early in the season due to less competition for food and water and thus enters into the reproductive phase early. Machin and Potter (1983), John and Paul (1995), Mohanty *et al.* (1997) and Khobragade *et al.* (1997) also observed that in wider spacing minimum days were taken to bud appearance, and 50% flowering. On the other hand, Beniwal *et al.* (2005) reported earliest bud initiation and flowering at a spacing of 20 cm x 20 cm as compared to 20 cm x 30 cm and 20 cm x 40 cm spacing.

The duration of flowering and size of flower were recorded maximum in the widest spacing of 45 cm x 60 cm. Development of more photosynthates due to increased photosynthetic activity in wider spacing might be responsible for longer duration and bigger flower size. Farina and Paterniani (1986) observed that bloom diameter fell with increasing plant density. Similar results were reported by Belgaonkar *et al.* (1997), Glas and Breedveld (1984) and Belorkar *et al.* (1992).

5.3 YIELD PARAMETERS

Flower yield in terms of number of flowers per plant and average weight of flowers was recorded maximum in 15th October planting which were at par with 1st November planting. Plants raised in these planting times were exposed to favourable climatic conditions thus produced more shoots and leaves early in the season, entered early into flowering and ultimately gave higher flower yields. These results are in close conformity with those of Gill *et al.*

(1985) in which they reported that with every delay in planting from October onwards, the quality and yield of blooms decreased to great extent. The results are similar to the finding of Mishra (1999). Contrary to this Meher *et al.* (1999) reported that cut flowers yield were highest from May planting in chrysanthemum. Similar results are reported by Datta (2000).

In case of spacing, the number of flowers per plant, average weight of flowers and yield per plant were recorded maximum in the plant spacing of 45 cm x 60 cm. This might be attributed to the fact that at wider spacing, due to less competition between plants for food and water maximum photosynthetic activity takes place resulting in synthesis of more photosynthates. Similar results are reported by Sastry *et al.* (1989), Ravindran *et al.* (1986) and Rao *et al.* (1992) in which they reported maximum number of flowers per plant, average weight of flowers and yield per plant at wider spacing. The closest spacing of 30 cm x 30 cm resulted in maximum yield per acre. These results are in conformity with those of Belgaonkr *et al.* (1996), Yang *et al.* (1989) and Ravindran *et al.* (1986) in which maximum yield per hectare was reported at the closest spacing.

CHAPTER-VI

Summary and Conclusion

The findings of the present investigations entitled, "Effect of time of planting and spacing on growth, flowering and yield of annual chrysanthemum (*Chrysanthemum coronaium* L.) cv. Local White Double" were carried out during the year 2004-05 with a view to standardize the agrotechniques like time of planting and spacing for maximizing the production of annual chrysanthemum. The salient findings of the investigations are summarized as under:

The plant height was taken at four interval viz. 30, 45, 60 and 90 days after transplanting. The maximum increase in growth was observed in first 45 days of transplanting. The maximum plant height was recorded in 15th October planting and the minimum height was observed in 1st December planting. The close spacing of 30cm x 30cm recorded maximum plant height whereas widest spacing of 45cm x 60cm recorded minimum height.

The plant spread and number of branches per plant were observed maximum in 15th October planting whereas minimum in 1st December planting. The number of branches per plant were also maximum in 15th October planting but at par with 1st November planting. In case of spacing, the widest spacing of 40cm x 60cm

recorded maximum plant spread and number of branches per plant. Which decreased with increase in plant density.

The minimum days to bud appearance and first flowering were taken by 1st November planting which were at par with 15th October planting whereas maximum days were taken by 15th September planting. The widest spacing of 45cm x 60cm recorded minimum days to bud appearance and first flowering whereas maximum day were recorded in the closest spacing of 30cm x 30cm.

The minimum days to 50% flowering were taken by 15th October planting which were at par with 1st November planting. The widest spacing of 45cm x 60cm recorded minimum days to 50% flowering which increased with the increasing plant density.

The maximum duration of flowering was observed in 15th October planting which was par with 1st November planting whereas the planting which was done on 1st December recorded minimum duration of flowering. In case of spacing, the widest spacing of 45cm x 60cm recorded maximum duration which was at par with 45cm x 45cm spacing and the minimum duration of flowering was observed at the closest spacing of 30cm x 30cm.

Among the various planting times, 15th October planting recorded the maximum size of flower whereas minimum size of flower was recorded in 15th September planting. The wider spacing of 45cm x 60cm recorded maximum size of flower which decreased with the increase in plant density.

The maximum number of flowers per plant and average weight of flowers was observed in 15th October planting which was at par with 1st November planting whereas minimum was found in 1st December planting which was at par with 1st November planting in case of average weight of flowers only. The wider spacing of 45cm x 60cm recorded maximum number of flowers per plant and average weight of flowers where as found minimum in the 30 cm x 30 cm spacing.

The maximum yield per plant was obtained in 15th October planting which was at par with 1st November planting and the minimum yield per plant was observed in 1st December planting. The spacing of 45cm x 60cm recorded maximum yield per plant and the closer spacing of 30cm x 30cm recorded minimum yield per plant.

The yield per acre was also recorded maximum in 15th October planting which was at par with 1st November planting yield per acre recorded whereas 1st December planting recorded minimum yield per acre. The closest spacing of 30cm x 30cm recorded maximum yield per acre and the widest spacing of 45cm x 60cm recorded minimum yield per acre.

