STUDIES ON CHRYSANTHEMUM CULTIVARS FOR PHOTOPERIODIC RESPONSE UNDER NORTHERN DRY ZONE OF KARNATAKA

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STUDIES ON CHRYSANTHEMUM CULTIVARS FOR PHOTOPERIODIC RESPONSE UNDER NORTHERN DRY ZONE OF KARNATAKA

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By

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C E R T I F I C A T E

This is to certify that the thesis entitled "**STUDIES ON CHRYSANTHEMUM CULTIVARS FOR PHOTOPERIODIC RESPONSE UNDER NORTHERN DRY ZONE OF KARNATAKA**" submitted by **Savita Basappa Parit** for the degree of **MASTER OF SCIENCE (HORTICULTURE)** in **FLORICULTURE AND LANDSCAPE ARCHITECTURE,** of the University of Horticultural Sciences, Bagalkot, is a record of research work carried out by her during the period of her study in this university, under my guidance and supervision, and the thesis has not previously formed the basis of the award of any degree, diploma, associateship, fellowship or other similar titles.

Place: Arabhavi

Date: July, 2013

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JULY, 2013 **(SAVITA BASAPPA PARIT)**


Affectionately dedicated to
My Beloved Parents,
Sisters and Teachers

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1. INTRODUCTION

Chrysanthemum is a leading commercial flower crop grown for cut, loose flowers and pot plants. It is commonly known as 'Queen of East', 'Autumn Queen' and '*Guldaudi*.' It ranks second in the International cut flower trade. Today the chrysanthemum has earned tremendous popularity in floriculture industry due to wide range of flower colour, forms and their excellent keeping quality. In India, it occupies a place of pride, both as commercial flower crop and as a popular exhibition flower. The major use of chrysanthemum in our country is for making garlands, *veni*, bracelets and for religious offering. Chrysanthemums have been successfully bred into a wide variety of colors, shapes, and textures, making them the flower of choice for the mass-market bouquet business (Winogrond, 1999).

The genus *Chrysanthemum* (Local names- Sanskrit: Sevanti, Hindi: Guldaudi, Bangla: Chandramallika, Kannada: Sevantige, Marathi: Shevati, Tamil: Akkarakkaram, Telgu: Chamunti, Punjabi: Gondi, Guledawoodi) belongs to the family Asteraceae. It is widely spread in temperate, tropical and subtropical regions of the globe. Several species of chrysanthemum are ornamental; and are grown in gardens for their beautiful flowers. Among different species, the autumn flowering garden chrysanthemum *i.e., Dendranthema grandiflorum* Tzvel. is most important flower crop throughout the world.

It is grown in many parts of the world and is among the three best selling flowers, owing to its unsurpassed beauty and economic values. It is originated in China. In India, earliest mention of chrysanthemum in Marathi literature was found in *Gyaneshwari*, the treatise on '*Gita*' by Saint Gyaneshwer in the 13th century A. D. However, the modern varieties, specially the large flowered ones, were introduced in India by the Britishers in 19th century (Bhattacharjee, 2003).

According to NHB database 2011-12, area under loose flower cultivation in India is 192 thousand hectare, 1033 thousand million tonnes production with 5.7 MT/ha productivity. In India, the major chrysanthemum growing states are Tamil Nadu, Karnataka, Maharashtra, Rajasthan, Madhya Pradesh and Bihar. It's cultivation around cities like Delhi, Kolkata, Lucknow, Kanpur, Bengaluru, Pune, Chennai and Allahabad is mainly for the purpose of decoration and for participation in flower

shows. According to statistics of horticultural crops in Karnataka state 2010-11, area under chrysanthemum cultivation in Karnataka is 4484 ha, 5667 MT production with 11.60 MT/ha productivity. Karnataka major chrysanthemum growing districts are Kolar, Bengaluru, Chitradurga, Haveri, Gadag, Mandya, Hassan, Tumkur, Davanagere and Belgaum.

Chrysanthemum is gaining lot of importance in recent days. The improvement of chrysanthemum depends on the identification of genotypes for different agro climatic conditions. Identification of cultivars will help the farmers for successful commercial cultivation of chrysanthemum. Increased flower production, quality of flowers and perfection in the form of plants are the important objectives to be reckoned in commercial chrysanthemum flower production. Though the yield potentiality is primarily a varietal trait, it is greatly influenced by prevailing climatic conditions. Different varieties / cultivars are being cultivated in different parts of our country and they vary very much in their performance. Cultivar 'Kundan' was superior as compared to other cultivars under Pune conditions (Anon., 1985), whereas 'Saraval' cultivar was superior over other cultivars under Dharwad conditions (Barigidad, 1991).

Flowering of chrysanthemum is very seasonal, generally from August to December. Exposing of crops to optimum climatic conditions goes a long way in maximizing the flower yields. Raman *et al.* (1969) recorded the highest yield in May planting, whereas Shanmugan and Muthuswamy (1973) recommended planting of chrysanthemum in July.

Chrysanthemum is a short day plant. It develops flower buds when days are less than 12 hours long and the blooming period is short under traditional cultural method. For commercial floriculture, programmed blooming is necessary for year round availability of flowers. Extensive work has been done to categorize the leading varieties into their response group and their sensitivity to photoperiodism for year round blooming. Results have tremendous commercial importance (Dutta and Gupta, 2012).

Flowering in chrysanthemum is controlled by length of day or rather length of light. During long days chrysanthemums form leaves and the increase in stem length and during short days flowers are formed in the stem apex and growth in length

terminates with the flowers. In natural conditions the chrysanthemum grows in length and produces leaves during the long days of summer, but in the shorter days of late summer and early fall, flower buds form and the plant flowers (Prasad and Kumar, 2005).

Chrysanthemum is classified as photo sensitive crop. However response varies with cultivars, hence there is a need to know the performance of the cultivars across the season under GLBC (Ghataprabha Left Bank Canal) area. In fact, Ghataprabha left bank canal is a 'boon' to the farmers of this area. Therefore, identification of high yielding cultivars for year round cultivation can be a great help to the farmers to take up chrysanthemum cultivation in a profitable manner. Therefore, a study was undertaken with the following objectives:

1) To study the performance of different cultivars across the different planting months for growth, yield and quality parameters.
2) To identify the constraints involved in cultivation during different months.
3) To work out the economics of chrysanthemum cultivation.

2. REVIEW OF LITERATURE

Chrysanthemum is one of the important commercial flower crops grown for it's attractive coloured flowers which are used as loose as well as cut flowers. Even though several varieties/ cultivars are under cultivation, their performance vary with different agro-climatic conditions. It is a photosensitive crop, the response also varies with cultivars.

Light, temperature and relative humidity are most important limiting factors for plant growth and development. Climatic factors like day length, day and night temperatures and relative humidity have greater influence on the performance of crops in terms of vegetative growth, flower initiation, flower development, yield and quality of flowers and incidence of pests and diseases. Adverse effect of these climatic factors may lead to low yields or complete failure of the crop.

The information on response of cultivars with respect to photoperiod is reviewed. Wherever the information on the above aspects of chrysanthemum is meagre, the information on other related crops is also reviewed. Reviews pertaining to the objectives of study are cited under the following major heads.

2.1 Season / date of planting

2.2 Varietal performance

2.3 Season v/s variety

2.1 Season / date of planting

2.1.1 Effect of season / date of planting

2.1.2 Effect of light

2.1.3 Effect of temperature

2.1.4 Effect of relative humidity

2.1.1 Effect of season / date of planting

2.1.1.1 Effect of season / date of planting on vegetative parameters of chrysanthemum

Influence of date of planting on the chrysanthemum has been reported previously by very few workers. Planting in May resulted in good and well developed plants, while late plantings resulted in reduction in stem height and overall vegetative growth in chrysanthemum (Kiyatkin, 1975). The plant height was promoted by early planting when wild chrysanthemums were sown at monthly intervals from June to August (Shin *et al.,* 1995). Plant height was maximum in chrysanthemum cv. Raja in case of June planting at 120 days after planting (Deotale *et al.,* 1995).

Chrysanthemum planting in May at Pune conditions produced the tallest and most spreading plants when compared to June or July plantings (Meher *et al.,* 1999a). Chrysanthemum cv. Vasantika planted in July and August resulted the maximum plant height, plant spread and number of branches over September planting (Dahiya *et al*., 2007). Chrysanthemum cv. Saraval planting in April-May produced maximum plant height with more number of primary and secondary branches compared to later months of planting (Kulkarni and Reddy, 2008). Among the four dates of planting in chrysanthemum *i.e.,* 18th February, 18th April, 17th June and 16th August, plant height was reduced with later planting dates (Aamir *et al.,* 2009). Plant height was maximum in chrysanthemum cv. Arati in case of July planting at Bihar condition (Sudhendu and Pal, 2011).

2.1.1.2 Effect of season / date of planting on reproductive parameters of chrysanthemum

Previous research have reported the influence of date of planting on reproductive parameters of chrysanthemum. The days from planting to bud appearance was favoured by later planting dates when chrysanthemum cv. Chandrama was planted at 2 weeks intervals from 15th July to 30th September (Barman *et al.,* 1993). Among the four dates of planting in chrysanthemum *i.e.,* 15th May, 4th June, 24th June and 14th July, time of bud initiation, flower opening and the difference between the two were reduced with later planting dates (Deotale *et al.,* 1994). Later planting dates delayed flowering when wild chrysanthemum was sown at monthly

intervals from June to August (Shin *et al.,* 1995). Among the planting dates, July planted plants were early to reach 50 per cent flowering at Pune conditions (Meher *et al.,* 1999b).

The yield was highest from the May planting and it was decreased with the later plantings upto November in *chrysanthemum indicum* (Raman *et al.,* 1969). Among the four planting dates of chrysanthemum *i.e.,* 15th May, 4th June, 24th June and 14th July, planting on 24th June gave the highest flower yield of 474 g per plant (Deotale *et al.,* 1994). Among the planting dates, cut chrysanthemum flower yield was the highest in May planting at Pune conditions (Meher *et al.,* 1999b). Chrysanthemum cv. Vasantika planted in July and August resulted in early flowering, maximum duration of flowering, more number of flowers per plant and yield per plant over September planting (Dahiya *et al*., 2007).

In chrysanthemum the number of flowers per plant decreased with plant density and this decrease was larger in summer than in winter (Lee *et al.,* 2002). The early planting in April-May was found best to obtain higher yields and quality flowers compared to later months of plantings in chrysanthemum cv. Saraval (Kulkarni and Reddy, 2008). Among the four dates of planting in chrysanthemum *i.e.,* 18th February, 18th April, 17th June and 16th August, planting on 18th February gave the highest fresh flower yield of 283.57 g per plant (Aamir *et al.,* 2009). The early planting of 15th July was found superior to obtain early flowering than 30th July and 15th August in chrysanthemum cv. Arati at Bihar conditions (Sudhendu and Pal, 2011). In chrysanthemum the highest number of flower heads was obtained in the plants potted between 2nd March and 2nd September and flowering from the end of April to November (Marek and Bres, 2011).

The flowers of chrysanthemum cv. Raja were heaviest (2.15 g) in 24th June planted plants as compared to 15th May, 4th June, 24th June and 14th July planting dates. The mean diameter of flowers was highest from the May planting and it decreased in later plantings (Raman *et al.,* 1969). Planting of chrysanthemum on 24th June resulted in the production of largest flowers (6.42 cm diameter) among the four planting dates *i.e.,* 15th May, 4th June, 24th June and 14th July (Deotale *et al.,* 1994). There was reduction in flower size in summer forcing as compared to natural cultivation in autumn (Shin *et al.,* 1994). The highest saleable chrysanthemum flowers

were obtained from the plants planted in July and August than from those plants planted in the month of September (Gill *et al.,* 1995). The flowers of chrysanthemum cv. Saraval were heaviest (2.12 g) in May planted plants as compared to delayed planting dates (Kulkarni and Reddy, 2008). The mean diameter of flowers was the highest from the May planting and it decreased in later plantings (Kulkarni and Reddy, 2010). The flower diameter and mean number of flowers per plant was observed maximum in 15th July planting than 30th July and 15th August in chrysanthemum cv. Arati at Bihar conditions (Sudhendu and Pal, 2011).

2.1.2 Effect of light

2.1.2.1 Effect of light on vegetative parameter of chrysanthemum

Lawrence (1950) and Hassan and Newton (1975) found that a daily radiation integral 1.2 and 1.6 MJ/m^2/day is necessary for adequate growth in chrysanthemum. The application of artificial light (400-W high-pressure sodium lamps) enhanced the number of flower buds and reduced the production time in *Dendranthema grandiflora* Tzvelev. Cultivar 'Surf' (chrysanthemum) was successfully grown in a greenhouse with supplementary light during short-day conditions (11 hours) (Andersson, 1990). According to Antably *et al.* (1991) the indigenous gibberellin contents (bioassayed) gradually decreased under short days, but increased under long days to a level at which roots were formed in chrysanthemum. Endogenous auxin contents behaved similarly, but the levels of growth inhibitors increased somewhat under short day condition. The short day treatment (8 or 8.5 hours) to the vegetative shoots of garden chrysanthemum resulted in quick initiation of flower buds (Cockshull and Kofranek, 1992). The plant height of wild chrysanthemum was reduced by short day treatment *i.e.*, 7 hours treatment (Shin *et al.,* 1995). In contrast, long days (16 hours) promoted stem elongation in chrysanthemum (Yulian *et al.,* 1995).

Janakiram *et al.* (2004) studied on effect of different photoperiod for production of cut flower chrysanthemum cv. Ravikiran under low cost polyhouse and reported that the 10 hour dark and 14 hour light period resulted the maximum plant height (77.73 cm), stem girth at bottom (0.62 cm) and leaf area (102.03 m^2) followed

by 11 hour dark and 13 hour light period. Guo *et al.* (2010) opinioned that the suitable light environment for growth of *Chrysanthemum morifolium* at vegetative stage is about 60-80 per cent of full sunlight. Leaf expansion and stem elongation occurred at a faster rate in plants grown in short days with irregular light breaks during the night period compared with plants grown in a climate with a consecutive long light period (Katrine and Carl, 2011).

2.1.2.2 Effect of light on reproductive parameters of chrysanthemum

The short-day plant *Chrysanthemum morifolium* cv. Polaris initiated flower buds in all irradiances of continuous light from 7.5 to 120 W m^{-2} (Cockshull, 1978). The optimum day length for flower bud differentiation and development in chrysanthemum is nine to ten hours (Nishio *et al.,* 1989). The short day treatment (8 or 8.5 hours) to the vegetative shoots of garden chrysanthemum resulted in quick initiation of flower buds (Cockshull and Kofranek, 1992). Garden chrysanthemums *[Dendranthemum* × *grandiflorum* (Ramat.) Kitamura] are characterized by early flowering in September and October when grown out-of-doors and by rapid flowering in short days (Kenneth and Anton, 1992). Short day treatment (7 or 11 hours) for four weeks promoted early flowering in wild chrysanthemum (Shin *et al.,* 1995). There was delay in commencement of flowering in chrysanthemum cv. CO-1 with a day length of 18 hours for 30 days beginning two months after planting (Dutta *et al.,* 1995). According to Hanke (1996), chrysanthemum plants grown in natural day length bloomed much later than those subjected to shorts day (19.8 hours dark period). Longer the day length earlier was the bud initiation in crysanthemum (Yulian *et al.,* 1995). Duration of flowering (205.33 days) was the longest when plants were subjected to day length of 16 hours beginning one month after planting for 15 days (Dutta *et al.,* 1995).

Ten hours dark and fourteen hours light period resulted in earliest flower initiation (124.67 days) and earliness to reach 50 per cent flowering (137.33 days) in chrysanthemum cv. Ravikiran grown under low cost polyhouse (Janakiram *et al.,* 2004). Flower initiation and developments were delayed when chrysanthemum was grown under low light conditions, but to extent of this delay depends on the cultivar Ravikiran (Van and Heuvelink, 2006).

In chrysanthemum cv. Reagan Sunny flower initiation was promoted by 8 hour photoperiod and delayed by 8 hours daylight and buds formed under 4 hour incandescent to develop into flowers (Kahar, 2008). Short-day treatment applied from 5.00 pm to 9.00 am induced the highest number, length and diameter of cut flowers and also the number of cut flower stems obtained from chrysanthemums that were covered at 5.00 pm to 9.00 am was more than double that obtained from control plants (Sipho and Paul, 2010).

A natural long day length suppressed flower bud development and promoted the formation of many involucral bracts in the capitulum, compared with inflorescences of plants grown under a 12 hour day length in chrysanthemum (Takahiro *et al.,* 2010). Flowering is effectively inhibited when the required long-night phase is interrupted by a short period of exposure to red light (night break) in chrysanthemum (Yohei *et al.,* 2012). Chrysanthemum develops flower buds when days are less than 12 hours long and the blooming period is short under traditional cultural method (Dutta and Gupta, 2012).

2.1.3 Effect of temperature

2.1.3.1 Effect of temperature on vegetative parameters of chrysanthemum

The lateral shoots and internodes were longer than the normal when the temperature exceeded 30^{o}C during the dark periods, but they were shorter than normal when the temperature exceeded 25^{o}C during the dark periods in chrysanthemum (Nishio *et al.,* 1989). A six hour drop in day temperature reduced the shoot length of chrysanthemum which was more pronounced when the drop treatment was given at the start of the day and the effectiveness increased with increasing temperature drop upto 8^{o}C (Cockshull *et al.,* 1995).

In chrysanthemum cv. Powerhouse, cool night temperature was ineffective in preventing a decrease in lateral branching of plants grown under high (35 ^{o}C) day temperature condition (Faust and Heins, 1992). Number of incomplete leaves in chrysanthemum increased when the temperature exceeded 25 ^{o}C during the dark periods (Nishio *et al.,* 1989). Dry matter in chrysanthemum was low with negative DIF (difference between day temperature and night temperature) for two hour around midnight (Jensen, 1993). In a greenhouse experiment with 25 chrysanthemum

cultivars, a significant variation was observed in temperature response (16 or 20 ^{o}C) for reaction time, total dry weight produced and stem length (Anke *et al.,* 2007).

2.1.3.2 Effect of temperature on reproductive parameters of chrysanthemum

Flowering was delayed in chrysanthemum when the temperature exceeded 25^{o}C in darkness during flower development (Nisho *et al.,* 1989). The rate of progress of flowering increased linearly with increasing effective temperature in chrysanthemum (Pearson *et al.,* 1993). There was a reduction in number of days taken to visible bud appearance in chrysanthemum cv. Choral Charm when grown at night temperature for two hours before sunrise (Jensen, 1993). Kaori *et al.* (2007) reported that fluctuation of August flowering time of cv. Iwa-no-hakusen was induced by fluctuation of temperature, and the low temperature induced delay in autumn flowering chrysanthemum type cv. Jinba in the Tohoku region. Lowering the day-time temperature to approximately 16°C, and compensating with a warmer night, delayed flowering by up to 2 weeks in chrysanthemum (Adams *et al.,* 2009). Delayed flowering of 'Seiun' chrysanthemum was noticed in the plants grown in short days at a day temperature of 30°C or more, or at a night temperature of 20°C or more (Takahiro *et al.,* 2009).

2.1.4 Effect of relative humidity

2.1.4.1 Effect of relative humidity on vegetative parameters of chrysanthemum

The shoot length and leaf area increased significantly in chrysanthemum with increased in relative humidity from 60 to 90 per cent (Gislerod and Mortensen, 1991). Among the humidity treatments of 0.1, 0.4, 0.7 and 1.1 Kpa vapour pressure deficit, there was some reduction in total leaf area of chrysanthemum in the highest humidity treatment (Hand *et al.,* 1996).

2.1.4.2 Effect of relative humidity on reproductive parameters of chrysanthemum

There was a reduction in the time taken for flowering in chrysanthemum as the relative humidity increased from 60 to 90 per cent (Gislerod and Mortensen, 1991).

High humidity delayed the flower development upto four to five days in chrysanthemum (Hand *et al.,* 1996). Higher relative humidity increased the flower induction (number of flower) in chrysanthemum (Gislerod and Mortensen, 1991). According to Hand *et al.* (1996), high humidity at harvest stage resulted in reduction in flower dry weight. The lowest vapour pressure deficits of 155, 420 and 660 Pa (corresponding to 93, 81 and 70% relative air humidity) delayed flowering by three to four days in pot and cut chrysanthemum (Mortensen, 2000).

2.2 Varietal performance

2.2.1 Vegetative parameters

Wilfert (1985) evaluated chrysanthemum cultivars grown as centre disbudded plants in six inch containers. The cv. Garland produced maximum plant height (40.25 cm) with maximum plant diameter (17.3 inches), while the cv. Esta produced the smallest plants (25.00 cm). The cv. Ritz recorded the lowest plant diameter (12.80 inches). Kanamadi and Patil (1993) studied the performance of eight chrysanthemum cultivars in the transitional tract of Karnataka and recorded the highest plant height (82.67 cm) in cultivar Basanthi, the lowest (29.50 cm) in Sharadmala. The maximum number of leaves per plant was observed in the cultivar Red Gold (168.33) and it was minimum in CO-1 (58.00). The cv. CO-1 produced the highest number of branches (20.33), while Basanthi (4.00) produced the lowest. Mishra (1999) reported the tallest plants with maximum plant spread in cv. Suneel.

Anuradha *et al.* (2000) evaluated seventeen varieties of chrysanthemum to ascertain their suitability for raising as pot mums under North Indian conditions. The ideal plant height for a 15 cm pot was recorded in varieties Arun Singar, Hemant Singar, Pancho, Sharad Singar and Suhag Singar. Evaluation of chrysanthemum cultivars under two different environmental conditions (open and polyhouse) by Gaikwad and Dumbrepatil (2001) revealed that polyhouse planting resulted in better growth compared to open planting. The cultivar Indira had maximum height and spread and higher number of branches as compared to other cultivars.

In an evaluation of chrysanthemum cultivars under sub-tropical humid climate of West Bengal, some cultivars exhibited significant differences for plant height,

which ranged from 25.93 cm (Amar) to 67.02 cm (Maharaja). The maximum number of branches (10.32) per plant was recorded in Red Gold (Mukeshkumar and Chattopadhyay, 2002).

Manohar and Pratap (2006) evaluated ten chrysanthemum varieties and reported the maximum plant height at first bud appearance stage was recorded in Neelima (57.33 cm), whereas minimum in Punjab Gold (25.80 cm), followed by Basanthi (29.93 cm). Chrysanthemum cv. Garden Beauty is a tall cultivar having plant height of 70.13 cm with plant spread of 50.50 cm (Poonam and Ashok, 2007).

Parul *et al.* (2011), evaluated fifteen chrysanthemum genotypes for their performance under mid hill conditions of Garhwal Himalaya, genotype Saifali recorded maximum (149.71 cm) plant height, followed by Terry (132.92 cm) but plant spread was maximum in Paris White (45.04 cm), followed by Suneel (44.50 cm), Genotype Paris White also produced maximum number of primary (15.16) and secondary branches (19.16) /plant.

2.2.2 Reproductive parameters

Among the 33 chrysanthemum cultivars evaluated cv. MDU-1 flowered late (140 days) when compared to local cultivar which took 120 days (Rajshekaran *et al.,* 1985). Mishra (1999) noticed longest period of blooming in chrysanthemum cv. Kundan. Manohar and Pratap (2006) evaluated ten chrysanthemum varieties and reported among the varieties, early flowering was recorded in Basanthi (50.17 day), which was significantly on par with Punjab Anuradha (51.33 day) and Arka Ravi (53.33). Madhumita *et al.* (2006), assessed the performance of 18 chrysanthemum cultivars under polyhouse cum rain shelter and open field condition. Cv. Bolare Deo bloomed earlier inside polyhouse (70.33 days) compared to open condition (79.67 days) and it was also the earliest cultivar to bloom over the two conditions (75.00 days).

Poonam and Ashok (2008), reported that the chrysanthemum variety Autumn Joy (hybrid of White Bouquet X Flirt), took 101.26 days for flowering (from transplanting) and was an early bloomer with long duration of flowering (35.81 days).

Chezhian *et al.* (1985b) initially evaluated 73 cultivars of chrysanthemum for flower yield. Seven of them were advanced to comparative yield trail. They compared

several local varieties and the new cultivar CO-1 and reported that the mean yield of CO-1 was 16.7 t/ha when compared to 9.28 to 16.00 t/ha in the local cultivars. The cv. MDU-1 produced the highest yield (30.59 t/ha) as compared to the local check, which produced the lowest yield of 26.44 t/ha (Rajashekaran *et al.,* 1985).

Among the 12 chrysanthemum varieties and three local varieties evaluated for three years under Bangalore conditions, variety Red Gold produced the highest flower yield (419.22 g/plant), followed by IIHR Sel-5 (363.62 g/plant) and these two were good for loose flower purpose among the red or pink coloured flower groups. In white coloured flower group, IIHR Sel-6 gave the highest yield (Negi *et al.,* 1988).

The number of flowers per plant were maximum in cv. Maghi (38.75), followed by Jayanti (28.5), whereas it was minimum in Sonali Tara (16.0), Megami (18.57) and Viva (23.0). The maximum yield per plant was obtained in the cv. Maghi (691.81 g), followed by Jayanti (149.0 g), Flirt (131.68 g), Shyamal (131.40 g), Lilith (114.43 g) and Jaya (96.50 g). The flower yield was minimum in Viva (18.5 g), Megami (24.72 g) and Sonali Tara (29.33) (Tewari and Umashankar, 1990).

Kanamadi and Patil (1993) evaluated eight chrysanthemum cultivars in the transitional tract of Karnataka and reported that the cv. Megami yielded the highest flower yield (82.33 g/plant), while Shanthi was the lowest (25.08 g/plant). Among the 15 genotypes of chrysanthemum evaluated for their relative performance during *kharif* (monsoon) of 1990 at Dharwad, Karnataka, cv. Indira proved to be the best for number of flowers per plant (29.0) and flower yield (36. 04 g/plant). But taking into account the market preference for yellow flowers, Bangalore (31.11 g/plant) followed by Karnool (29.60 g/plant) and Saraval (29.32 g/plant) were recommended (Barigidad and Patil, 1997).

In a chrysanthemum varieties performance trail for flower production under Akola (Maharashtra) conditions, Damke *et al.* (1998) recorded the highest flower yield per plant in cv. Tara (47.8 g) followed by Kirti (43.3 g). Mishra (1999) reported the highest number of flowers per plant in cv. Suneel.

Gaikwad and Dumbrepatil (2001) reported higher yield (35-40%) from polyhouse grown chrysanthemum compared to open planting. The cultivar Indira recorded maximum number of flowers per spray followed by Mutant No. 9.

Mukeshkumar and Chattopadhyay (2002) evaluated chrysanthemum cultivars under sub-tropical humid climate of West Bengal. They found higher flower yields of 1855.02 g per plant and 1663.07 g in cultivars Nanaku and Kanhai, respectively as compared to other varieties.

Poonam and Ashok (2008), reported that the chrysanthemum variety Autumn Joy (hybrid of White Bouquet x Flirt) exhibited 11.73 numbers of sprays per plant and 25.33 flowers per spray and 283.46 number of flowers per plant.

Among the eight chrysanthemum cultivars assessed by Kanamadi and Patil (1993) in the transitional tract of Karnataka, cv. Indira recorded the highest flower diameter of 7.56 cm, while cv. CO-2 recorded the lowest flower diameter of 3.80 cm. Aliman and Streitz (1995) assessed eleven chrysanthemum cultivars for their ability, commercial quality and outdoor pot production. These cultivars differed for various plant development characters and flower diameter. Data recorded on shoot and spray length, inflorescence diameter and number of inflorescence and buds showed that, cv. Moonstone gave the best and most consistent results in terms of quality and cv. Iris the poorest results (Przymaska, 1997). Mishra (1999) obtained the biggest flower from cv. Shyamala's blooms and the longest freshness retaining flowers from cv. Jayanthi. Among the chrysanthemum cultivars evaluated, cultivars Indira followed by Mutant No.9 recorded good spray length and maximum flower diameter (Gaikwad and Dumbrepatil, 2001).

Kulkarni and Reddy (2004) evaluated seventeen chrysanthemum genotypes and reported that the genotypes Mutant No. 9 recorded the widest flower diameter (5.70 cm) and which was on par with Harvest Home (5.65 cm), Sonali Tara (5.53 cm), Karnool (5.51 cm), Chandrika (5.41 cm), Saraval (5.39) and Bangalore (5.27 cm).

Madhumita *et al.,* 2006, assessed the performance of eighteen chrysanthemum cultivars under polyhouse cum rain shelter and open field condition and obtained the maximum flower size in Snow Ball (19.81cm) and Sonar Bangla (18.08 cm).

Poonam and Ashok (2007), reported that chrysanthemum cv. Garden Beauty exhibited flowers size of 9.97 cm, and weight of indivisual flower was 2.35g. Autumn Joy recorded flower size and weight of 6.60 cm and 3.90 g, respectively (Poonam and Ashok, 2008).

2.2.3 Disease incidence

Blotch disease caused by *Septoria chrysanthemella* Sacc. on chrysanthemum was common and wide spread and has been reported from Pusa, Bihar and Dehra Dun, Uttar Pradesh and Ludhiana (Pavgi and Upadhyay, 1966). The varieties Flirt, Gumti, Phillips and SHG-3 were resistant to blotch disease.

Thirty chrysanthemum cultivars were screened against Rust and *Verticillium* Wilt and the cultivars Brown Eyes, Copper Anne, Gay Anne, Gem and Goldstrike found resistant to rust, whereas Classic, Cloud, Copper Anne, Deep Conquest and Festive Cushion showed resistance against *Verticillium* wilt and remaining cultivars found to be susceptible to both the diseases (Thomas *et al.,* 1980).

Ten chrysanthemum cultivars were screened for resistant to wilt caused by *Fusarium oxysporum f. sp. Chrysanthemi* race 2, and among the cultivars tested Morden Fiesta, Morden Garnet, Susan Brandon, Morden Gaiety, Morden Delight and Morden Cameo were found highly resistant to the disease (Huang *et al.,* 1993).

Sixty chrysanthemum cultivars were screened against leaf spot disease caused by *Septoria chrysanthemella* and *Alternaria sp.* None of them were free from disease. Ten were classed as resistant, 13 as moderately resistant and the remaining 37 cultivars were moderate to highly susceptible (Sen and Pathania, 1997).

The spring chrysanthemum cultivars Jushanbei, Jushan Huang and Jushan Hong, the autumn cultivars Jaguar and Marvelousrose and winter cultivars Beijing Huang were highly resistant to the disease caused by *Puccinia horiana* (Ding and Dungdin, 2001).

2.2.4 Economics

Varadarajan and Raveendran (1976), studied the economics of flower marketing in Coimbatore city, estimated the cost of cultivation of jasmine was ₹. 5448 per hectare and the net profits was ₹. 2209 per hectare. They also indicated that large percentage of labour was used for harvesting.

Hoon and Vander (1979), studied the economics of fressia cultivation for cut flowers reported that returns remained same continuously for three years (1976-1978), however, costs had risen considerably. A similar study conducted by Rijssel and

Oprel (1979) revealed that the cultivation of roses for three years, the cost of cultivation increased with the time but profitability declined greatly. As per the suggestions of Starangh (1983) cultivation of gerbera for two years is more economical than cultivating for one year.

Totth (1984) reported that cultivation of carnation for cut flowers was no longer profitable due to enormous increase in production costs. However, profitability can be improved by adopting improved cultural methods and also by the introduction of highly productive good quality cultivars.

Subramanyam (1986) studied the economics of production and marketing of chrysanthemum flowers in Karnataka and concluded that labour cost accounted the major portion of input and there was a huge difference in returns when the cut flowers were sold through channel I (sale through commission) and channel II (sale to pre-harvest contractors).

Rameshkumar (1989) studied the economics of production and investment in jasmine flowers in Madurai district in Tamil Nadu. The total expenditure incurred by jasmine growers for establishing the jasmine garden in the first year was ₹. 13,700 per hectare. Among the different items of establishment planting and plant material had accounted for the major portion *i.e.,* about 31 per cent of establishment cost. The maintenance cost for carrying out various operations was ₹. 32148 per hectare.

In rose cultivation, the major item of input cost was planting and plant material. The investment in roses was found to be economically viable as it gave a benefit-cost ratio of 1.7 to 1.8 with hardly 2 to 3 years payback period depending upon the channel of sale (Subramanyan, 1989).

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 period of ten years. According to him chrysanthemum production has showed lowest increase in labour cost. Rapid growing cycle and closer planting resulted in higher productivity.

Ferratto *et al.* (1994) studied the economics of carnation cut flower production during winter by promoting supplementary light and concluded that the utilization of

supplementary light can increase yields. Their opinion is that for positive economics 30 per cent increase in the yield and prices are essential.

The returns of cut roses can be increased during winter by increasing the plant density and by providing supplementary heating than traditional system of management (Ferratto and Bendetto, 1994).

Though greenhouse cultivation results in higher returns by producing higher yields of good quality produce, its initial investments and maintenance costs are much higher than natural or traditional cultivation methods. Therefore, growers should be provided with the same technology and structures at lower costs to suit the Indian conditions. This results in better feasibility and profitability (Khan, 1995).

Ambad *et al.* (2001) reported that gerbera has become a crop of choice in polyhouse cultivation. Construction of polyhouse needs high investments. MPKV, Rahuri has developed handy wooden structure affordable to all categories of growers with reasonably low cost.

The cv. Lexus realized maximum returns of ₹. 2,70,672 in 560 m^2 area with a B:C ratio of 2.65 followed by Alberino (₹. 2,55,120: ₹. 2.50), Scilla (₹. 2,52,720: 2.48) and Bonnie (₹. 1,98,096: 1.94) compared to other genotypes studied in gerbera (Hemlanaik *et al.*, 2006).

Verma *et al.,* 2011, studied the economics as influenced by integrated nutrient management (INM) in chrysanthemum cv. Raja during *kharif* season of 2009 and economics analysis clearly indicated that net returns per hectare and B:C ratio were highest (₹. 3,28,504 and 6.04 respectively) in the plots treated with *Azospirillum*, PSB, vermicompost and 50 % recommended NPK (T_8) and these findings can be used in making chrysanthemum production more profitable.

2.3 Cultivars v/s seasons

Heidemans and Stolk (1984) evaluated fifteen chrysanthemum cultivars for spring culture and reported that cultivars Bright Lumeet, Impala and Lucky Steike were the best cultivars. Chezhian *et al.* (1985a) assessed the performance of 27 chrysanthemum cultivars over two years under pot conditions. The height of the plants ranged from 6.15 cm to 33.5 cm in first year and 8.15 cm to 33.45 cm in the

second year. The number of branches ranged from 4.5 to 21.55 and 6.0 to 21.55 during first and second year, respectively. Cut flower chrysanthemum cultivars Buttercup, Day Mark, Pink Day Mark, Yellow Day Mark, Cream Day Mark, Palaver and Wall Stree could be grown successfully in unheated greenhouse during the period from November to April (Cormeno, 1989).

Laskar and Yadav (1991) studied the performance of 14 small flowering chrysanthemum cultivars during 1986 to 1987 at Horticultural research station, Mandouri, India, for plant growth characters and flower yield. They found that the cultivars Basanti, Jubilee and Alison produsedthe highest yield of 71, 63 and 60 lakh flowers per hectare, respectively. The chrysanthemum cultivars Basanti, Bazuria Red, Dhruba White, Jaya, KS-6, KS-16, KS-17, KS-19, Maharaja, Pink Star and Sharadmala were highly suitable for commercial cultivation as winter crop under Kalyani (West Bengal) conditions (Mukeshkumar and Chattopadhyay, 2002). Kishan *et al.* (2008), evaluated fifteen chrysanthemum cultivars for winter season under Delhi conditions and reported that cultivars Poornima, Snow Don, Yellow Bangla and Tata Centenary as the best cultivars.

Among the 27 chrysanthemum cultivars assessed for two years under field conditions, cv. Sharad Shobha was found to be the earliest to flower in both the seasons (Chezhian *et al.,* 1985a). Negi *et al.* (1988) evaluated 12 chrysanthemum varieties along with three local varieties for three years under Bangalore conditions and found that variety Indira was the earliest to flower (107.97 days), followed by IIHR-Sel-5 (114.18 days). Whereas, IIHR-Sel-4 was late to flower (140.52 days). Kulkarni and Reddy (2004) evaluated seventeen chrysanthemum genotypes for two years (2000 and 2001) to study their performance in farmer's field. Among the different accessions Harvast Home, Mutant No. 9, Selection-5, Karnool, Saraval and Chandrika were superior for their flower yield as compared to other genotypes.

3. MATERIAL AND METHODS

The present investigation was carried out to study the performance of different cultivars across the different planting months of chrysanthemum (*Dendranthema grandiflorum*). The experiment was conducted during June, 2012 to April, 2013 at experimental field of Department of Floriculture and Landscape Architecture, Kittur Rani Channamma College of Horticulture, Arabhavi, University of Horticultural Sciences, Bagalkot, Karnataka. The materials used, techniques adopted and observations recorded during the investigation are furnished in this section.

3.1 Geographical location and climatic conditions of the experimental site

Arabhavi is located in the northern dry zone *i.e.* zone 3 of Region 2 of Karnataka state at 16^0 12' north latitude, 74^0 54' east longitude and at an altitude of 640 m above the mean sea level. Arabhavi has benefits of both south west and north east monsoon. The average rainfall of this area is about 520 mm distributed over period of five to six months (May-October) with peaks during September. The command area receives water from Ghataprabha left bank canal from mid July to mid March. The meteorological data recorded during the investigation period of meteorological observatory of the Agricultural Research Station, Arabhavi is presented in Appendix- I.

3.2 Experimental details

The experiment was laid out during rainy season of 2012 with ten cultivars with four planting months in two factorial randomized complete block design with two replications to know the photoperiodic response.

3.2.1 Design and layout of the experiment

Design : Two Factorial Randomized Complete Block Design.

Factor A : Ten cultivars

Factor B : Four planting months

1. June
2. August
3. October
4. December

Number of replications : 2

Spacing : 30 cm x 30 cm

Number of plants / plot : 30

Gross plot size : 1.8 m x 1.5 m

Net plot size : 1.5 m x 1.2 m

Cultivars details :

Sl. No.	Cultivar	Source	Features
1	Dundi	Farmer's field, Dharwad	Open centered, 4-5 whorls, anemone flowers
2	Accession No. 2	Farmer's field, Belgaum	White colour flowers with yellowish centre; disc is invisible, 4-5 whorls.
3	Chitradurga Local	Farmer's field, Chitradurga	White flowers, centre is yellow.
4	Autumn Joy	IIHR, Bengaluru	Quill petals, single whorl, yellow colour disc is visible
5	Garden Beauty	IIHR, Bengaluru	Pink colour flowers, multiwhorl (5-6 whorls)
6	Accession No.1	KRCCH, Arabhavi	Bronze colour flowers with open centre, 2-4 whorls
7	Winter Queen	IIHR, Bengaluru	Spatualate petals (Spoon), Single whorl
8	Karnool	Farmer's field, Dharwad	Refluxed yellow flowers, disc is partially visible
9	Raja	Farmer's field, Belgaum	White colour flowers with open centre, 4-6 whorls.
10	States Man	IIHR, Bengaluru	Tube shaped yellow petals, disc is not visible.

Dundi

Karnool

Chitradurga Local

Accession No. 2

Garden Beauty

States Man

Raja

Accession No. 1

Winter Queen

Automn Joy

Plate 1: Cultivars of chrysanthemum used in the experiment

Plate 2: General view of mother block in polyhouse with lighting

3.2.2 Planting material

Chrysanthemum cultivars obtained from different sources were raised in a naturally ventilated polyhouse (mother block) which was oriented in North–South direction of a size 22 m length and 28 m width and central height of 6 m, with galvanized iron pipe frame. Glazing was provided with 200m (800 gauge) thick ultra violet stabilized low density polythene film. The suckers of 10 chrysanthemum cultivars were planted in naturally ventilated polyhouse with a spacing of 30 cm x 30 cm in raised beds. After one month of planting 100 watt bulbs were used to create long day condition to keep the plants in vegetative growth stage. The artificial lighting should be provided from 7 pm to 6 am. From the mother plants cuttings were taken, rooted in cocopeat with IBA 500 ppm pre treatment for 10 minutes. The rooted cuttings were used for planting in the main field as per date of planting.

3.3 Cultural operations

3.3.1 Land Preparation

The land area was brought to a fine tilth by repeated ploughing and harrowing. All the weeds, stubbles, stones *etc.* were removed. Well decomposed farm yard manure was added into the soil at the rate of 20 t per hectare.

In main field, the experimental plot was divided into plots of measuring 1.8 m x 1.5 m size and 0.5 m space between two replications was provided for laying out of irrigation channels and bunds.