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ANNEXURE-I

Weekly meteorological data during crop growing season 2004-05

Standard weeks	Temperature (ºC)		AVP (mm)		Relative humidity (%)		Sunshine (hrs.)	PAN Evp. (mm)	Rainfall (mm)
	Max.	Min.	M	E	M	E			
35	35.8	23.8	21.2	21.2	80	49	9.2	6.7	0.0
36	36.9	22.2	18.1	15.1	73	32	9.8	7.3	0.0
37	36.8	23.5	18.5	20.1	75	49	8.8	6.4	38.0
38	33.1	23.1	21.1	20.7	87	54	8.2	4.6	0.0
39	34.3	21.1	19.5	15.3	81	39	8.9	5.2	3.0
40	32.8	21.2	19.9	20.1	88	58	7.2	3.4	28.4
41	31.3	18.2	17.7	14.8	88	50	7.3	4.2	8.0
42	31.3	15.8	14.0	12.1	82	36	8.4	4.9	0.0
43	30.5	12.5	12.2	9.4	89	30	6.4	4.3	0.0
44	28.3	9.8	10.9	9.3	89	33	7.5	2.9	0.0
45	29.4	7.3	8.7	8.4	92	28	8.7	3.4	0.0
46	30.0	9.2	9.9	8.4	88	27	7.0	3.7	0.0
47	30.2	10.7	11.3	10.8	92	39	7.6	2.9	0.0
48	24.6	11.4	11.6	12.4	93	55	4.1	2.1	0.0
49	24.4	6.0	7.7	8.8	92	40	7.1	2.5	0.0
50	23.8	4.1	7.5	8.6	93	39	6.9	1.7	0.0
51	22.6	7.5	8.9	9.8	95	58	4.3	1.8	0.0
52	18.8	5.7	8.0	8.4	96	56	3.7	1.4	2.0
1	18.4	5.2	7.7	9.1	95	57	3.4	4.5	13.0
2	20.4	3.5	7.1	7.6	94	43	2.3	6.7	0.0
3	18.9	4.0	6.7	7.7	88	50	2.8	5.4	0.0
4	15.9	3.7	7.1	8.4	94	65	4.2	2.0	9.2
5	18.1	2.7	6.8	7.5	91	47	2.9	8.0	0.0
6	19.3	11.4	11.5	12.7	95	78	7.9	3.2	51.5
7	22.3	10.0	10.5	11.6	94	61	5.3	6.5	5.0
8	19.1	3.4	7.7	7.7	95	47	3.6	8.2	0.0
9	24.5	9.7	10.9	12.7	94	55	4.5	6.5	2.0
10	25.8	12.8	13.1	14.6	97	64	5.2	5.9	39.0
11	29.0	14.6	13.7	16.1	96	53	3.1	9.6	0.0
12	28.4	13.7	13.5	14.0	91	49	5.7	9.0	16.2
13	30.1	12.1	12.9	89.5	88	30	3.8	9.7	0.0
14	35.7	14.1	11.0	8.5	64	19	5.5	9.7	0.0
15	32.8	12.1	8.5	5.4	48	15	5.6	8.4	0.0

16	37.9	16.0	9.6	7.2	44	15	4.1	9.2	0.0
17	35.7	18.9	14.7	13.6	68	35	5.3	7.2	16.5

ABSTRACT

Title of thesis	:	**Effect of time of planting and spacing on growth, flowering and yield of annual chrysanthemum**
Name of degree holder	:	**Ankush Joshi**
Title of degree	:	Master of Science
Name and address of Major advisor	:	**Dr. D.S. Dahiya** Associate Professor Department of Horticulture College of Agriculture CCS Haryana Agricultural University, Hisar- 125004
Degree awarding University/Institute	:	Chaudhary Charan Singh Haryana Agricultural University, Hisar-125004, Haryana (INDIA)
Year of award of degree	:	2006
Major subject	:	Horticulture
Total number of pages in the thesis	:	55+vi
Number of words in the abstract	:	Approx. 320

Key words: Annual chrysanthemum, time of planting and spacing

The present investigations entitled, “Effect of time of planting and spacing on growth, flowering and yield of annual chrysanthemum” were carried out at the experimental orchard, Department of Horticulture, Chaudhary Charan Singh Haryana Agricultural University, Hisar during the year 2004-05. The experiment was laid out in split plot design having six planting times (mid September to December) and four spacings (30 cm x 30 cm, 30 cm x 45 cm, 45 cm x 45 cm and 45 cm x 60 cm) with three replications.

The plant growth in terms of plant height, spread and number of branches per plant was recorded maximum in 15th October planting whereas minimum in 1st December planting. The number of branches per plant were found maximum in 15th October planting which was at par with 1st November planting. The days to bud appearance and first flowering were recorded minimum in 1st November planting which were at par with 15th October planting. The minimum days to 50% flowering were taken by 15th October planting which were at par with 1st November planting. The maximum duration of flowering and size of flower was observed in 15th October planting. In case of yield parameters, the number of flowers per plant, the maximum average weight of flowers, yield per plant and yield per acre and were observed maximum in 15th October planting which were at par with 1st November planting whereas minimum in 1st December planting.

The maximum plant height was recorded at the closest spacing of 30 cm x 30 cm which decreased with increase in spacing. The maximum plant spread and number of branches per plant were recorded at the widest spacing of 45 cm x 60 cm. The minimum days bud appearance, first flowering and 50% flowering were recorded in 45 cm x 60 cm spacing. The duration of flowering and size of flower was also recorded maximum in the spacing of 45 cm x 60 cm. The number of flowers per plant, average weight of flowers and yield per plant was recorded maximum at the widest spacing of 45 cm x 60 cm whereas minimum in 30 cm x 30 cm spacing. The maximum yield per acre was recorded at the closest spacing of 30 cm x 30 cm which decreased with increase in spacing.

MAJOR ADVISOR

SIGNATURE OF STUDENT

HEAD OF THE DEPARTMENT