3.3.2 Planting

The planting was carried out by planting 30 days old rooted cuttings of 10 different cultivars in the second week of planting months (two months interval) from June 2012 to December 2012. Planting was taken in respective plots at a row spacing of 30 cm and 30 cm between the plants. Light irrigation was given immediately after planting. The crop was raised and maintained by following standard cultural practices as per package of practice of University of Agricultural Sciences, Dharwad (Anon., 2002).

Rooting of cuttings in protrays

Planting of chrysanthemum cultivars

Plate 3: Propagation and planting of chrysanthemum cultivars

June planting

August planting

Plate 4a: General view of experimental plot

October planting

December planting

Plate 4b: General view of experimental plot

3.3.3 Application of fertilizers

The recommended dose of fertilizers *i.e.,* 100:150:100 kg NPK per ha (Anonymous, 2002) was applied in the form of urea, single super phosphate and muriate of potash, respectively. At the time of planting 33 kg nitrogen and full dose of phosphorus and potassium were applied in a circular band of 3-4 cm around each plant and the crop was top dressed with remaining nitrogen after one month of planting.

3.3.4 Irrigation

The irrigation was given by flood method at an interval of five to seven days, depending upon the soil moisture status and climatic conditions, in open field. In polyhouse irrigation was provided through hosepipe.

3.3.5 Weeding

Hand weeding was followed whenever it was necessary to keep the plots free from weeds.

3.3.6 Plant protection measures

Alternaria leaf spot was serious disease noticed during the investigation in the month of August to October and was controlled by spraying 2 g Mancozeb 75 WP per litre of water. No serious pest was observed in the experimental plot except aphids which were controlled by spraying 0.5 ml Rogar per litre of water.

3.4 Compilation of experimental data

In each treatment five plants were selected randomly to collect observations on different parameters during vegetative and flowering period.

3.4.1 Growth parameters

The observations were recorded at grand growth stage for all the growth parameters such as, plant height, number of primary and secondary branches, plant spread and leaf area of the plant.

3.4.1.1 Height of plant

The Plant height was measured from the tagged plants, from the base to the tip of the plant, at grand growth stage. The average plant height was worked out and expressed in centimeters.

3.4.1.2 Number of primary and secondary branches

The branches arising from the main stem are primary branches and branches from the primary branches are considered as secondary branches. Number of primary and secondary branches were recorded at grand growth stage.

3.4.1.3 Plant spread

Plant spread was recorded in E - W and N – S direction from all tagged plants. The average plant spread in each direction was expressed in centimeter (cm).

3.4.1.4 Leaf area

The length of the leaf was recorded from the leaf blade joint to the tip of the leaf along the midrib and width was recorded at widest point of leaf lamina. The leaf area was computed by multiplying the leaf length, width and correction factor to arrive at the actual leaf area and it is multiplied with number of leaves to get the leaf area per plant. The correction was computed by dividing the actual leaf area recorded on a graph sheet by computed leaf area (length and breadth) and expressed in centimeter square.

3.4.2 Flowering parameters

Flowering characters such as days taken for first flower bud initiation, for first flower opening, for 50 per cent flowering and for 100 per cent flowering, duration of flowering and flower yield and quality parameters were recorded.

3.4.2.1 Days taken for first flower bud initiation

This was recorded from the tagged plants by counting the days from the day of planting to the stage at which the first flower bud was formed in different treatments.

3.4.2.2 Days taken for first flower opening

This was recorded by counting the number of days from the date of planting to the stage at which the first flower bloomed in each plot. This was recorded from the tagged plants and average was worked out.

3.4.2.3 Days taken for 50 per cent flowering

The number of days taken for 50 per cent of the plants to produce first flower were recorded from each plot by counting days from the date of planting.

3.4.2.4 Days taken for 100 per cent flowering

The number of days taken by all the plants to produce first flower in each plot were recorded by counting days from the date of planting.

3.4.2.5 Duration of flowering

Number of days taken from the first flowering to the last flowering was recorded as the total duration of flowering in each treatment. This was observed in tagged plants.

3.4.3 Yield parameters

3.4.3.1 Number of flowers per plant

Number of flowers produced per plant from the five tagged plants was recorded and the average number of flowers produced was worked out.

3.4.3.2 Flower yield per plant (g)

Flower yield was recorded in grams and average yield per plant was worked out.

3.4.3.3 Flower yield per plot (kg)

Flower yield per plot was recorded. The average number of flowers produced was worked out and expressed in kilo grams.

3.4.3.4 Flower yield per hectare (t/ha)

This was worked out from weight of the flowers harvested from each plots.

3.4.4 Flower quality parameters

3.4.4.1 Individual fresh flower weight

Flowers were selected from the tagged plants at full bloom stage and weight of these flowers was recorded and the average weight of flower was worked out in grams.

3.4.4.2 Flower diameter

Diameter of the flower was measured at the point of maximum breadth. Average diameter was calculated and expressed in centimeters.

3.4.4.3 Shelf life

Fully opened flowers were harvested from each plot and kept in paper plates in lab condition. Number of days was counted until the flowers lost their marketable quality.

3.4.4.4 Incidence of *Alternaria* disease

Screening of different chrysanthemum cultivars against the *Alternaria* disease was undertaken to find out resistant sources, if any. The disease intensity was recorded using 0 to 5 point disease rating scale. The observation on severity of disease was recorded from randomly selected plants in each cultivar.

Observations and grading

Observations on the intensity of disease was recorded from the randomly selected leaves from each of the five randomly selected plants from each cultivar and graded as per 0 to 5 scale (Kotasthane and Agarwal, 1976).

Scale: 0-5

0 – Leaves free from infection

1- Up to 5 per cent of leaf area affected

2- 6 to 20 per cent of leaf area affected

3- 21 to 40 per cent of leaf area affected

4- 41-70 per cent leaf area affected

5- 71 per cent and above leaf area affected

The per cent disease incidance was calculated by using the following formula:

$$PDI = \frac{\text{Sum of all rating}}{\text{Total number of leaves observed x maximum class rating}} \times 100$$

To assess the degree of susceptibility or resistance in chrysanthemum cultivars, the following disease rating and varietal reaction table was used (Deshapande *et al*., 1979).

Disease rating	**Varietal reaction**
0.5 per cent infection	Resistant (R)
6-15 per cent infection	Moderately resistant (MR)
16-35 per cent infection	Moderately susceptible (MS)
36-55 per cent infection	Susceptible (S)
56 per cent and above	Highly susceptible (HS)

3.5 Environmental parameters

The observations on environmental parameters *viz.,* temperature, relative humidity, day length and light intensity recorded during the experimental period are presented in Appendix- I. The temperature and relative humidity were recorded with the help of hygrothermometer clock instrument and expressed in degree celsius and percentage respectively, whereas light intensity was recorded by lux meter (Model LX-101) and expressed in terms of lux.

3.6 Economics

The cost of cultivation of chrysanthemum cultivars planted in different months were worked out based on prevailing market prices. Economic analysis during different seasons for different cultivars in terms of gross returns, net returns and B:C ratio were calculated by the following formula.

Gross returns = Gross return was calculated by multiplying the price of produce (flowers) to computed yield for one hectare.

Net returns = Gross returns - Cost of cultivation

$$\text{B:C ratio} = \frac{\text{Net returns}}{\text{Cost of cultivation}}$$

3.7 Statistical analysis

Statistical analysis of data was carried out by following the Fisher's analysis of variance technique as given by Panse and Sukhatme (1967) for two factorial randomized completely block design. The level of significance employed for 'F' and 't' test was P=0.05.

4. EXPERIMENTAL RESULTS

The results of the field experiment carried out to achieve the objectives of the experimentation are presented in this chapter.

4.1 Effect of months of planting on performance of chrysanthemum cultivars

4.1.1 Vegetative characters

The data pertaining to vegetative parameters are presented in Tables 1 to 4.

4.1.1.1 Plant height

The data on plant height as affected by different months of planting in different cultivars are presented in Table 1 and Fig. 1. Planting of chrysanthemum cultivars on different months resulted in significant differences in plant height at grand growth stage of the crop.

In general, the plant height as affected by months of planting in different cultivars gradually decreased right from June planting to December planting. Among the different planting months, early planting (June) resulted in taller plants (49.20 cm) when compared to other months of planting, whereas, planting in later months resulted in reduction in plant height. The plants of December month planting recorded the least plant height (19.14 cm).

Among the different cultivars, Automn Joy recorded the highest plant height (41.20 cm) and which was on par with Winter Queen was recorded 39.30 cm. The next genotype in the order was Accession No. 2 (33.12 cm). Cultivar Dundi was recorded the plant height of 28.97 cm which was on par with Chitradurga Local (28.24 cm), Raja (27.10 cm) and Karnool (26.45 cm). Genotype Accession No. 1 recorded the least plant height of 16.07 cm.

Among the interactions, June month planted Automn Joy variety recorded the highest plant height (71.30 cm) which was on par with the June month planted Winter Queen (67.80 cm) and Accession No. 2 (65.60 cm). The next cultivars in the increased order were Chitradurga Local (54.50 cm), Dundi (48.90 cm) and Karnool

Table 1: Plant height in different chrysanthemum cultivars planted in different months

Cultivars	Plant height (cm)				Mean
	Planting months				
	June	August	October	December	
Dundi	48.90	29.20	16.90	20.90	28.97
Accession No. 2	65.60	29.00	18.20	19.70	33.12
Chitradurga Local	54.50	20.95	21.30	16.20	28.24
Automn Joy	71.30	40.30	24.50	28.70	41.20
Garden Beauty	34.80	20.90	18.60	15.90	22.55
Accession No. 1	24.00	13.80	14.70	11.80	16.07
Winter Queen	67.80	37.60	25.40	26.40	39.30
Karnool	42.80	20.90	20.70	21.40	26.45
Raja	42.40	31.10	19.00	15.90	27.10
States Man	39.90	20.70	18.70	14.55	23.46
Mean	49.20	26.44	19.80	19.14	-

Source	SEm±	CD at 5%
Months	0.64	1.83
Cultivars	1.01	2.90
Interaction	2.03	5.80

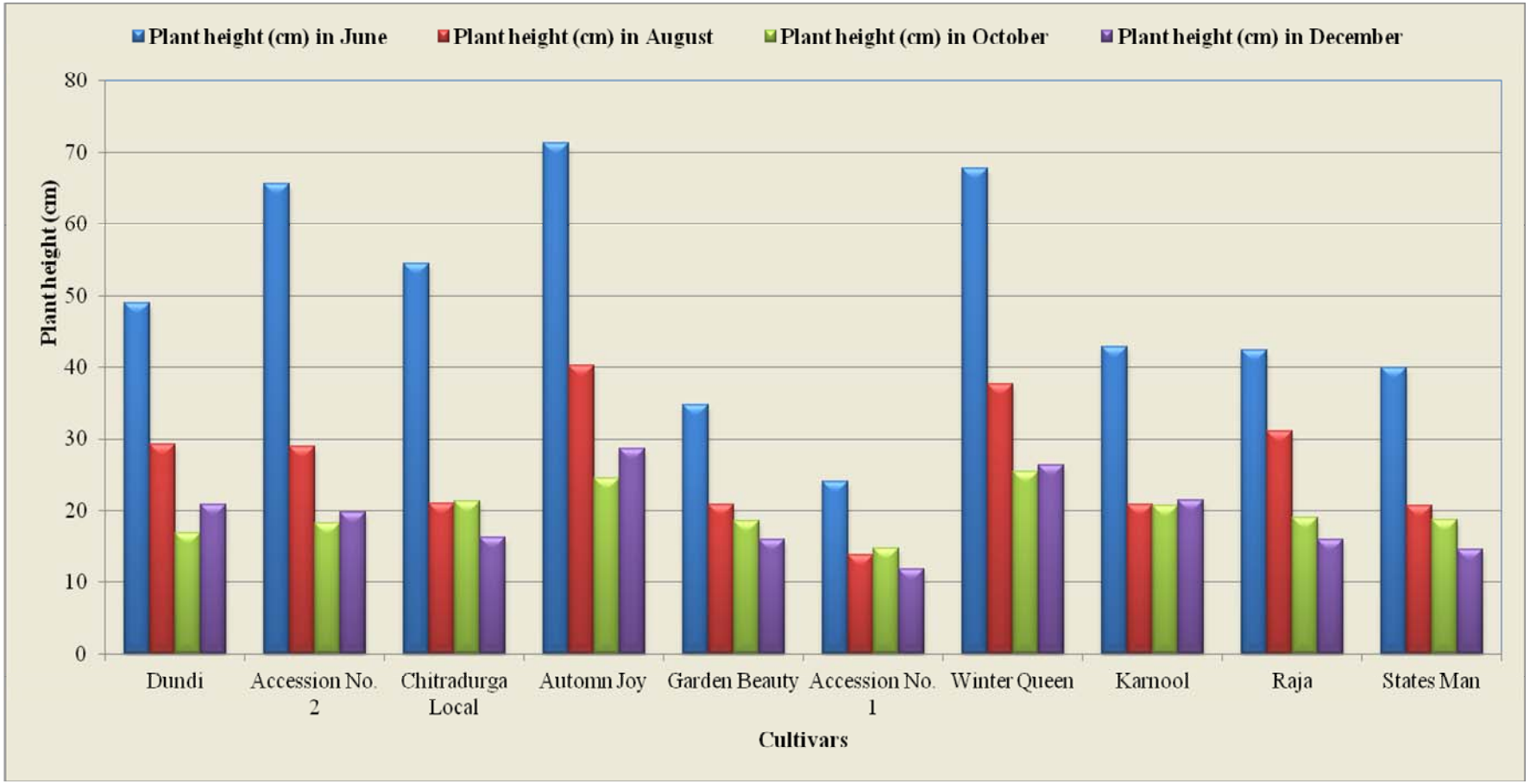


Fig. 1. Plant height in different chrysanthemum cultivars planted in different months

(42.80 cm). Whereas, the least plant height was recorded in December month planted Accession No. 1 (11.80 cm) genotype.

4.1.1.2 Number of primary branches

There was significant difference among the cultivars and date of planting with respect to number of primary branches produced per plant at grand growth stage (Table 2).

Significantly higher number of primary branches per plant was recorded in June planted plants (3.12) as compared to other planting dates. The reduction was noticed upto December planting which recorded 1.17 number of primary branches per plant.

The differences with reference to number of primary branches produced per plant among the different cultivars were significant at grand growth stage of the crop. Garden Beauty was recorded the highest number of primary branches per plant (2.85) which was on par with Automn Joy (2.80). The next cultivar in the order for increased number of primary branches was Accession No. 1 (2.25). Cultivar Winter Queen was recorded 1.87 number of primary branches which was on par with Accession No. 2 (1.75), Dundi (1.72), Karnool (1.60) and Raja (1.60). Chitradurga Local was recorded the least number of primary branches per plant (1.20).

Among the interactions, June month planted Automn Joy (6.50) recorded the highest number of primary branches per plant, followed by Garden Beauty (5.00) and Accession No. 1 (4.00). The least number of primary branches per plant was recorded in December planted Dundi (1.00), Accession No. 2 (1.00), Karnool (1.00), Raja (1.00), States Man (1.00) and October month planted Accession No. 2 (1.00), Chitradurga Local (1.00) and Automn Joy (1.00).

4.1.1.3 Number of secondary branches

The data pertaining to the number of secondary branches per plant recorded at grand growth stage are presented in Table 2.

Significantly higher number of secondary branches per plant (11.45) was recorded in June planted plants when compared to other months of planting at grand growth stage. In later months, there was reduction in number of secondary branches

Table 2: Number of primary and secondary branches in different chrysanthemum cultivars planted in different months.

Cultivars	Number of primary branches				Mean	Number of secondary branches				Mean
	Planting months					Planting months				
	June	August	October	December		June	August	October	December	
Dundi	2.90	1.80	1.20	1.00	1.72	10.60	6.10	4.10	1.70	5.62
Accession No. 2	2.70	2.30	1.00	1.00	1.75	10.80	5.00	2.70	1.70	5.05
Chitradurga Local	1.40	1.30	1.00	1.10	1.20	7.00	3.00	2.80	0.20	3.25
Automn Joy	6.50	2.00	1.00	1.70	2.80	12.30	5.20	4.70	3.30	6.37
Garden Beauty	5.00	3.20	1.90	1.30	2.85	18.20	8.80	6.30	2.00	8.82
Accession No. 1	4.00	1.90	1.90	1.20	2.25	14.60	5.40	9.60	1.50	7.77
Winter Queen	2.50	2.20	1.40	1.40	1.87	12.00	5.00	5.50	2.90	6.35
Karnool	2.10	1.70	1.60	1.00	1.60	12.00	5.70	3.90	1.50	5.77
Raja	2.30	1.50	1.60	1.00	1.60	7.20	6.80	3.80	2.10	4.97
States Man	1.80	1.20	1.40	1.00	1.35	9.80	5.60	4.20	0.30	4.97
Mean	3.12	1.91	1.40	1.17		11.45	5.66	4.76	1.72	
Source	**SEm±**		**CD at 5%**			**SEm±**		**CD at 5%**		
Months	0.063		0.18			0.21		0.62		
Cultivars	0.10		0.28			0.34		0.97		
Interaction	0.20		0.57			0.68		1.95		

produced per plant. December planting plants had an average of 1.72 number of secondary branches per plant. After June planting, August planting was next in the order for increased production of secondary branches per plant (5.66) and October planting (4.76).

Among the cultivars, Garden Beauty was recorded higher number of secondary branches per plant (8.82). The next cultivar in the order for increased production of secondary branches per plant was Accession No. 1 (7.77) and Automn Joy (6.37) was on par with Winter Queen (6.35). Cultivar Chitradurga Local was recorded the lowest (3.25) number of secondary branches per plant.

Among the interactions, June planted Garden Beauty variety recorded the higher number of secondary branches (18.20) per plant, followed by Accession No. 1 (14.60), Karnool (12.00), Winter Queen (12.00), Accession No. 2 (10.80) and Dundi (10.60). Whereas lowest number of secondary branches were recorded in December planted Chitradurga Local (0.20) cultivar.

4.1.1.4 Plant spread

4.1.1.4.1 East-West (E-W)

Planting of chrysanthemum cultivars in different months resulted in significant difference with respect to plant spread (E-W) at grand growth stage (Table 3).

In general, plant spread (E-W) as affected by different months of planting gradually decreased right from June planting to December planting. Planting of chrysanthemum in June followed by August resulted in higher plant spread (37.62 cm and 19.42 cm, respectively) when compared to other months of planting. Whereas, as later planting resulted in reduction in plant spread (E-W). The plants of December planted had least plant spread (8.56 cm) and October month planted plants had 15.12 cm plant spread.

Among the cultivars, the plants of Automn Joy was recorded higher plant spread (E-W) of 24.78 cm, which was on par with Winter Queen (22.83 cm). Next in the order for plant spread (E-W) were Accession No. 2 (21.55 cm) which was on par with Raja (20.98 cm), Dundi (20.78 cm), Accession No. 1 (19.66 cm) and Karnool (19.48 cm). The plant spread was lowest (14.83 cm) in States Man variety.

Table 3: Plant spread (E-W and N-S) in different chrysanthemum cultivars planted in different months

Cultivars	Plant spread E-W (cm)				Mean	Plant spread N-S (cm)				Mean
	Planting months					Planting months				
	June	August	October	December		June	August	October	December	
Dundi	41.40	17.80	14.50	9.40	20.78	39.70	20.80	15.70	10.40	21.65
Accession No. 2	40.60	19.40	17.00	9.20	21.55	37.60	16.00	14.50	8.50	19.15
Chitradurga Local	37.30	15.20	12.00	8.90	18.35	33.40	15.20	12.20	7.00	16.95
Automn Joy	54.30	18.70	14.00	12.10	24.78	41.90	18.70	13.65	10.30	21.14
Garden Beauty	32.90	18.40	15.20	7.80	18.58	31.20	18.40	17.60	7.30	18.63
Accession No. 1	29.60	26.20	16.70	6.15	19.66	27.70	27.20	16.50	7.30	19.68
Winter Queen	41.70	23.30	16.60	9.70	22.83	36.90	22.10	15.00	7.95	20.49
Karnool	35.10	19.60	15.00	8.20	19.48	37.60	17.90	14.40	8.35	19.56
Raja	36.30	21.50	18.80	7.30	20.98	31.30	21.60	19.00	7.95	19.96
States Man	27.00	14.10	11.40	6.80	14.83	26.00	14.90	11.80	6.90	14.90
Mean	37.62	19.42	15.12	8.56		34.33	19.28	15.04	8.20	

Source	SEm±	CD at 5%	SEm±	CD at 5%
Months	0.51	1.47	0.46	1.31
Cultivars	0.81	2.32	0.73	2.08
Interaction	1.62	4.65	1.45	4.15

Among the interactions, June month planted Automn Joy variety recorded the highest plant spread (54.30 cm), followed by Winter Queen (41.70 cm) and Dundi (41.40 cm), while lowest was recorded in December month planted Accession No. 1 (6.15 cm).

4.1.1.4.2 North-South (N-S)

Planting of chrysanthemum cultivars, in different months resulted in significant difference with respect to plant spread (N-S) at grand growth stage (Table 3).

Significantly higher plant spread (N-S) was recorded in June (34.33 cm) planted plants when compared to other months of planting at grand growth stage. In later months, there was reduction in plant spread (N-S). After June planting, August planting was next in the order for increased plant spread (N-S) of 19.28 cm. The least plant spread (N-S) was in December planting (8.20 cm).

Among the cultivars, the plants of Dundi was recorded higher plant spread (N-S) of 21.65 cm, which was on par with Automn Joy (21.14 cm), Winter Queen (20.49 cm), Raja (19.96 cm) and Accession No. 1 (19.68 cm). The plant spread was lowest (14.90 cm) in the variety States Man.

Among the interactions, June month planted Automn Joy (41.90 cm) cultivar was recorded the highest plant spread (N-S), which was on par with Dundi (39.70), Accession No. 2 (37.60 cm) and Karnool (37.60 cm). Whereas the least plant spread (N-S) was recorded in December month planted States Man (6.90 cm) variety.

4.1.1.5 Leaf area

Planting of chrysanthemum cultivars in different months resulted in significant difference in leaf area (LA) per plant at grand growth stage (Table 4 and Fig. 2). Significantly higher leaf area (LA) per plant (3850.07 cm^2) was recorded in June month planted plants as compared to other months of plantings. In the later plantings, leaf area per plant decreased right upto December planting which was recorded 164.24 cm^2 LA per plant. After June planting, August planted plants were next in order for increased LA per plant (1914.43 cm^2). October planting plants had LA of 671.99 cm^2 / plant.

Table 4: Leaf area in different chrysanthemum cultivars planted in different months

Cultivars	Leaf Area (cm^2)				Mean
	Planting months				
	June	August	October	December	
Dundi	4285.30	2858.56	577.95	250.26	1993.02
Accession No. 2	6858.06	3442.80	800.48	204.50	2826.48
Chitradurga Local	3036.22	949.59	337.57	120.31	1110.93
Automn Joy	3266.56	1710.53	580.62	155.06	1428.19
Garden Beauty	1764.17	726.34	449.29	148.24	772.01
Accession No. 1	2584.30	1244.39	551.75	166.65	1136.77
Winter Queen	4354.42	1943.68	1007.30	149.20	1863.66
Karnool	7579.96	3521.37	1483.60	221.71	3201.67
Raja	3853.66	2287.49	767.50	142.585	1762.81
States Man	918.06	459.49	163.76	83.87	406.30
Mean	3850.07	1914.43	671.99	164.24	

Source	SEm±	CD at 5%
Months	6.95	19.87
Cultivars	10.98	31.42
Interaction	21.97	62.84

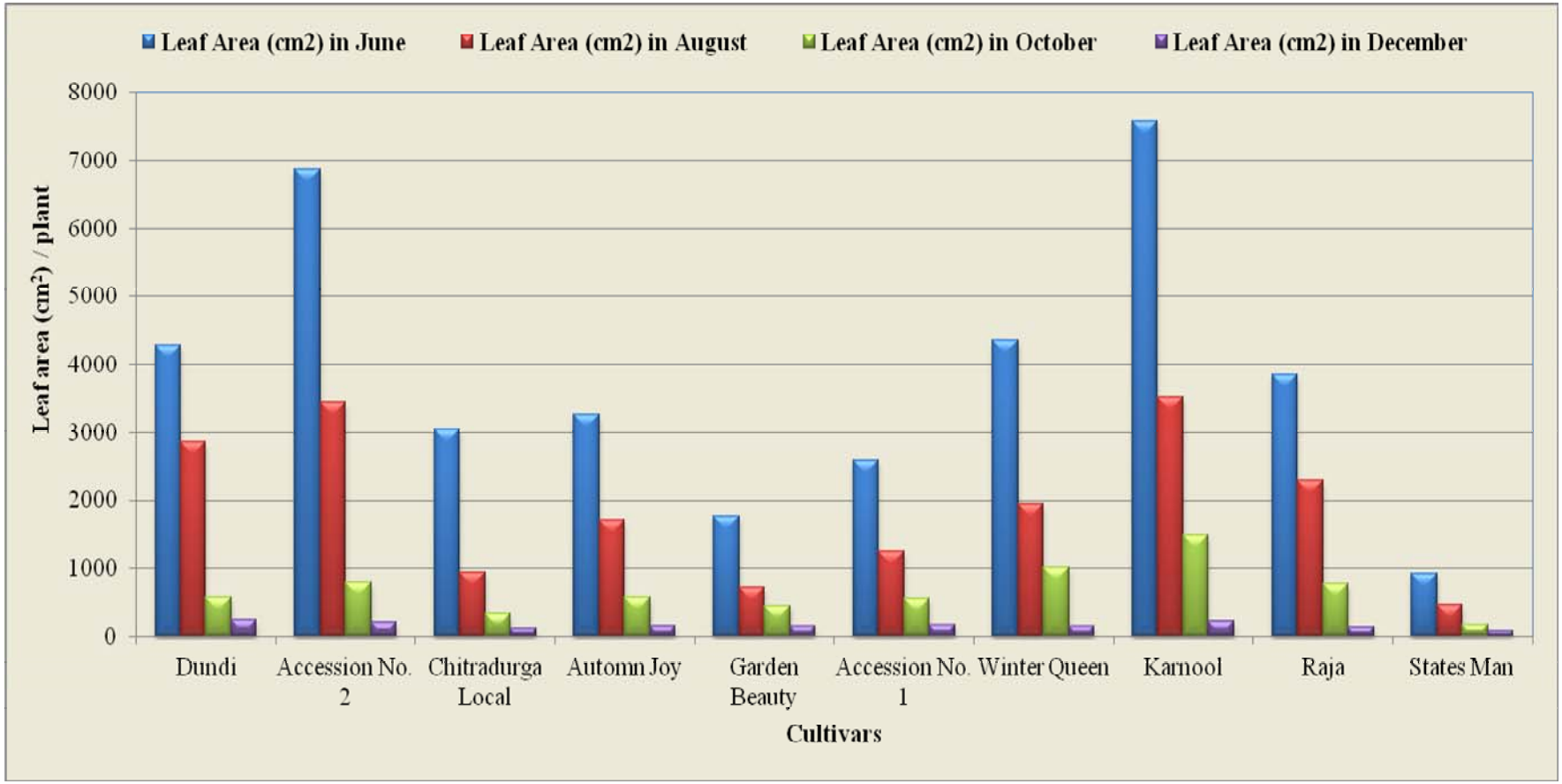


Fig. 2. Leaf area in different chrysanthemum cultivars planted in different months

Among the cultivars, the plants of Karnool was recorded higher leaf area per plant of 3201.67 cm^2. The next cultivar in the order for increased LA per plant was Accession No. 2 (2826.48 cm^2), Dundi (1993.02 cm^2) and Winter Queen (1863.66 cm^2). The leaf area was recorded lowest (406.30 cm^2) in the variety States Man.

Among the interactions, June month planted Karnool (7579.96 cm^2) cultivar recorded the higher leaf area per plant and the lowest was recorded in December planted States Man (83.87 cm^2). The June month planted Accession No. 2 (6858.06 cm^2), Winter Queen (4354.42 cm^2) and Dundi (4285.30 cm^2) cultivars were next in the order for more leaf area per plant.

4.1.2 Flowering

Planting of chrysanthemum cultivars in different months resulted in significant difference with respect to days taken for first bud initiation, first flower opening, 50 per cent flowering, 100 per cent flowering and duration of flowering (Table 5-7).

4.1.2.1 Days taken for flower bud initiation

Significant differences were observed among the chrysanthemum cultivars planted in different months for the days taken to first bud initiation (Table 5). Bud initiation was early as the months of planting advanced from June to December. December followed by October planted plants were early to initiate flower buds *i.e.* 19.55 and 38.13 days after planting (DAP), respectively), whereas June planted plants were late to initiate flower buds (75.57 DAP).

Among the cultivars, Accession No. 1 was first to show its visible flower buds (15.13 DAP) followed by Garden Beauty (41.50 DAP), States Man (44.65 DAP) and Raja (45.55 DAP). The cultivars Winter Queen (51.00 DAP), Dundi (52.23 DAP) and Automn Joy (53.88 DAP) were on par with each other to initiate first flower buds. The cultivar Chitradurga Local was last to initiate flower buds (55.23 DAP). The genotype Accession No. 1 failed to initiate flower buds in August, October and December month plantings. Whereas, cultivars Automn Joy, Raja and States Man failed to initiate flower buds in December month planting.

Table 5: Number of days taken for flower bud initiation and first flowering in different chrysanthemum cultivars planted in different months

Cultivars	No. of days to reach 50% flowering				Mean	No. of days to complete flowering				Mean
	Planting months					Planting months				
	June	August	October	December		June	August	October	December	
Dundi	134.00	88.00	82.00	59.07	90.75	141.00	109.00	101.00	82.00	108.25
Accession No. 2	124.00	108.50	119.00	**	87.88	139.50	120.50	***	***	65.00
Chitradurga Local	139.00	112.00	87.00	**	84.50	145.00	125.50	***	***	67.63
Automn Joy	161.50	105.00	103.50	*	92.50	179.50	120.50	***	*	75.00
Garden Beauty	85.50	67.50	59.00	71.50	70.88	97.00	83.50	94.50	***	68.75
Accession No. 1	89.50	*	*	*	22.39	*	*	*	*	*
Winter Queen	133.00	99.00	71.00	**	75.75	145.00	105.50	100.50	***	87.75
Karnool	120.00	88.50	67.50	66.00	85.50	145.00	107.50	98.00	***	87.63
Raja	139.50	83.00	68.50	*	72.75	151.50	121.50	101.00	***	93.50
States Man	140.50	109.00	85.00	*	83.63	153.00	127.50	118.50	***	99.75
Mean	126.65	86.05	74.25	19.65	-	129.65	102.10	61.35	8.2	-
Source	**SEm±**		**CD at 5%**			**SEm±**		**CD at 5%**		
Months	0.52		1.50			0.60		1.72		
Cultivars	0.82		2.35			0.95		2.73		
Interaction	1.64		4.70			1.91		5.46		

*No flowering. **Not attended 50% flowering. ***Not attended 100% flowering.

Among the interactions, October month planted Winter Queen (28.50 DAP) cultivar was early to initiate flower buds. Whereas, June month planted Automn Joy (116.20 DAP) was last to initiate flower buds.

4.1.2.2 Days taken for first flowering

Significant differences were observed among the chrysanthemum cultivars planted in different months for the days taken to first flower opening (Table 5). Flowering was early as the months of planting advanced from June to December. December followed by October planted plants were early to first flower opening (24.50 DAP and 48.75 DAP, respectively), whereas June planted plants were late to first flower opening (108.70 DAP) and August month planted plants took 67.90 days.

Among the cultivars, Accession No. 1 was early to open first flower (15.50 DAP), followed by Garden Beauty (52.63 DAP). Raja (60.63 DAP) and Karnool (62.00 DAP) were on par with each other for days to first flowering and were flower next in the order. The cultivar Chitradurga Local (76.38 DAP) and Accession No. 2 (75.00 DAP) were late flowering types. The plants of the genotype Accession No. 1 which did not initiated flower buds in August, October and December month plantings not proceeded for the next stage. Similarly, cultivars Automn Joy, Raja and States Man planted in December month failed to attain flowering.

Among the interactions, December month planted Garden Beauty cultivar was early to open first flower (33.00 DAP) followed by Winter Queen (33.50 DAP) and Accession No. 2 (34.40 DAP). While, June month planted Automn Joy late to flower (138.00 DAP).

4.1.2.3 Days to reach 50 per cent flowering

The differences for days taken to reach 50 per cent flowering varied significantly among the chrysanthemum cultivars planted in different months (Table 6 and Fig. 3). In general, the days taken to reach 50 per cent flowering gradually decreased from June to December planting. December followed by October planted plants were the earliest to reach 50 per cent flowering stage (19.65 DAP and 74.25 DAP, respectively), whereas June month planted plants were last to attain 50 per cent flowering (126.65 DAP).

Table 6: Number of days to reach 50% flowering and complete flowering in different chrysanthemum cultivars planted in different months

Cultivars	No. of days to reach 50% flowering				Mean	No. of days to complete flowering				Mean
	Planting months					Planting months				
	June	August	October	December		June	August	October	December	
Dundi	134.00	88.00	82.00	59.07	90.75	141.00	109.00	101.00	82.00	108.25
Accession No. 2	124.00	108.50	119.00	**	87.88	139.50	120.50	***	***	65.00
Chitradurga Local	139.00	112.00	87.00	**	84.50	145.00	125.50	***	***	67.63
Automn Joy	161.50	105.00	103.50	*	92.50	179.50	120.50	***	*	75.00
Garden Beauty	85.50	67.50	59.00	71.50	70.88	97.00	83.50	94.50	***	68.75
Accession No. 1	89.50	*	*	*	22.39	*	*	*	*	*
Winter Queen	133.00	99.00	71.00	**	75.75	145.00	105.50	100.50	***	87.75
Karnool	120.00	88.50	67.50	66.00	85.50	145.00	107.50	98.00	***	87.63
Raja	139.50	83.00	68.50	*	72.75	151.50	121.50	101.00	***	93.50
States Man	140.50	109.00	85.00	*	83.63	153.00	127.50	118.50	***	99.75
Mean	126.65	86.05	74.25	19.65	-	129.65	102.10	61.35	8.2	-
Source	**SEm±**		**CD at 5%**			**SEm±**		**CD at 5%**		
Months	0.52		1.50			0.60		1.72		
Cultivars	0.82		2.35			0.95		2.73		
Interaction	1.64		4.70			1.91		5.46		

*No flowering. **Not attended 50% flowering. ***Not attended 100% flowering.

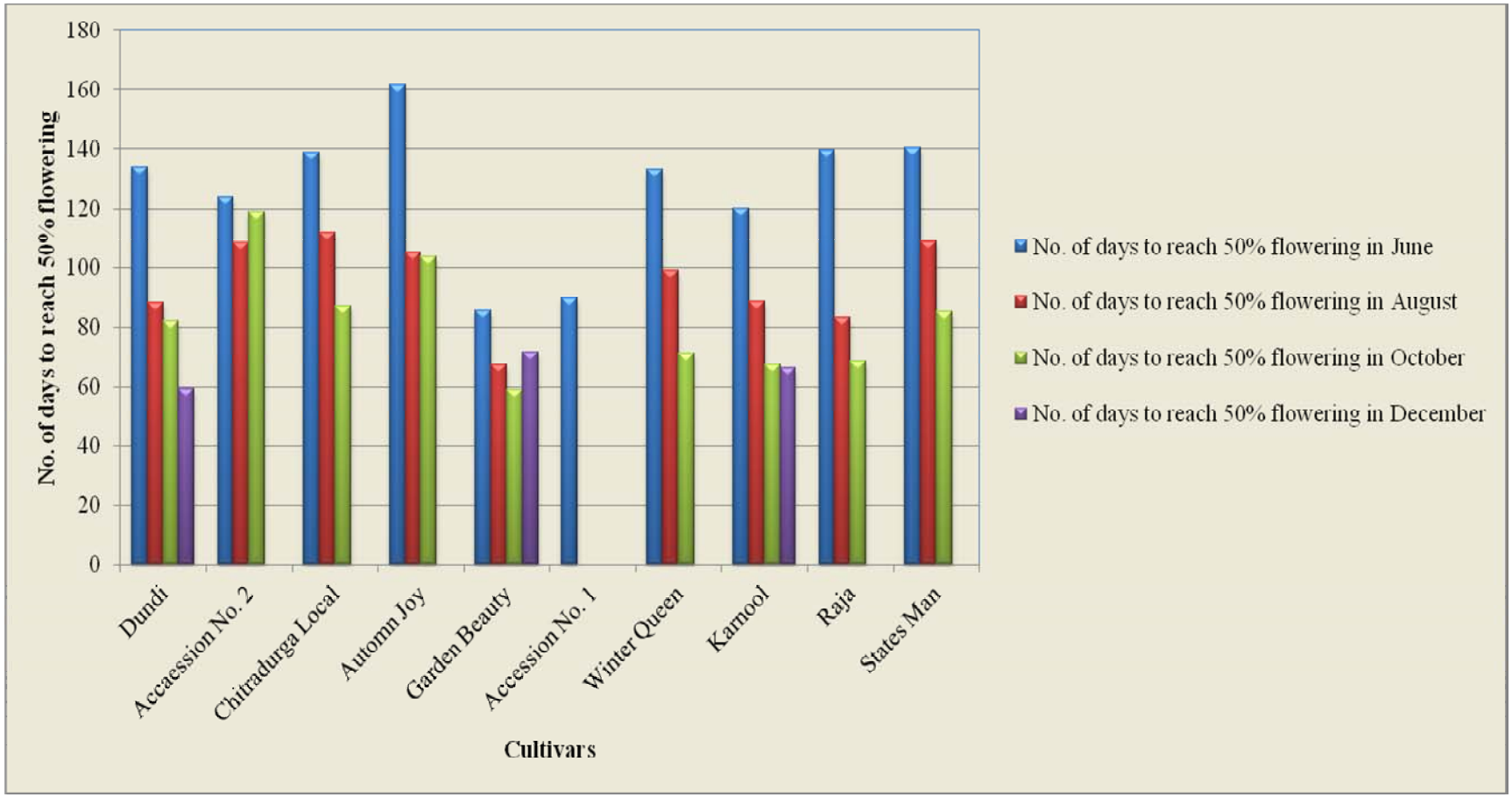


Fig. 3. Number of days taken to reach 50% flowering in different chrysanthemum cultivars planted in different months

Among the cultivars, Accession No. 1 which was early to initiate flower bud, was early to reach 50 per cent flowering (22.39 DAP). Next early cultivars in the order to reach 50 per cent flowering were Garden Beauty (70.88 DAP), Raja (72.75 DAP) and Winter Queen (75.75 DAP). The cultivar Dundi took more number of days (90.75 DAP) to reach 50 per cent flowering. Genotype Accession No. 1 not at all attended the 50 per cent flowering stage when planted in August, October and December months as it did not initiated flower buds during these months of planting. The cultivars Accession No. 2, Chitradurga Local and Winter Queen were also not reached 50 per cent flowering stage when planted in December month.

Among the interactions, October month planted Garden Beauty (59.00 DAP), followed by December month planted Dundi (59.07 DAP) cultivars were early to reach 50 per cent flowering stage. The June month planted Automn Joy was late (161.50 DAP) to reach 50 per cent flowering stage.

4.1.2.4 Days to complete flowering

Significant differences were observed among the chrysanthemum cultivars planted in different months to reach 100 per cent flowering stage (Table 6). Among the different planting months June planted plants took 129.65 days to reach 100 per cent flowering which was late compared to other months of planting, whereas August (102.10 days), October (61.35 days) and December (8.2 days) planting months were in decreased order to reach 100 per cent flowering.

Among the cultivars, Accession No. 2 was early to reach 100 per cent flowering (65.00 DAP), which was on par with Chitradurga Local (67.63 DAP). The cultivar Dundi took more number of days (108.25 DAP) to reach cent per cent flowering. The cultivars Accession No. 2, Chitradurga Local and Automn Joy planted in October month did not attend cent per cent flowering. In December planting Dundi was only the cultivar which attended cent per cent flowering.

Among the interactions, December month planted Dundi (82.00 DAP) was early to reach cent per cent flowering stage followed by August planted Garden Beauty (83.50 DAP) and June month planted Automn Joy was late to reach 100 per cent flowering stage (179.50 DAP).

4.1.2.5 Duration of flowering

Significant differences were seen with respect to duration of flowering in chrysanthemum cultivars planted in different months (Table 7 and Fig. 4). In general, October planting had longer duration of flowering (66.55 days) as compared to that of December planting which experienced very short flowering duration (30.70 days). June planted plants had 57.70 days and August planted plants had 45.35 days of flowering duration.

Among the cultivars, Garden Beauty flowered for a maximum period of 78.25 days, followed by Karnool (65.87 days) and Accession No. 2 (59.37 days). The next cultivar in the order was Chitradurga Local (54.37 days) which was on par with Winter Queen (50.75) and Dundi (50.25 days). Flowering duration was minimum in Accession No. 1.

Among the interactions, October month planted Gadren Beauty variety had maximum duration of flowering (110.50 days), followed by States Man (78.00 days), Automn Joy (76.50 days) and Karnool (76.00 days). June planted Accession No. 1 had minimum flowering duration (32.00 days).

4.1.3 Flower yield

The data on number of flowers per plant, flower yield per plant, flower yield per plot and flower yield per hectare are presented in Table 8-9.

4.1.3.1 Number of flowers per plant

Chrysanthemum cultivars planted in different months differed significantly for number of flowers produced per plant (Table 8). The number of flowers produced per plant which was maximum in June planting gradually decreased in later months and reached minimum in December planting. Significantly increased number of flowers per plant was recorded in June and August planted plants (115.89 and 53.70, respectively), whereas, the flower production per plant was least in December planting (22.05). After June and August plantings, October planting was next in the order for increased number of flowers per plant (37.25).

Among the cultivars, flower production was maximum (112.05) in Garden Beauty and Winter Queen (84.89). The next cultivar in the order for maximum

Table 7: Duration of flowering in different chrysanthemum cultivars planted in different months

Cultivars	Duration of flowering				Mean
	Planting months				
	June	August	October	December	
Dundi	44.00	43.00	67.00	47.00	50.25
Accession No. 2	56.50	57.50	63.00	60.50	59.37
Chitradurga Local	53.50	57.50	69.50	37.00	54.37
Automn Joy	49.00	36.50	76.50	*	40.50
Garden Beauty	77.50	61.00	110.50	64.00	78.25
Accession No. 1	32.00	*	*	*	8.00
Winter Queen	54.00	38.50	62.50	48.00	50.75
Karnool	75.00	62.00	76.00	50.50	65.87
Raja	65.00	56.00	62.50	*	45.87
States Man	70.50	41.50	78.00	*	47.50
Mean	57.70	45.35	66.55	30.70	

Source	SEm±	CD at 5%
Months	0.93	2.65
Cultivars	1.46	4.20
Interaction	2.93	8.37

*No flowering.

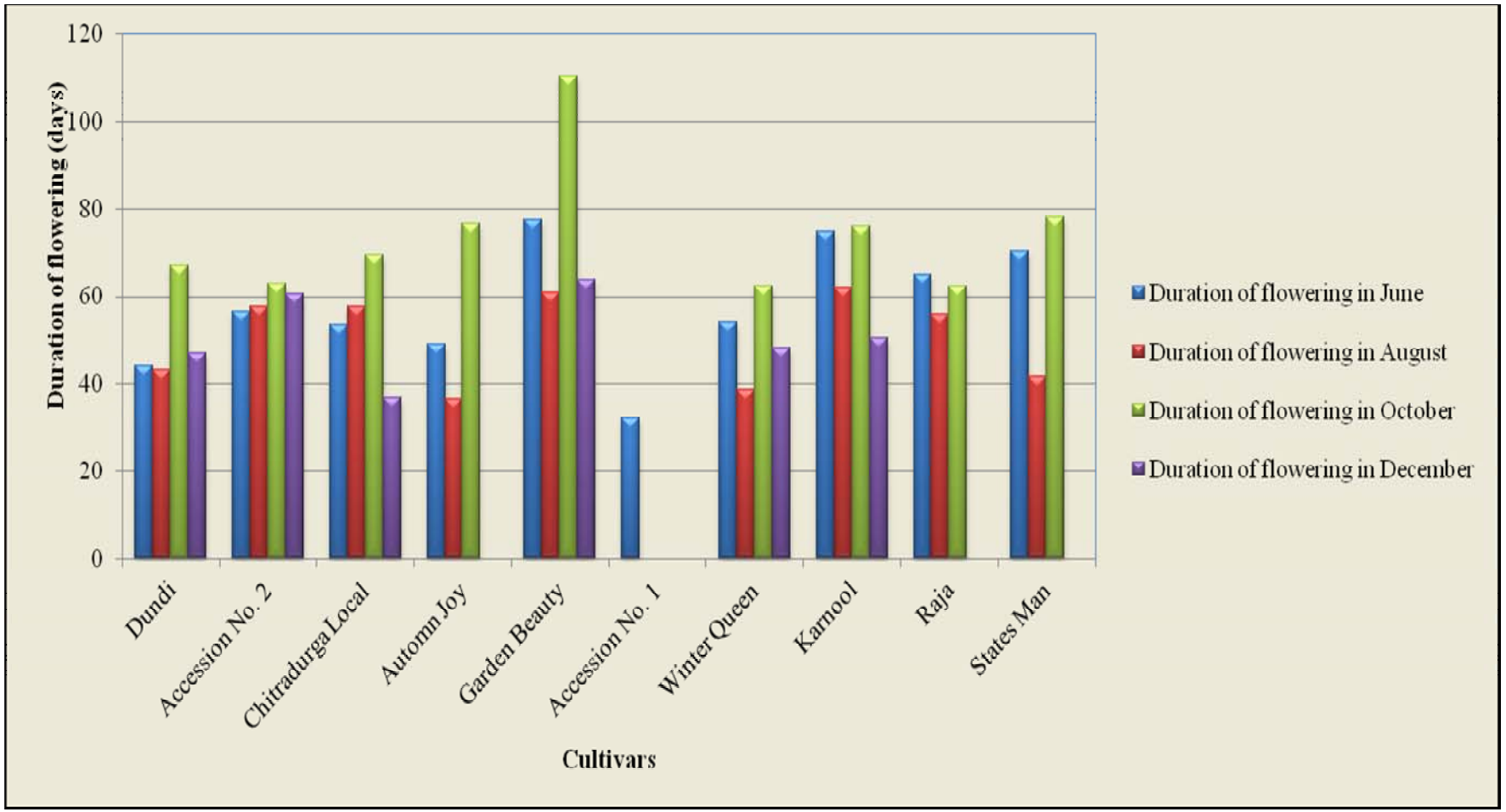


Fig. 4. Duration of flowering in different chrysanthemum cultivars planted in different months

number of flowers per plant was Automn Joy (78.79), Karnool (70.95) and Dundi (65.53). The genotype Accession No. 1 recorded the lowest number of flowers per plant (8.06).

Among the interactions, June month planted Garden Beauty produced maximum number of flowers per plant (214.60) followed by Winter Queen (192.60), Automn Joy (164.65), Karnool (122.40), Accession No. 2 (117.80) and Dundi (83.00). Whereas, December month planted Winter Queen was recorded minimum number of flowers per plant (12.45).

4.1.3.2 Flower yield per plant

The significant differences were observed for flower yield per plant in chrysanthemum cultivars as planted in different months (Table 8).

The flower yield gradually decreased with delay in planting from June to December. Flower yield per plant was higher in the plants planted in June (186.00 g) and August (83.54 g), while, it was lower in plants planted in December (26.76 g), followed by October (48.09 g).

Among the cultivars, flower yield per plant was maximum (145.47 g) in Garden Beauty which was on par with Karnool (137.06 g). The next cultivar in the order for maximum flower yield per plant was Dundi (117.11 g) and Accession No. 2 (97.94 g). The flower yield per plant was minimum (8.47 g) in Accession No. 1 and it did not produced flowers in August, October and December months of planting.

Among the interactions, June planted Garden Beauty followed by Accession No. 2 produced higher yields (275.81 g and 263.05 g, respectively). The next cultivars in the order for maximum flower yield per plant were Raja (223.83 g), Winter Queen (218.51 g), Karnool (214.70 g) and Dundi (187.32 g). The flower yield per plant was minimum in December planted Winter Queen (11.82 g) as it had the minimum number of flowers per plant.

4.1.3.3 Flower yield per plot

The significant differences were observed for flower yield per plot (2.7 m^2) in chrysanthemum cultivars planted in different months (Table 9).

Table 8: Number of flowers and flower yield per plant in different chrysanthemum cultivars planted in different months

Cultivars	No. of flowers/plant				Mean	Flower yield/plant (g)				Mean
	Planting months					Planting months				
	June	August	October	December		June	August	October	December	
Dundi	83.00	64.50	56.50	58.10	65.53	187.32	103.94	101.39	75.78	117.11
Accession No. 2	117.80	37.00	20.00	14.30	47.28	263.05	78.87	29.89	19.94	97.94
Chitradurga Local	64.85	39.50	23.00	16.15	35.88	184.77	63.68	33.96	16.25	74.67
Automn Joy	164.65	100.00	50.50	*	78.79	136.52	73.51	36.65	*	61.67
Garden Beauty	214.60	94.50	69.50	69.60	112.05	275.81	156.00	70.78	79.29	145.47
Accession No. 1	32.25	*	*	*	8.06	33.86	*	*	*	8.47
Winter Queen	192.60	81.00	53.50	12.45	84.89	218.51	88.38	60.90	11.82	94.90
Karnool	122.40	61.00	50.50	49.90	70.95	214.70	177.08	91.93	64.54	137.06
Raja	109.20	32.50	27.50	*	42.30	223.83	50.09	31.04	*	76.24
States Man	57.50	27.00	21.50	*	26.50	121.61	43.85	24.37	*	47.46
Mean	115.89	53.70	37.25	22.05	-	186.00	83.54	48.09	26.76	-
Source	**SEm±**		**CD at 5%**			**SEm±**		**CD at 5%**		
Months	1.05		3.01			1.91		5.47		
Cultivars	1.66		4.75			3.02		8.65		
Interaction	3.32		9.50			6.05		17.31		

*No flowering.

The flower yield gradually decreased with delay in planting from June to December. Flower yield per plot was higher in plants planted in June (5.48 kg / 2.7 m^2) and August (2.56 kg), while it was lower in plants planted in December (0.72 kg), followed by October (1.33 kg).

Among the chrysanthemum cultivars, flower yield per plot was maximum (4.36 kg) in Garden Beauty followed by Karnool (4.10 kg) and Dundi (3.63 kg). The next cultivars in the order for maximum flower yield per plot were Accession No. 2 (2.82 kg), Winter Queen (2.79 kg), Chitradurga Local (2.05 kg) and Raja (2.04 kg). The flower yield per plot was minimum (0.18 kg / 2.7 m^2) in Accession No. 1 as it did not produced flowers in August, October and December months of planting.

Among the interactions, June planted Garden Beauty followed by Accession No. 2 recorded maximum flower yields per plot / 2.7 m^2 (8.25 and 8.06 kg / 2.7 m^2, respectively), followed by Winter Queen (6.54 kg), Karnool (6.42 kg) Raja (5.71 kg) and Dundi (5.62 kg). The flower yield per plot was minimum in December month planted Winter Queen (0.14 kg) as it had minimum number of flowers per plant.

4.1.3.4 Flower yield per hectare

Differences in flower yield in terms of per hectare were significant among the chrysanthemum cultivars planted at different months (Table 9 and Fig. 5). In general, the flower yield gradually decreased right from June planting to December planting. The plants planted in June recorded the highest flower yield (19.30 t/ha) as compared to plants planted in August, October and December which recorded significantly lower yields (9.49 t/ha, 4.91 t/ha and 1.99 t/ha, respectively).

Among the cultivars, flower yield was maximum (15.73 t/ha) in Garden Beauty, followed by the Dundi (13.46 t/ha) which was on par with Karnool (13.19 t/ha). The flower yield was minimum (0.68 t/ha) in Accession No. 1 genotype.

Among the interactions, June planted Garden Beauty recorded the maximum flower yield per hectare (29.05 t/ha), which was on par with June month planted Accession No. 2 (28.01 t/ha). The next cultivars in the order for higher flower yield were Karnool (22.27 t/ha), Winter Queen (22.07 t/ha), Raja (21.13 t/ha) and Dundi (20.81 t/ha). The lowest flower yield per hectare was recorded in December planted Winter Queen (0.53 t/ha).

Table 9: Flower yield per plot and per hectare in different chrysanthemum cultivars planted in different months.

Cultivars	Flower yield/plot (kg)				Mean	Flower yield/ha (t)				Mean
	Planting months					Planting months				
	June	August	October	December		June	August	October	December	
Dundi	5.62	3.57	3.03	2.31	3.63	20.81	13.23	11.21	8.57	13.46
Accession No. 2	8.06	2.48	0.55	0.19	2.82	28.01	9.2	2.03	0.73	9.99
Chitradurga Local	5.45	1.92	0.62	0.21	2.05	19.17	7.11	2.27	0.78	7.33
Automn Joy	4.10	2.22	0.69	*	1.75	13.18	8.22	2.55	*	5.99
Garden Beauty	8.25	4.68	2.14	2.37	4.36	29.05	17.33	7.95	8.57	15.73
Accession No. 1	0.72	*	*	*	0.18	2.70	*	*	*	0.68
Winter Queen	6.54	2.65	1.82	0.14	2.79	22.07	9.83	6.73	0.53	9.79
Karnool	6.42	5.29	2.74	1.93	4.10	22.27	19.61	10.16	0.71	13.19
Raja	5.71	1.51	0.92	*	2.04	21.13	5.61	3.40	*	7.54
States Man	3.94	1.28	0.73	*	1.49	14.59	4.75	2.73	*	5.52
Mean	5.48	2.56	1.33	0.72	-	19.3	9.49	4.91	1.99	-
Source	**SEm±**		**CD at 5%**			**SEm±**		**CD at 5%**		
Months	0.05		0.14			0.18		0.51		
Cultivars	0.08		0.22			0.28		0.80		
Interaction	0.16		0.45			0.56		1.61		

*No flowering

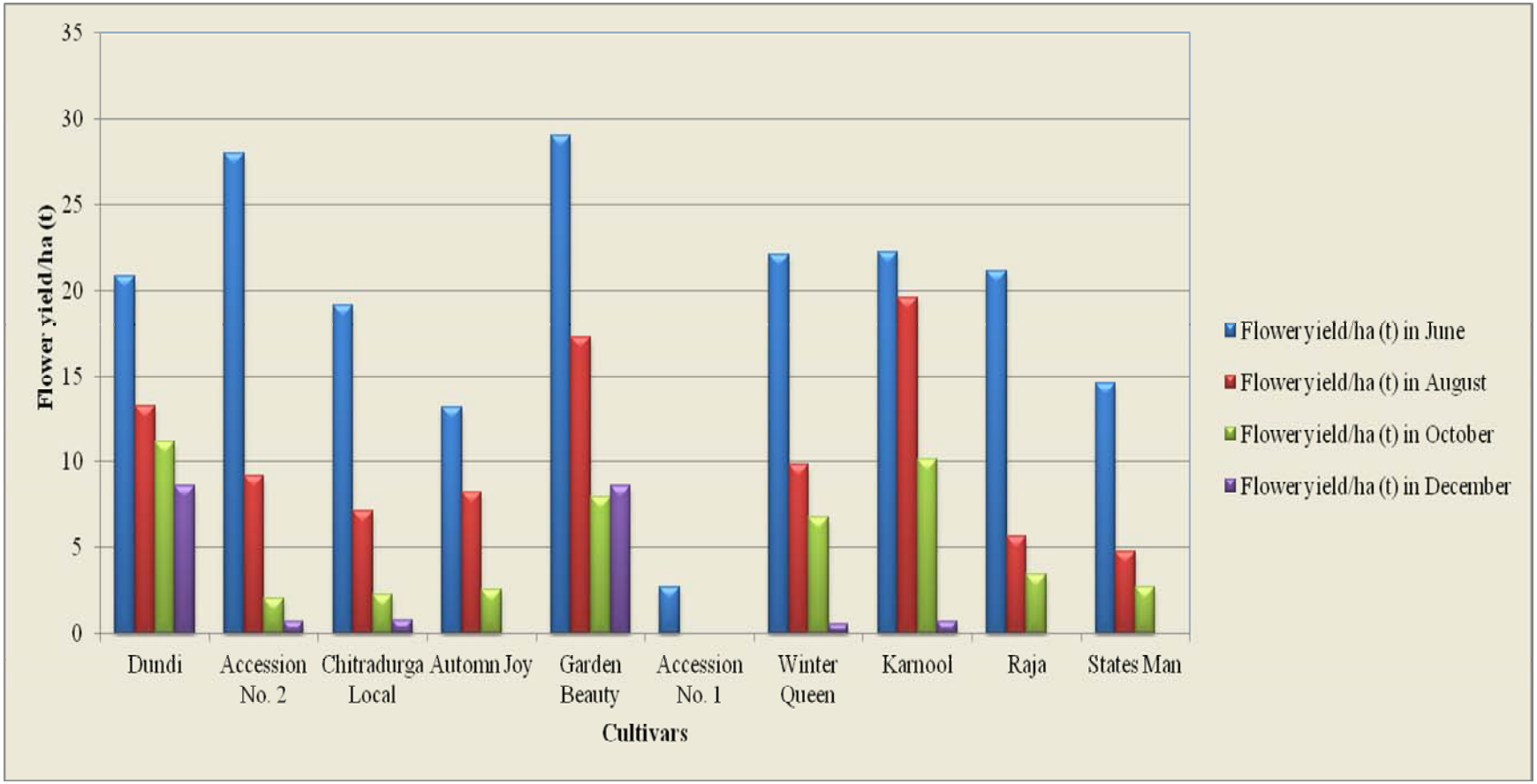


Fig. 5. Flower yield per hectare in different chrysanthemum cultivars planted in different months

Plate 5: High yielding cultivars of chrysanthemum

Dundi

Plate 6: Photo insensitive cultivar of chrysanthemum

4.1.4 Flower quality

The data on flower diameter, individual flower weight and shelf life are presented in Table 10-11.

4.1.4.1 Flower diameter

The average flower diameter of chrysanthemum cultivars varied significantly due to planting in different months (Table 10). The flowers obtained from the plants planted in June were larger in size (5.41 cm). August planted plants were next in the order for larger flower diameter (4.27 cm), which was on par with the October planted plants flower diameter (4.23 cm), whereas the flower diameter was minimum (2.71 cm) in December planting.

Among the cultivars, Garden Beauty recorded the widest flower diameter (5.99 cm), followed by Karnool (5.55 cm) which was on par with Winter Queen (5.50 cm). The next cultivar in the order for flower diameter was Accession No. 2 (4.98 cm) which was on par with Dundi (4.93 cm). The flower diameter was least (1.18 cm) in Accession No. 1.

Among the interactions, June month planted Garden Beauty recorded the maximum flower diameter (6.60 cm), and was on par with June month planted Dundi (6.16 cm), Accession No. 2 (6.07 cm), Karnool (6.04 cm) and August month planted Garden Beauty (6.09 cm). The flower diameter was least in August month planted States Man (1.62 cm).

4.1.4.2 Individual flower weight

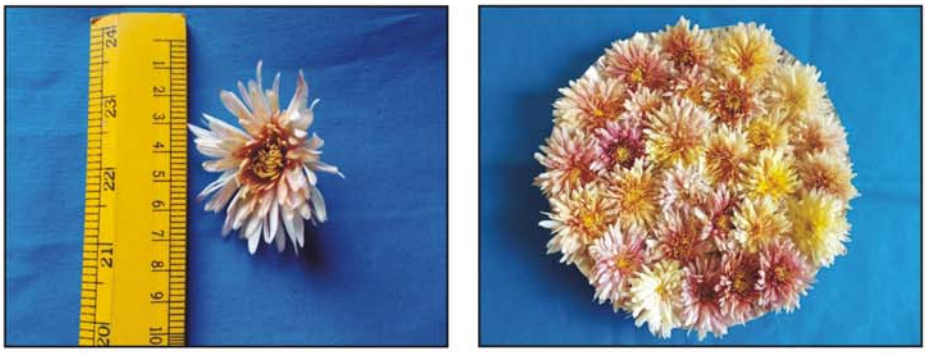
Data varied significantly with respect to individual flower weight due to planting of chrysanthemum cultivars in different months (Table 10). In general, the individual flower weight was decreased as the planting months advanced from June to December.

Significantly heavier flowers were obtained from the plants planted in June (1.73 g/flower) followed by August (1.48 g/flower) and October (1.17 g/flower) planting. Whereas the flowers obtained from December planted plants were light in weight (0.71 g/flower).

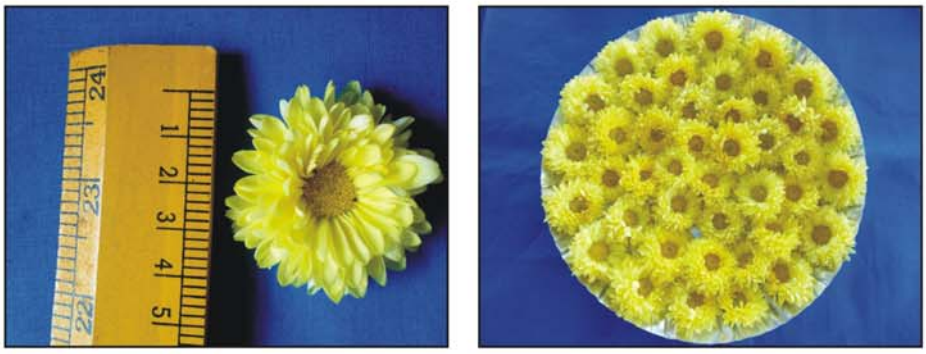
Table 10: Diameter of the flower and indivisual flower weight in different chrysanthemum cultivars planted in different months.

Cultivars	Diameter of the flower (cm)				Mean	Indivisual flower weight (g)				Mean
	Planting months					Planting months				
	June	August	October	December		June	August	October	December	
Dundi	6.16	4.10	5.12	4.33	4.93	2.26	1.61	1.79	1.31	1.75
Accession No. 2	6.07	5.76	4.39	3.68	4.98	2.52	2.11	1.49	1.39	1.88
Chitradurga Local	4.13	4.37	4.58	3.67	4.19	2.85	1.61	1.48	1.01	1.74
Automn Joy	4.47	5.00	4.61	*	3.52	0.80	0.73	0.72	*	0.57
Garden Beauty	6.60	6.09	5.58	5.67	5.99	1.32	2.58	1.02	1.14	1.27
Accession No. 1	4.73	*	*	*	1.18	1.01	*	*	*	0.25
Winter Queen	5.65	5.65	5.41	5.28	5.50	1.14	1.09	1.14	0.95	1.08
Karnool	6.04	5.75	5.97	4.44	5.55	1.76	2.90	1.82	1.29	1.94
Raja	5.93	4.40	3.73	*	3.52	2.05	1.51	1.13	*	1.17
States Man	4.29	1.62	2.87	*	2.20	1.61	1.62	1.11	*	1.08
Mean	5.41	4.27	4.23	2.71	-	1.73	1.48	1.17	0.71	-
Source	**SEm±**		**CD at 5%**			**SEm±**		**CD at 5%**		
Months	0.06		0.18			0.04		0.11		
Cultivars	0.10		0.28			0.06		0.17		
Interaction	0.20		0.56			0.12		0.35		

*No flowering.



Garden Beauty



Dundi

Karnool

Plate 7: Flower diameter and shelf life studies of promising cultivars of chrysanthemum

Among the cultivars, weight of the individual flower was maximum in Karnool (1.94 g/flower) which was on par with Accession No. 2 (1.88 g/flower). The next cultivar in the order for higher individual flower weight was Dundi (1.75 g/flower), which was on par with Chitradurga Local (1.74 g/flower). The average flower weight was minimum (0.25 g) in Accession No. 1.

Among the interactions, August month planted Karnool cultivar recorded the maximum flower weight (2.90 g/flower), which was on par with June planted Chitradurga Local (2.85 g/flower) and August planted Garden Beauty (2.58 g/flower), followed by June planted Accession No. 2 (2.52 g/flower), Dundi (2.26 g/flower) and Raja (2.05 g/flower). The average flower weight was minimum in October month planted Automn Joy (0.72 g/flower) variety.

4.1.4.3 Shelf life of flowers

Loose flowers of chrysanthemum cultivars differed significantly with each other for shelf life when planted in different planting months (Table 11).

The shelf life of flowers was maximum (3.53 days) in June month planted plants, followed by August (1.81 days) and October (1.06 days) month plantings. The shelf life was least (0.67 days) in December planted plants.

Among the cultivars, shelf life was maximum in Accession No. 2 (2.40 days) flowers, which was on par with Dundi (2.38 days). Cultivars Karnool (2.20 days) and Chitradurga Local (2.10 days) were at par with respect to shelf life of loose flowers. The shelf life was least in States Man (1.09 days) variety.

Among the interactions, June month planted Accession No. 1 genotype recorded the maximum shelf life of loose flowers (5.70 days), followed by Accession No. 2 (5.00 days), Chitradurga Local (4.30 days), Dundi (3.75 days), Raja (3.70 days) and Karnool (3.60 days), whereas December month planted Chitradurga Local, Garden Beauty, Winter Queen and October planted Garden Beauty, Winter Queen, States Man recorded the minimum shelf life of loose flowers (1.00 days each).

4.1.4.4 *Alternaria* disease incidence

Cultivars of chrysanthemum planted in different months varied significantly for per cent disease incidence (PDI) on leaves (Table 12). The per cent disease

Table 11: Shelf life of flowers in different chrysanthemum cultivars planted in different months

Cultivars	Shelf life (days)				Mean
	Planting months				
	June	August	October	December	
Dundi	3.75	2.95	1.50	1.30	2.38
Accession No. 2	5.00	2.20	1.30	1.10	2.40
Chitradurga Local	4.30	1.90	1.20	1.00	2.10
Automn Joy	2.15	1.30	1.10	*	1.14
Garden Beauty	2.50	2.70	1.00	1.00	1.80
Accession No. 1	5.70	*	*	*	1.43
Winter Queen	2.30	1.30	1.00	1.00	1.40
Karnool	3.60	2.50	1.40	1.30	2.20
Raja	3.70	2.10	1.10	*	1.73
States Man	2.25	1.10	1.00	*	1.09
Mean	3.53	1.81	1.06	0.67	-

Source	SEm±	CD at 5%
Months	0.03	0.08
Cultivars	0.05	0.13
Interaction	0.10	0.27

*No flowering.

Table 12: Per cent disease incidence in different chrysanthemum cultivars planted in different months

Cultivars	Per cent disease incidence (PDI)				Mean
	Planting months				
	June	August	October	December	
Dundi	80.00	54.00	39.00	63.00	59.00
Accession No. 2	39.00	15.00	7.00	10.00	17.75
Chitradurga Local	24.00	6.00	10.00	22.00	15.50
Automn Joy	5.00	6.00	6.00	5.00	5.50
Garden Beauty	48.00	6.00	13.00	20.00	21.75
Accession No. 1	3.00	5.00	2.00	2.00	3.00
Winter Queen	5.00	8.00	8.00	18.00	9.75
Karnool	78.00	4.00	10.00	14.00	26.50
Raja	4.00	8.00	3.00	12.00	6.75
States Man	4.00	24.00	7.00	18.00	13.25
Mean	29.00	13.60	10.50	18.40	

Source	SEm±	CD at 5%
Months	1.19	3.40
Cultivars	1.88	5.37
Interaction	3.75	10.74

Dundi (Highly susceptible)

Accession No. 1 (Resistant)

Plate 8: Plate showing incidence of *Alternaria* leaf spot disease in chrysanthemum

Table 13: *Alternaria* leaf spot in different chrysanthemum cultivars planted in different months

Rating	Reaction	Response of varieties
0-5 per cent	Resistant (R)	Accession No. 1
6-15 per cent	Moderately resistant (MR)	Automn Joy, Raja, Winter Queen, States Man
16-35 per cent	Moderately susceptible (MS)	Chitradurga Local, Accession No. 2 , Karnool, Garden Beauty
36-55 per cent	Susceptible (S)	-
56 per cent and above	Highly susceptible	Dundi

incidence was minimum (10.50 %) in October month planted plants, whereas the PDI was maximum (29.00 %) in June month planted plants followed by December (18.40 %) and August (13.60 %) month plantings.

Among the cultivars, Accession No. 1 (3.00 %) and Automn Joy (5.50 %) recorded the minimum percent disease incidence. Cultivar Dundi recorded the miximum (59.00%) PDI as compared to other cultivars.

Among the interactions, October and December month planted Accession No. 1 (2 %) genotype recorded the minimum PDI and June month planted Dundi recorded miximum (80.00 %) PDI, which was on par with June month planted Karnool (78.00 %).

The genotype Accession No. 1 was grouped under resistant, whereas Automn Joy, Raja, Winter Queen and States Man were moderately resistant, while Chitradurga Local, Accession No. 2, Karnool and Garden Beauty were moderately susceptible, there were no cultivars which were resistant and Dundi grouped under highly susceptible type (Table 13).

4.1.4.5 Economics

The economics of chrysanthemum cultivars planted in different months were worked out and presented in Table 14. The cost of cultivation is given in appendix-II. The cost of cultivation for the chrysanthemum cultivation of one hectare area was ₹. 1,91,641.00. The economic analysis revealed that the maximum gross returns, net returns and B:C ratio were obtained from June month planted plants followed by August month planting. Whereas the lowest gross returns, net returns and B:C ratio were in December planting.

June month planted Accession No. 2 genotype yielded maximum gross returns (₹. 9,80,350/ha) with maximum net returns and B:C ratio (₹. 7,88,709 and 4.12, respectively), followed by August month planted Karnool with a gross returns of ₹. 7,84,400/ha and B:C ratio of 3.10. The next cultivars in the increased order for gross returns were Raja (₹. 7,39,550/ha), Karnool (₹. 6,68,100/ha), and Dundi (₹. 6,24,300/ha) as compared to other genotypes and these also had maximum B:C ratio of 2.85, 2.50 and 2.26, respectively.

Table 14: Economics of production of different chrysanthemum cultivars planted in different months

Cultivars	June					August				
	Planting months					Planting months				
	Yield (t/ha)	Flower rate/kg (₹)	Gross Return (₹)	Net return (₹)	B:C ratio	Yield (t/ha)	Flower rate/kg (₹)	Gross Return (₹)	Net return (₹)	B:C ratio
Dundi	20.81	30.00	6,24,300	4,32,659	2.26	13.23	40.00	5,29,200	3,37,559	1.76
Accession No. 2	28.01	35.00	9,80,350	7,88,709	4.12	9.20	45.00	4,14,000	2,22,359	1.16
Chitradurga Local	19.17	30.00	5,75,100	3,83,459	2.01	7.11	40.00	2,84,400	92,759	0.48
Automn Joy	13.18	15.00	1,97,700	6,059	0.03	8.22	20.00	1,64,400	-27,241	-0.14
Garden Beauty	29.05	15.00	4,35,750	2,44,109	1.27	17.33	20.00	3,46,600	1,54,959	0.81
Accession No. 1	2.705	30.00	81,000	-1,10,641	-0.57	*	*	*	*	*
Winter Queen	22.07	15.00	3,31,050	1,39,409	0.72	9.83	20.00	1,96,600	4,959	0.02
Karnool	22.27	30.00	6,68,100	4,79,459	2.50	19.61	40.00	7,84,400	5,92,759	3.10
Raja	21.13	35.00	7,39,550	5,47,909	2.85	5.61	45.00	2,52,450	60,809	0.32
States Man	14.59	15.00	2,18,850	27,209	0.14	4.75	20.00	95,000	-96,641	-0.50

* No flowering in the cultivars.

Contd…

Cultivars	October					December				
	Yield (t/ha)	Flower rate/kg (₹)	Gross Return (₹)	Net return (₹)	B:C ratio	Yield (t/ha)	Flower rate/kg (₹)	Gross Return (₹)	Net return (₹)	B:C ratio
Dundi	11.21	60.00	6,72,600	4,80,959	2.51	8.57	70.00	5,99,900	4,08,259	2.13
Accession No. 2	2.03	65.00	1,31,950	-59,691	-0.31	0.73	75.00	54,750	-1,36,891	-0.71
Chitradurga Local	2.27	60.00	1,36,200	-55,441	-0.29	0.78	70.00	54,600	-1,37,041	-0.72
Automn Joy	2.55	30.00	76,500	-11,51,41	-0.60	*	*	*	*	*
Garden Beauty	7.95	30.00	2,38,500	46,859	0.24	8.57	35.00	2,99,950	1,08,309	0.56
Accession No. 1	*	*	*	*	*	*	*	*	*	*
Winter Queen	6.73	30.00	2,01,900	10,259	0.05	0.53	35.00	18,550	-1,73,091	-0.90
Karnool	10.16	60.00	6,09,600	4,17,959	2.18	0.71	70.00	49,700	-1,41,941	-0.74
Raja	3.40	65.00	2,21,000	29,359	0.15	*	*	*	*	*
States Man	2.73	30.00	81,900	-1,09,741	-0.57	*	*	*	*	*

* No flowering in the cultivars.

Table 15: Consumer acceptance for loose flower purpose of chrysanthemum cultivars

Cultivars	Shape	Colour	Overall acceptance	Shelf life
Dundi	4.95	4.90	5.00	5.00
Accession No. 2	4.45	4.80	4.75	4.25
Chitradurga Local	4.40	4.55	4.15	3.15
Automn Joy	3.30	4.50	3.05	1.15
Garden Beauty	3.00	4.00	3.55	3.40
Accession No. 1	4.80	5.00	4.50	4.70
Winter Queen	3.10	4.65	2.75	1.75
Karnool	4.45	4.85	4.95	4.95
Raja	4.05	4.60	4.10	4.10
States Man	1.70	4.15	1.15	1.55
SEm±	0.20	0.14	0.10	0.12
CD at 5%	0.62	0.31	0.25	0.26

Scoring 0-5

1 - Not acceptable

2 – Moderately acceptable

3 – Good

4 – Acceptable

5 – Highly acceptable

4.1.4.5 Consumer acceptance for loose flower

Consumer acceptance for loose flower purpose of chrysanthemum cultivars are presented in Table 15. Cultivars Dundi and Karnool had maximum scoring for consumer acceptance with respect to shape (4.95 and 4.45), colour (4.90 and 4.85), overall acceptance (5.00 and 4.95) and shelf life (5.00 and 4.95, respectively). The next cultivars in the order for consumer acceptance were Accession No. 2, Accession No. 1 and Raja.

5. DISCUSSION

Among the various factors that influence plant growth and development, climatic conditions play an important role in the performance of crops. For successful cultivation of any crop, crop should be exposed to an optimum climatic condition during the growing period, so as to get maximum production of quality flowers.

Differences in planting months would bring about a variation among the cultivars with respect to growth, yield and flower quality parameters. So, selection of suitable time of planting is necessary for a particular cultivar to maximize the flower yield and quality inturn to get more profit.

5.1 Effect of months of planting on chrysanthemum cultivars

5.1.1 Vegetative characters

5.1.1.1 Plant height

The plant height differed significantly at all stages of crop growth. At the grand growth stage, the plants of June planting were tallest, followed by those of August and October plantings. The plants planted during December month were dwarf. The plants planted in June experienced the favourable climatic conditions particularly the light intensity (1845.53 Lux) and duration (12.57 hours) accompanied by optimum temperature (22.80 to 32.42 ^{o}C) and relative humidity (59 to 79%).

Light affects the growth of chrysanthemum quantitatively by influencing photosynthetic activity and qualitatively due to the phenomenon of photoperiodism. Lawrence (1950) and Hassan and Newton (1975) found that a daily radiation integral between 1.2 and 1.6 MJ/m^2/day is necessary for adequate growth in chrysanthemum.

The plants planted in December and October were exposed to lower light intensity (1457.86 and 1440.63 Lux) and duration (short days) and lower night temperature (30.48 and 30.39) during the period of their rapid vegetative growth stage. The decreased plant height in later planting dates (October and December) was also due to the early induction of flowering which limited the vegetative growth. These results are in confirmation with those of Kiyatkin (1975), Shin *et al*. (1995), and Sudhendu and Pal (2011).

The cultivars Automn joy and Winter Queen were vigorous in growth in terms of plant height, whereas the cultivars Accession No. 2, Dundi, Chitradurga Local, Raja and Karnool were medium in vigour in terms of plant height. The genotype Accession No. 1 was dwarf recording minimum plant height at the grand growth stage. Being a genetical factor, the plant height varied among the cultivars. Similar variation in plant height due to cultivars was also observed previously in chrysanthemum (Chezhian *et al.*, 1985a, Wilfert 1985, Anuradha *et al.,* 2000, Mukeshkumar and Chattopadhyay, 2002, Manohar and Pratap, 2006 and Parul *et al.,* 2011.

Among the interactions, June month planted Automn Joy, Winter Queen and Accession No. 2 recorded the highest plant height. Whereas the least plant height was recorded in December month planted Accession No. 1 genotype.

5.1.1.2 Number of primary and secondary branches

The plants planted in June month had more number of primary and secondary branches. Those planted in December, October and August produced less number of primary and secondary branches, probably due to less congenial growing conditions that prevailing during their rapid vegetative growth period. On the other hand, the plants planted in June months experienced congenial climate (long days and optimum temperatures) and remained longer in vegetative phase as had maximum number of primary and secondary branches as worked by Dahiya *et al*. (2007) and Kulkarni and Reddy (2008).

The number of primary branches produced per plant was higher in cultivars Garden Beauty, Automn Joy, Accession No. 1, Winter Queen, Accession No. 2 and Dundi as compared to other cultivars. The differences in number of primary branches could be attributed to the genetical makeup of the cultivars.

Secondary branches were maximum in cultivars Garden Beauty, Automn Joy, Accession No. 1, Winter Queen, Accession No. 2 and Dundi as these cultivars also had higher number of primary branches. Whereas, Chitradurga Local, Raja and States Man had less number of secondary branches per plant. The difference in number of branches among the cultivars could be due to the influence of genetical makeup of the cultivars. Similar variations for number of branches were observed previously in

chrysanthemum by Kanamadi and Patil (1993), Mukeshkumar and Chattopadhyay, (2002) and Parul *et al.* (2011).

Among the interactions, June month planted Automn Joy, Garden Beauty and Accession No. 1 had higher number of branches. Whereas, December planted Accession No. 2, Karnool, Raja, States Man and Chitradurga Local had less number of branches.

5.1.1.3 Plant spread

Plant spread of E-W and N-S was influenced significantly by different dates of planting and it decreased from June to December month planting. The plants planted in June were more spreading, while those planted in August and onwards recorded decreased plant spread at grand growth stage. The spreading growth in plants of June planting was mainly due to increased production of branches. Comparatively, less spreading was observed in plants planted in August and onwards because of reduction in number of branches which could be their exposure to less congenial weather conditions during their growth period, which coincied with winter months. These results are in confirmation with those of Meher *et al.* (1999a).

The plant spread was more in the cultivars Automn Joy and Winter Queen. The cultivars Accession No. 2, Raja, Dundi, Accession No. 1 and Karnool were next in the order for increased plant spread. The plant spread was lowest in States Man variety. This increase in plant spread was mainly due to production of increased number of branches and wider angles between the primary and secondary branches at a point of origin. The lesser plant spread was due to production of less number of both primary and secondary branches and also erects growth habit of branches in some of the cultivars. Varietal differences in plant spread was also reported earlier by Kanamadi and Patil (1993), Mukeshkumar and Chattopadhyay (2002) and Parul *et al.* (2011).

Among the interactions, June month planted Automn Joy, Winter Queen and Dundi cultivars recorded the highest plant spread. Whereas, the least plant spread was recorded in December month planted States Man variety.

5.1.1.4 Leaf area

Leaf area in chrysanthemum cultivars differed significantly due to different months of planting. The leaf area per plant was highest in the plants planted in June. The next planting month in the order for increased leaf area was August. Leaf area was minimum in the plants planted during December and October months. This reduced leaf area in later planting months might be due to production of less number of leaves and less number of primary and secondary branches on plants, which could be due to reduction in plant height. Increased leaf area in the plants of June plantings could be attributed to the production of more number leaves and more number of primary and secondary branches on plants which could be directly correlated to the increased plant height. The similar results were also reported by previous workers in chrysanthemum (Kiyatkin, 1975).

In general the cultivars Karnool, Accession No. 2, Dundi, Winter Queen and Raja recorded maximum leaf area. Higher leaf area in these cultivars was due to the increased number of leaves and their size. Smaller leaves and less number of leaves per plant resulted in minimum leaf area in the variety States Man. Since cultivars varied for their number of leaves and size of the leaf, leaf area also varied. Variation in leaf production could be expected among the cultivars as the attribute is genetically controlled one. Variation in leaf area production due to the cultivars was also observed by Kanamadi and Patil (1993).

Among the interactions, June month planted Karnool and Accession No. 2 recorded the higher leaf area per plant and the lowest was recorded in December planted States Man.

5.1.2 Flowering parameters

Flowering was early with the advanced months of plantings from June to December in different chrysanthemum cultivars.

5.1.2.1 Days taken for bud initiation

The time taken for first bud initiation was early in December and October month planted plants, while the plants of June were late for the same. Early bud initiation in December and October month planted plants could be due to exposure of

plants to unfavourable climatic conditions (short days) during the vegetative growth period as a result they entered early into the reproductive phase as they experienced short days and low temperatures which favours bud initiation in chrysanthemum. Early bud initiation due to short day conditions has been reported by previous workers in chrysanthemum (Cockshull and Kofranek, 1992) and Barman *et al.,* 1993).

The time taken for first flower bud initiation was minimum in the cultivars Accession No. 1, Garden Beauty, States Man and Raja. Whereas the cultivar Chitradurga Local was last to initiate first flower bud followed by Winter Queen, Dundi and Automn Joy. The variation in flower bud initiation was expected among the chrysanthemum cultivars due to the differences in the genetical makeup. Similarly variation in flower bud initiation was also reported previously by Rajshekaran *et al.* (1985), Negi *et al.* (1988) and Manohar and Pratap (2006).

Among the interactions, October month planted Winter Queen variety was early to initiate flower buds. Whereas, June month planted Automn Joy was last to initiate flower buds.

5.1.2.2 Days to first flowering

The plants of December and October month plantings were early to first flowering, while the plants of June were late to flower. Early flowering in December and October months of planting was due to early bud initiation in these plants. The earliness in flowering due to short days may be attributed to an earlier morphological differentiation of flowers. The earlier cessation of vegetative phase immediately after planting as observed in the plant height and number of leaves per plant at early stages of the growth in the treatments of December and October month plantings should have also contributed to the earliness in flowering in these treatments. Earliness in flowering due to short day conditions has been reported by previous workers in chrysanthemum (Barman *et al.,* 1993 and Meher *et al.,* 1999b). On the other hand, the plants planted in June months experienced congenial climate (long days and optimum temperatures) and remained sufficiently longer in vegetative phase as took maximum days for flowering as worked by Shin *et al.* (1995).

The cultivars Accession No. 1, Garden Beauty, Raja and Karnool took minimum days to first flowering as these were early to initiate flower buds. Whereas

cultivar Chitradurga Local was late flowering type followed by Winter Queen, Dundi and Automn Joy, as these were late to initiate flower buds. The variation in flowering among the chrysanthemum cultivars was expected due to the differences in the genetical makeup. Similarly variation in flower opening was also reported previously by Mishra (1999), Madhumita *et al.* (2006) and Poonam and Ashok (2008).

Among the interactions, December month planted Garden Beauty variety was early to open first flower followed by Winter Queen and June month planted Automn Joy late to flower.

5.1.2.3 Days to reach 50% flowering stage

The December and October month planted plants were early to reach the 50 per cent flowering stage as these months planted plants attended the early bud initiation and experienced the short day climatic condition as it favours for early reproductive crop growth. On the other hand, the plants planted in the June months experienced congenial climate (long days and optimum temperatures) and remained sufficiently longer in vegetative phase as took more days for 50 per cent flowering as reported by Deotale *et al.* (1994).

The genotype Accession No. 1 which was early to initiate flower bud, was early to reach 50 per cent flowering. Next cultivars in the order to reach 50 per cent flowering at early were Garden Beauty, Raja and Winter Queen. The cultivar Dundi took more number of days to reach 50 per cent flowering stage. The variation in days taken for 50 per cent flowering was expected among the chrysanthemum cultivars due to the differences in the genetical makeup. The results are in accordance with the findings of Manohar and Pratap (2006) for chrysanthemum.

Among the interactions, October month planted Garden Beauty followed by December month planted Dundi cultivars were early to reach 50 per cent flowering stage. The June month planted Automn Joy was late to reach 50 per cent flowering stage.

5.1.2.4 Days taken to complete flowering

The 100 per cent flowering stage was reached early by December and October month planted plants, while June month planted plants were late to reach 100 per cent

flowering stage as these plants experienced long days and remained sufficiently longer in vegetative phase. December and October months experienced the short day climatic condition as it favours for early reproductive crop growth so these plants attained 100 per cent flowering in short period. Early flowering due to short day conditions has been reported by previous workers in chrysanthemum (Cockshull and Kofranek, 1992 and Barman *et al.,* 1993).

The cultivars Accession No. 2, Raja, Chitradurga Local and Garden Beauty took minimum days to attain 100 per cent flowering stage. The cultivar Dundi took more number of days to reach cent per cent flowering. This variation was expected among the chrysanthemum cultivars due to the differences in the genetical makeup. The results are in close conformity with the findings of Mishra (1999) and Poonam and Ashok (2008).

Among the interactions, December month planted Dundi was early to reach cent per cent flowering stage and June month planted Automn Joy was late to reach 100 per cent flowering stage.

5.1.2.5 Duration of flowering

Long flowering duration was observed in October month plantings and this was possibly due to increased number of branches and leaves which might have enabled them to synthesis increased amounts of photosynthates which in turn resulted in increased flowering duration. On the otherhand, plants of later plantings (December), which experienced lower light intensity and duration, lower night temperatures during their vegetative growth period, remained dwarf and had less number of branches and leaves and as a result had decreased flowering duration. The results are in accordance with the findings of Shin *et al.* (1995) and Meher *et al.* (1999b) for chrysanthemum.

As per as flowering duration was concerned, the cultivars Garden Beauty flowered for a maximum period, followed by Karnool and Accession No. 2. Flowering duration was minimum in Accession No. 1. The variation in flowering duration was expected among the chrysanthemum cultivars due to the differences in the genetical makeup. Similarly variation in flowering duration was also reported previously by Poonam and Ashok (2008).

Among the interactions, October month planted Gadren Beauty variety had maximum duration of flowering followed by States Man as these plants had minimum incidence of *Alternaria* disease problem. June planted Accession No. 1 had minimum flowering duration.

5.1.3 Flower yield parameters

5.1.3.1 Number of flowers per plant

The number of flowers per plant decreased with delay in planting months from June to December. June month plantings proved best to obtain more number of flowers per plant. The plants of June month plantings which experienced congenial climatic conditions had luxurious vegetative growth in terms of plant height, number of branches, number of leaves, leaf area and plant spread which enabled them to produce increased amount of photosynthates and in turn resulted in more number of flowers per plant. On the otherhand, the plants of October and December plantings experienced unfavourable climatic conditions and as a result produced short plants with less number of branches, plant spread, leaves and leaf area which might have resulted in lesser number of flowers per plant. Similarly, Dahiya *et al*. (2007) and Marek and Bres (2011) obtained higher number of flowers per plant in early months of plantings.

The number of flowers per plant was maximum in Garden Beauty, Winter Queen, Automn Joy, Accession No. 2, Karnool and Dundi. Similar variations in yield with respect to number of flowers per plant had been reported by Tewari and Umashankar, (1990), Kanamadi and Patil (1993), Barigidad and Patil (1997) and Mukeshkumar and Chattopadhyay (2002).

Among the interactions, June month planted Garden Beauty, Automn Joy, Winter Queen, Dundi and Karnool produced maximum number of flowers per plant. Whereas, December month planted Winter Queen recorded minimum number of flowers per plant.

5.1.3.2 Flower yield per plant

The plants planted in June months produced more flower yield per plant as they recorded more numbers of flowers per plant. As the planting months advanced

the flower yield per plant was reduced. The plants of June month plantings were exposed to fevourable climatic conditions which had luxurious vegetative growth, which enabled them to produce increased amount of photosynthates and in turn resulted in more flower yield per plant. On the otherhand, the plants of October and December plantings experienced unfavourable climatic conditions and as a result produced short plants with less number of branches, plant spread, leaves and leaf area which might have resulted in lower flower yield per plant. Similarly, Subhendu *et al.* (2011) reported that the higher flower yield per plant was obtained in June month planting.

The flower yield per plant was maximum in Garden Beauty, Karnool, Dundi and Accession No. 2. These cultivars had more number of flowers per plant as resulted in increased flower yield per plant. The flower yield per plant was minimum in Accession No. 1. This was because of the fact that, it had lesser number of branches, plant spread, leaf area *etc.,* which resulted in less dry matter accumulation and small sized flowers even though the cultivars recorded fairly more number of flowers. Variation in flower yield per plant among the cultivars was also observed previously by Rajashekaran *et al.* (1985), Tewari and Umashankar (1990), Kanamadi and Patil (1993), Barigidad and Patil (1997) and Mukeshkumar and Chattopadhyay (2002), Kulkarni and Reddy (2004).

Among the interactions, June planted Garden Beauty, Accession No. 2, Winter Queen, Automn Joy, Karnool and Dundi produced higher yields. The flower yield per plant was minimum in December planted Winter Queen as it had the minimum number of flowers per plant.

5.1.3.3 Flower yield per hectare

The flower yield per hectare was higher in June month planted plants and as the planting advanced, the yield was gradually decreased. June month planted plants exposed more to long days which was favourable for chrysanthemum cultivation as had more vegetative growth in terms of plant height, number of branches, number of leaves, leaf area and plant spread which enabled them to produce increased amount of photosynthates and in turn resulted in more number of flowers per plant ultimately higher yields per hectare. December and October months planted plants had short day condition which favours reproductive growth of the crop as a result had short plant

height with less number of branches, less number of flowers, less flower weight inturn lower flower yield per hectare. Similarly, Sudhendu and Pal (2011) reported higher flower yield per hectare in June month planting.

The cultivars Garden Beauty, Dundi and Karnool high yielding (t/ha). As these cultivars had more number of flowers per plant with larger size, more individual flower weight inturn more yield per plant as well as per plot. This was because of the fact that, it had more number of branches, plant spread, leaf area etc., which resulted in larger sized flowers. The flower yield was minimum in Accession No. 1 genotype. Variation in flower yield per hectare among the cultivars was also observed previously by Laskar and Yadav (1991), Mukeshkumar and Chattopadhyay (2002), Kulkarni and Reddy (2004) and Poonam and Ashok (2008).

Among the interactions, June planted Garden Beauty recorded the maximum flower yield per hectare followed by Accession No. 2, Dundi and Karnool. The lowest flower yield per hectare was recorded in December planted Winter Queen.

5.1.4 Flower quality parameters

5.1.4.1 Flower diameter

The plants of June and August month plantings produced better quality of flowers in terms of flower diameter, whereas the plants of December and October month planting produced small flowers. The plants of June and August were taller with increased number of primary and secondary branches and plant spread which in turn resulted in increased number of leaves and leaf area. This might have favoured the production of increased flower diameter. On the otherhand, the plants of December planting produced less number of branches which in turn produced less number of leaves. This might have resulted in reduction in production of photosynthates and resulted in decreased diameter of the flowers. The results are in line with the findings of Raman *et al.* **(**1969) and Subhendu and Pal (2011).

The flower diameter was maximum in the cultivars Garden Beauty, Karnool, Winter Queen, Accession No. 2, Dundi and Chitradurga Local and it was minimum in genotype Accession No. 1. Variation in flower diameter was due to varietal variation in their genetical make up. Similar variations have been reported previously by

Kanamadi and Patil (1993), Mishra (1999), Kulkarni and Reddy (2004) and Madhumita *et al.* (2006).

Among the interactions, June month planted Garden Beauty, Dundi, Accession No. 2 and Karnool recorded the maximum flower diameter. The flower diameter was least in August month planted States Man variety.

5.1.4.2 Individual flower weight

The heavier flowers were obtained from the plants planted in June and August months of plantings, whereas the lowest individual weight of flowers was obtained from December and October month planted plants. As the June month planted plants were taller with increased number of primary and secondary branches and plant spread which in turn resulted in increased number of leaves and leaf area. This might have favoured the production of heavier flowers. On the otherhand, the plants of December planting produced less number of branches which in turn produced less number of leaves. This might have resulted in reduction in production of photosynthates and resulted in lower weight of the flowers. The results are in line with the findings of Gill *et al.* (1995) Kulkarni and Reddy (2008).

In general, the average weight of fresh flower was maximum in the cultivars Karnool, Accession No. 2, Dundi and Chitradurga Local, whereas it was minimum in Accession No. 1. This variation among the cultivars was mainly because of increased flower size with fairly increased number of florets. Further, being a genetical factor, variations were expected among the cultivars of chrysanthemum. Variation in individual flower weight among the cultivars was also observed previously by Aliman and Streitz (1995) and Poonam and Ashok (2008)

Among the interactions, August month planted Karnool, Chitradurga Local, Garden Beauty and Dundi recorded the maximum flower. The average flower weight was minimum in October month planted Automn Joy variety.

5.1.4.3 Shelf life

The shelf life of the loose chrysanthemum flowers was more in the flowers obtained from June month planted plants. Whereas the shelf life of flowers was less in the flowers obtained from the plants planted in December and October month. Thus

the June month planting was found to be best, as these month plants had good quality flowers with respect to individual flower weight and diameter, as a result shelf life of flowers was also more. The similar results on extension of shelf life were observed by Gill *et al.,* (1995).

In general, the shelf life of loose flowers was higher in cultivars Accession No. 2, Dundi, Karnool, Accession No. 1 and Chitradurga Local as compared to other cultivars while, it was less in States Man. The Variation in shelf life among the cultivars was due to varietal variation in their genetical make up. The similar results were also reported previously in chrysanthemum by Mishra (1999).

Among the interactions, June month planted Accession No. 1, Accession No. 2, Dundi and Karnool cultivars recorded the maximum shelf life of loose flowers. Whereas, December October planted cultivars recorded the minimum shelf life.

5.1.5 *Alternaria* disease incidence

With regard to *Alternaria* disease, the per cent disease incidence on leaves was minimum in August and October. Whereas, the per cent disease incidence was maximum in June month planted plants, followed by December month plantings. The variation in per cent disease incidence was due to the fluctuation of climatic conditions. *Alternaria* leaf spot is a soil borne disease, the incidence of disease was more in high temperature, relative humidity and rain fall, which helps for the outbreak of fungus spores, as June month plants were experienced the favourable climatic conditions for fungus growth, as a result disease incidence was more in June plantings. These results are in close conformity with the findings of Ding and Dungdin (2001) for chrysanthemum.

The *Alternaria* disease per cent disease incidence on leaves was minimum in the cultivars Accession No. 1, Automn Joy, Raja and Winter Queen. Were it was maximum in Dundi and Karnool. The degree of variations occurred with respect to response of cultivars to *Alternaria* leaf spot disease was expected, since any resistance or susceptibility of the cultivars to the disease is controlled by the genetic constitution of cultivars. Similarly, Pavgi and Upadhyay (1966) and Thomas *et al.* (1980) reported the same results for chrysanthemum.

5.1.6 Economics

The economic analysis revealed that the maximum gross returns and net returns were obtained from June month planted plants followed by August month plantings compared to other planting months. These months plants had maximum B:C ratio also. This is because of the production of higher yields with good quality flowers. The economic analysis was lowest in October and December month plantings as plants produced lesser yields. These results are in close conformity with the findings of Ferratto *et al.* (1994).

The maximum gross returns were obtained from the cultivars Accession No. 2, Raja, Dundi and Karnool with maximum net returns as compared to other cultivars. These cultivars also had a maximum B:C ratio. Whereas, the lowest economic analysis revealed for the Accession No. 1, States Man and Chitradurga Local as these cultivars recorded the lesser yields. The variation among the cultivars due to the variation of yields in particular cultivars. These results are in close conformity with the findings of Hemlanaik *et al.* (2006).

Among the interactions, June month planted cultivars revealed the maximum economics as these reported higher yields followed by August month plantings. Whereas, the gross returns were minimum in the October and December plantings as these plants not attended the full flowering stage as yielded lower yields.

5.1.7 Consumer acceptance for loose flower

The consumers acceptance was recorded in terms of scoring. The maximum scoring was obtained for Dundi and Karnool cultivars followed by Accession No. 2 and Accession No. 1 with respect to shape of the flowers, colour of flowers, overall acceptance and shelf life. Whereas, the lowest scoring was obtained for States Man, Garden Beauty, Winter Queen and Automn Joy cultivars.

Future line of work

1. Cultivar Dundi seems to be photo insensitive could be tested in other months of planting.
2. Evaluation of other cultivars could be done across the seasons or months.
3. The planting interval may be done at monthly intervals for different cultivars.

6. SUMMARY AND CONCLUSIONS

An investigation on studies on chrysanthemum cultivars for photoperiodic response under Northern dry zone of Karnataka was undertaken in the Department of Floriculture and Landscape Architecture, Kittur Rani Channama College of Horticulture, Arabhavi, Belgaum district. The performance of ten different cultivars *viz*., Dundi, Accession No. 2, Chitradurga Local, Autumn Joy, Garden Beauty, Accession No. 1, Winter Queen, Karnool, Raja, Statesman, was tested in four different planting months at two months intervals *viz.,* June, August, October and December. The results obtained are summarized hereunder.

The entries were evaluated for growth and yield characters, in all the four planting months of different chrysanthemum cultivars *viz*., plant height, plant spread, leaf area, number of primary branches, number of secondary branches at grand growth stage of the crop, days taken for flower bud initiation, for first flower opening, for 50 per cent flowering, for 100 per cent flowering, duration of flowering, number of flowers per plant, yield per plant (g), yield per plot (g), yield per hectare(t), average fresh flower weight, flower diameter and shelf life. The economics was also worked out and disease incidence also recorded.

Planting of chrysanthemum cultivars was done at two months intervals starting from June, 2012 to April, 2013. The experiment was laidout by following two factorial randomized complete block design with two replications.

Growth parameters

In general, the plant height gradually decreased as the date of planting advances. The plants of June followed by August month plantings had optimum vegetative growth. The plants planted in these months were tall, spreading, sturdy and had more number of branches, leaves and more leaf area per plant. Among the different cultivars, Automn Joy, Winter Queen, Accession No. 2, Dundi and Karnool were vigorous in growth. The varieties Automn Joy and Winter Queen recorded higher plant height (41.20 cm and 39.30 cm, respectively). Whereas, genotype Accession No. 1 recorded minimum plant height (16.07 cm).

The plant spread was maximum in Automn Joy, Winter Queen, Accession No. 2, Raja, Dundi and Karnool. It was minimum in States Man. Cultivars Garden Beauty, Automn Joy, Accession No. 1, Winter Queen, Accession No. 2 and Dundi produced higher number of branches when compared to other cultivars. The leaf area was higher in the cultivars Karnool (3201.67 cm^2 / plant), Accession No. 2 (2826.48 cm^2 / plant), Dundi (1993.02 cm^2 / plant) and Winter Queen (1863.66 cm^2 / plant) as compared to other cultivars, while it was minimum (406.30 cm^2 / plant) in States Man variety.

Flowering parameters

The plants of June month planting were late to flower (108.70 DAP), while the plants of December followed by October month plantings flowered early (24.50 and 48.75 days, respectively). Genotype Accession No. 1 was early to flower (15.50 DAP) followed by Garden Beauty (52.63 DAP), Raja (60.63 DAP) and Karnool (62.00 DAP). Whereas, cultivar Chitradurga Local was late in flowering followed by Winter Queen, Dundi and Automn Joy. The flowering duration was maximum in October month (166.40 days) plantings, followed by June (57.70 days), August (45.35 days) and December (30.70 days) months. Cultivars Garden Beauty, Karnool, Accession No. 2 and Dundi flowered for more number of days (78.25, 65.87, 59.37 and 50.25 days, respectively).

Yield and quality parameters

The flower yield gradually decreased right from June to December month planting. The flower yield was maximum in plants planted in June (19.3 t/ha) month followed by August (9.49 t/ha) month. Among the cultivars, flower yield was higher in Garden Beauty (15.73 t/ha), Dundi (13.46 t/ha) and Karnool (13.19 t/ha) as compared to other cultivars and was minimum (0.68 t/ha) in Accession No. 1 genotype. The cultivars Dundi and Karnool had more consumer acceptance with respect to shape, colour and over all acceptance. Flower quality in terms of flower diameter was the best in June month planting (5.41 cm) followed by August month planting (4.27 cm). The fresh weight of flowers was also maximum in June month planting (1.73 g) followed by August month planting (1.48 g). The plants of

December month planting produced small sized flowers with light weight (2.71 cm and 0.71 g, respectively).

The cultivar Garden Beauty recorded the widest flower diameter (5.99 cm), nearly followed by Karnool (5.55 cm) which was on par with Winter Queen (5.50 cm). The flower diameter was least (1.18 cm) in Accession No. 1. The shelf life of the loose flowers was more in the flowers obtained from June (3.53 days) month planted plants followed by August (1.81 days) planting, and it was decreased as planting month advanced. Among the cultivars, shelf life of loose flowers was more in Accession No. 2 (2.40 days), Dundi (2.38 days), Karnool (2.20 days) and Chitradurga Local (2.10 days) and it was least (1.09 days) in States Man.

Disease incidence

The *Alternaria* per cent disease incidence was more in June month plantings followed by December and it was lowest in October month plantings. Cultivar Accession No. 1 is resistant to *Alternaria* disease as compared to others. Whereas, Dundi was highly susceptible.

Economics

The maximum gross returns, net returns and B:C ratio were obtained from June month planted plants. Whereas, the lower returns were obtained from December and October month plantings, because these month planted plants produced lower yields as they did not flower completely. The gross returns, net returns and B:C ratio were maximum in cultivars Accession No. 2, Raja, Dundi and Karnool, because these cultivars produced higher yields. Even though flower yield was higher in the variety Garden Beauty, it was not accepted as a loose flower variety by the consumers.

June month planting found best to produce good quality flowers with higher yields and economics, however the per cent disease incidence was more. Dundi produced 100 per cent flowering even in December month planting also, but other cultivars were specific in flowering to a particular month. Automn Joy, Raja and States Man cultivars did not produced flowers in December month. Accession No. 1 produced flowers only in June month planting. Dundi found to be better for planting from June to December months.

REFERENCES

Aamir, N., Shahena, G., Muhammad, A. A. and Farrukh, N., 2009, Effect of various sucker sizes and planting times on growth and flower yield of chrysanthemum. Pak. J. Agri. Sci., **46** (1): 7-11.

Adams, S. R., Valdes, V. M. and Fuller, D., 2009, The effects of day and night temperature on *Chrysanthemum morifolium*: investigating the safe limits for temperature integration. J. Hortl. Sci. and Biotechnol., **84** (6): 604-608.

*Aliman, A. and Streitz, D., 1995, Multiflora chrysanthemums for cut flower outdoor production. Gartenbau Magdzin, **3**: 12-14.

Ambad, S. N., Bakar, M. C., Mulla, A., Thakur, N. J. and Takate, R. L., 2001, A new low cost polyhouse technique for gerbera cultivation. Indian Hort., **46** (1): 16-17.

Anderson, N. E., 1990, Effects of level and duration of supplementary light on development of chrysanthemum. Scientia Hort., **44** (1-2): 163-169.

Anke, V. D. P., Ranathunga J. K. N., Kularathne, Susana, M. P., Carvalho and Heuvelink, E., 2007, Variation between cut chrysanthemum cultivars in response to sub optimal temperature. J. Amer. Soc. Hortl. Sci., **132** (1): 52–59.

Anonymous, 1985, Progress report of All India Co-Ordinated Floriculture Improvement Project, Pune Centre.

Anonymous, 2002, Package of Practices for Horticultural Crops, University of Agricultural Sciences, Dharwad, pp. 310-311.

*Antably, H. M., Habib, S. A. and Robie, K. A. E., 1991, The relationship between the rooting of cuttings, photoperiodism and plant growth harmones in chrysanthemum. Annala of Agric. Sci. Cairo, **36** (1): 69-83.

Anuradha, M., Arora, J. S. and Sidhu, G. S., 2000, Evaluation of chrysanthemum varieties for pot culture. J. Ornamental Hort., **3** (2): 79-82.

Barigidad, H. and Patil, A. A., 1997, Relative performance of chrysanthemum cultivars under transitional tract of Karnataka. Karnataka J. Agric. Sci., **10** (1): 98-101.

Barigidad, H. P., 1991, Studies on relative performance variability, correlation and path coefficient analysis in chrysanthemum (*Chrysanthemum morifolium* Ramat). M. Sc. (Agri.) Thesis, Uni. Agric. Sci., Dharwad (India).

Barman, D., Ghosh, S. and Pal, P., 1993, Effect of planting date and pinching height on cut flowering of chrysanthemum (*Chrysanthemum morifolium* Rmat.) cv. Chandrama. Hort. J., **6** (2): 121-124.

Bhattacharjee, S. K., 2003, Advances in commercial floriculture. Avishkar publishers, distributors, Jaipur, Rajasthan, India, pp: **1**: 229.

Chezhian, N., Ponnauswami, Y., Thamburaj, S., Khader, J. B. M., Nanjan, K. and Gunasekaran, N., 1985a, Evaluation of chrysanthemum cultivars. South Indian Hort., **33**: 279-182.

Chezhian, N., Thamburaj, S., Khader, J. B. M., Ponnauswami, V., Sambandamurthi, S. and Rangaswamy, P., 1985b, New varieties of horticultural crops released by Tamil Nadu Agricultural University, Coimbatore during 1985, CO-I chrysanthemum. South Indian Hort., **33**: 72-73.

Cockshull, K. E. and Kofranek, A. M., 1992, Response of garden chrysanthemum to day length. Hort. Sci., **27**: 113-115.

Cockshull, K. E., 1978, Effects of irradiance and temperature on flowering of *Chrysanthemum morifolium* Ramat. in continuous light**.** Annals of Botanyaob.oxfordjournals.org. **44** (4): 451-460.

Cockshull, K. E., Laugton, F. A. and Cave, C. R. J., 1995, Differential effects of different DIF treatments on chrysanthemum and poinsettia. Acta Hort., **378**: 8-11.

Cormeno, P., 1989, Cultivation of chrysanthemum in winter in unheated greenhouse on the coast of Gulf of Cadiz and areas of maritime influence. Acta Hort., **246**: 121-129.

Dahiya, D. S., Sehravat, S. K., Godara, A. K. and Yadav, B. S., 2007, Effect of staggered planting on growth, flowering and yield of chrysanthemum cv. Vasantika. Haryana J. Hort. Sci., **36** (1&2): 78-79.

Damke, M. M., Jadho, B. J., Hedau, C. V. and Patil, V. S., 1998, Performance of chrysanthemum varieties for flower production under Akola conditions. MPKV Res. J., **22** (1): 148-150.

Deotale, A. B., Belorkar, P. V., Patil, S. R., Dahale, M. H. and Drnage, S. D., 1995, Effect of date of planting and foliar spray of GA_3 on quality of chrysanthemum. J. Soils and Crops, **5** (1): 70-72.

Deotale, A. B., Belorkar, P. V., Patil, S. R., Zode, V. N. and Keche, M. B., 1994, Effect of date of planting and foliar spray of GA_3 on flowering and yield of chrysanthemum. J. Soils and Crops, **4** (2): 148-151.

Deshapande, G. D., Anserwadeker, R. W. and Warke, D. C., 1979, A note on the varietal reaction of hybrid Tea roses to powdery mildew. Res. Bull. No. 3, Uni. Agric. Marathawada**.**

Ding, S. and Dungdin, X. I., 2001, Infection pattern of *Puccinia horiana* and its control by chemicals. Plant Protect., **27** (2): 293-299.

Dutta, J. P., Seemanthini, S. and Ramdas, J., 1995, Regulation of flowering in chrysanthemum cv. CO-1 through supplementary illumination. J. Agri. Sci. Soc. North East India, **8**:29-32.

Duttta, S. K. and Gupta, V. N., 2012, Year round cultivation of garden chrysanthemum (*Chrysanthemum morifolium* Ramat.) through photoperiodic response. Sci. and Cult., **78** (1-2): 71-77.

Faust, J. E. and Heins, R. D., 1992, High night temperature do not cause poor lateral branching of chrysanthemum. Hort. Sci., **15** (39): 71-74.

Ferratto, J., Armeriso, L. and Bendetto, A. D., 1994, Profitability of growing carnations under greenhouse conditions. Horticultura Argentina, **13** (33): 4-49.

Ferratto, S. and Bendetto, A. D., 1994, Technology and production costs of roses (*Rosa hybrida*) for cuttings. Horticultura Argentina, **13** (33): 38-43.

Gaikwad, A .M. and Dumbrepatil, S. S., 2001, Evaluation of chrysanthemum varieties under open and polyhouse conditions. J. Ornamental Hort., **4** (2): 95-97.

Gill, A. P. S., Mandhir, S. and Padaki, P. M., 1995, Effect of date of planting on the quality of cut flowers of *Chrysanthemum morofolium* cv. Chandrama. J. Res., **22**: 253-257.

Gislerod, H. R. and Mortensen, L. M., 1991, Air humidity and nutrient concentration affect nutrient uptake and growth of some greenhouse plants. Acta Hort., **294**: 141-146.

Guo, Q., Wang, Y., Zang, X. and Jin, M., 2010, Effects of light intensity on physiological and biochemical characteristics of *Chrysanthemum morifolium* at vegetative stage. Institute of Chinese Medicinal Materials, Nanjing Agric. Uni. Nanjing, China, **35** (5): 1-4.

Hand, D.W., Langton, F. A., Hannah, M. A. and Cockshull, K. E ., 1996, Effect of humidity on growth and flowering of cut flowers chrysanthemum (*Dendranthema grandiflora* Tzvelev.). J. Hort. Sci., **71** (2): 227-234.

*Hanke, H., 1996, Short day decreases the risk of late flowering of chrysanthemums. Taspo Gartenbaumagatin, **5** (8): 8.

Hassan, M. R. A. and Newton, P., 1975, Comm. Gr. No. 4131, pp.484.

*Heidemans, C. and Stolk, T. H., 1984, Chrysanthemum cultivars for spring culture. Vakblad Voorda Bleomisterij, **39** (51/52): 57-60.

Hemlanaik, B., Neelam C., Patil, A. A., Patil, V. S. and Patil, B. C., 2006, Comparative performance of gerbera (*Gerbera jamesonii* Bolus ex Hooker F.) cultivars under naturally ventilated polyhouse. J. Ornamental Hort., **9** (3): 204-207.

Hoon, W. M. and Vander, 1979, Freesia growers will have to become more efficient all the time. Vakblad Voor de Bloemisterij, **34** (32): 46-47.

Huang, H. C., Henry, H. M., Lynn, M. C., Debbie L. M. and Marion, J. K., 1993, Screening hardy chrysanthemums for resistance to *Fusarium oxysporum f. sp. Chrysanthemi* race 2. Plant Pathol. Bull., **2**:103-105.

Janakiram, T., Mahantesh, I. M. and Prabhakar, B. S., 2004, Standardization of photoperiod for production of chrysanthemum cv. Ravikiran under low cost polyhouse. J. Ornamental Hort., **7** (3-4): 202-205.

Jensen, H. E. K., 1993, Influence of duration and placement of a night temperature on morphogenesis of *Dendranthema grandiflora*. Sci. Hort., **54**: 327-335.

Kahar, S. A., *2008,* Effects of photoperiod on growth and flowering of *Chrysanthemum morifolium* Ramat cv. Reagan Sunny. J. Trop. Agric. and Food Sci., **36** (2): 1-8.

Kanamadi, V. C. and Patil, A. A., 1993, Performance of chrysanthemum varieties in the transitional tract of Karnataka. South Indian Hort., **41** (1): 58-60.

Kaori, N., Takayoshi, Y., Hiroko, Y., Katsuhiko, I. and Atsushi, Y., 2007, Influence of temperature during reproductive phase on flowering and floral morphology in summer-to-autumn flowering- type 'Iwa-no-hakusen' and autumn flowering type 'Jinba' chrysanthemum (*chrysanthemum morifolium* Ramat.). **6** (3): 479-485.

Katrine, H. K. and Carl, O. O., 2011, Growth of chrysanthemum in response to supplemental light provided by irregular light breaks during the night. J. Amer. Soc. Hort. Sci., **136** (1): 3-9.

Kenneth, E. C. and Anton, M. K., 1992, Responses of garden chrysanthemums to day length. Hort. Sci., **27** (2):113-115.

Khan, M. M., 1995, Relevance of green house – A report from training on construction and management of low cost greenhouse, 8-10th May, 1995, pp. 1-8.

Kishan, S., Prasad, K. V. and Raju, D. V. S., 2008, Evaluation of chrysanthemum (*Dendranthema grandiflora* Tzvelev.) germplasm in winter season under Delhi conditions. J. Ornamental Hort., **11** (1): 58-61.

*Kiyatkin, A. K., 1975, The effect of planting dates on chrysanthemum growth and development in Uzebekistun 1974. Referatiunyizhurnal, **23**: 755-915.

Kotasthane, S. R. and Agarwal, S. C., 1976, Control of foliar diseases of mung bean (*Phaseolus aureous*) by fungicides. Pesticides, **19** (80): 35-36.

Kulkarni, B. S. and Reddy, B. S., 2004, Vegetative growth, flower yield and quality of different chrysanthemum cultivars. J. Ornamental Hort., **7** (3-4): 32-36.

Kulkarni, B. S. and Reddy, B. S., 2008, Effect of different date of planting on growth and flowering of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. Saraval. J. Ornamental Hort., **11** (3): 177-180.

Kulkarni, B. S. and Reddy, B. S., 2010, Effect of date of planting on yield and quality of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. Saraval. Karnataka J. Agric. Sci., **23** (2): 402-403.

Laskar, M. A. and Yadav, L. P., 1991, Varietal performance with chrysanthemum in the plains of West Bengal. Environ. Ecol., **9**: 979-982.

Lawrence, W. J. C., 1950, Science and the glass house. Oliver and Boyd, Edinburgh. pp. 54-58.

Lee, J. H., Heuvelink, E. and Challa, H., 2002, Effects of planting date and plant density on crop growth of cut chrysanthemum. J. Hort. Sci. and Biotechnol., **77**: 238-247.

Madhumita, C. T., Sangita, M. and Bhaskarjyoti, S., 2006, Evaluation of standard chrysanthemum (*Dendranthema grandiflora* Tzvelev.) cultivars under polyhouse cum rain shelter and open field condition. J. Ornamental Hort., **9** (2): 110-113.

Manohar, R. A. and Pratap, M., 2006, Evaluation of varieties and variability studies in chrysanthemum (*Dendranthema grandiflora* Tzvelev.). J. Ornamental Hort., **9** (2): 221-223.

Marek, J. and Bres, W., 2011, Seasonal changes of photoperiodic response and inflorescence quality in pot cultivars of *Chrysanthemum* × *grandiflorum* grown in greenhouse. Acta Agrobotanica, **64** (4): 85–90.

Meher, S. P., Joitode, D. J., Turkhede, A. B., Darange, S. O., Dhawad, C. S. and Thorat, K. A. W., 1999a, Effect of planting time and growth regulators on growth of chrysanthemum. Crop Res. Hissar, **18** (3): 486-489.

Meher, S. P., Joitode, D. J., Turkhede, A. B., Darange, S. O., Ghatol, P. U. and Dhawad, C. S., 1999b, Effect of planting time and growth regulator treatments on flowering and yield of chrysanthemum. Crop Res. Hissar, **18** (3): 345-348.

Mishra, H. P., 1999, Evaluation of small flowered varieties of chrysanthemum for calcarious belt of North Bihar. Indian J. Hort., **56** (2): 184-188.

Mortensen, L. M., 2000, Effects of air humidity on growth, flowering, keeping quality and water relations of four short-day greenhouse species. Scientia Hort., **86** (4): 299-310.

Mukeshkumar and Chattopadhyay, T. K., 2002, Varietal performance of chrysanthemum under Kalyani condition. Environ. Ecol., **20** (1): 16-19.

Negi, S. S., Rao, T. M. and Janakiram, T., 1988, Varietal evaluation in chrysanthemum In: floriculture technology, trade and trends. Ed. Prakash, J. and Bhandary, K. R., Oxford and JBH Publishing Co. Pvt. Ltd, New Delhi, pp. 340-344.

Nishio, J., Yamaguchi, T. and Yonemura, K., 1989, Effects of day length on flowering of chrysanthemum in shade culture. Tech. Bull. No. 21, Aichi-Ken Agric. Res. Centre.

Panse, V. S. and Sukhatme, P. V., 1967, Statistical methods for agricultural workers, ICAR, New Delhi, pp. 152-155.

Parul, P., Rao, V. K. and Sharma, S. K., 2011, Evaluation of different chrysanthemum (*Chrysanthemum morifolium*) genotypes under mid hill conditions of Garhwal Himalaya. Indian J. Agril. Sci., **81** (9): 123-127.

*Pavgi, M. S. and Upadhyay, H. P., 1966, Parasitic fungi from North India VI. Mycopath. Mycol. Appli., **30**: 257-260.

Pearson, S., Hadley, P. L. and Wheldon, A. E., 1993, A reanalysis of the effects of temperature and irradiance on time of flowering in chrysanthemum. J. Hort. Sci., **68**: 89-97.

Poonam and Ashok, K., 2007, Garden Beauty- A promising chrysanthemum (*Dendranthema grandiflora* Tzvelev.) cultivar for garden decoration. J. Ornamental Hort., **10** (3): 165-168.

Poonam and Ashok, K., 2008, Autumn Joy – A new variety of chrysanthemum for garden decoration. Indian J. Plant Genet. Resources, **21** (1): 56-61.

Prasad, S. and Kumar, U., 2005, Commercial floriculture. Updesh printers for Agrobios, Jodhpur, Rajasthan, India, pp: 131-133.

*Przymaska, J., 1997, Estimation of yields of spray chrysanthemum cultivars (*Dendranthema grandiflora*) in an unbeated plastic tunnel. Zeszyty Problemowe Postpow Nauk Rolniczych, **449**: 161-172.

Rajashekaran, L. R., Shanmugavelu, K. G. and Nagaraja, N. S., 1985, New varieties of horticultural crops released by Tamil Nadu Agricultural University, Coimbtore, during 1985, MDU-1 chrysanthemum. South Indian Hort., **33**: 70-71.

Raman, K. R., Ahmadshah, H. and Shanmugam, A., 1969, A note on time of planting in chrysanthemum. South Indian Hort., **17** (44): 88-90.

Rameshkumar, S. C., 1989, Economics of production and investment in jasmine flowers in Madurai district in Tamil Nadu. M.Sc. (Agri.) Thesis, Uni. Agric. Sci. Bangalore.

Rijssel, E. V. and Oprel, L., 1979, Causes of differences in productivity on rose nurseries. Vakblad Voor de Bloemisterij, **34** (39): 26-27.

Sen, S. and Pathania, N. S., 1997, Field evaluation of chrysanthemum germplasm against leaf spot fungi. Plant Dis. Res., **12** (7): 149-150.

Shanmugan, A. and Muthuswamy, S., 1973, Influence of modified photoperiod on the carbohydrate and total nitrogen content of chrysanthemum varieties. South Indian Hort., **21** (4): 123-125.

Shin, H., Kang, S. H., Jung, J. W., Yu, C. J. and Kwun, K. C., 1994, Changes of cut flower qualities in summer forcing to spray – mum (*Chrysanthemum morifolium*). RDA J. Agric. Sci., Hort., **36**: 417-421.

Shin, H., Kim, J. Y. and Jin, S., 1995, Control of growth and flowering by planting time and short day treatments in Korean wild chrysanthemums. RDA J. Agric. Sci., **37**: 389-395.

Sipho, M. H. and Paul, G. J., 2010, The effects of light on growth and development of chrysanthemum. Scientia Hort., **5** (7): 99-107.

Starangh, 1983, Extension of the range of gerbera after by self production. Zierptlanzenbau, **25** (18): 762-763.

Subramanyam, K. V., 1986, Economics of production and marketing of chrysanthemum flowers in Karnataka. Indian J. Hort., **43** (3&4): 281-286.

Subramanyam, K. V., 1989, Economics of production and marketing of rose in Karnataka. Indian J. Hort., **46** (3): 407-412.

Sudhendu, S. G. and Pal, P., 2011, Comparative performance of spray chrysanthemum cultivars under polyhouse and open field cultivation at different dates of planting. J. Hortl. Sci., **6** (2): 123-129.

Takahiro, T., Hiroshi, M. and Yasuo, K., 2009, Effects of temperatures on delayed flowering and production of proliferate inflorescence and methods of reducing Proliferate capitula in summer-toautumn-flowering *Chrusanthemum morifolium* Ramat. 'Seiun'. Hort. Res. Japan, **8** (4): 495-501.

Takahiro, T., Kazunao, S., Toshihiro, K., Takatoshi, M., Chisako, N., Asuka, Y. and Takuro, S., 2010, Temperature and day length affect time to flowering and abnormal capitulum formation in summer-to-autumn flowering cultivars of *Chrysanthemum morifolium* (Ramat.). J. Japanese Soc. Hort. Sci., **79** (4): 372-376.

Tewari, G. N. and Umashankar, S., 1990, Evaluation of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cultivars for cut flowers with special reference to export In: Floriculture Technology, Trade and Trends. Ed. Prakash, J. and Bhandary, K. R., Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, pp. 136.

Thomas, G. B., Arthur H. M. and Thomas M. K., 1980, Testing chrysanthemums for disease resistance. California Agric. Uni. Florida Plant Corporation, Fremont, 14-15.

Totth, G., 1984, Economics of greenhouse carnation production. Vakblad Voor de Bloemisterij, **48** (10): 303-310.

Van, A. D. P. and Heuvelink, E., 2006, The influence of temperature on growth and development of chrysanthemum cultivars: a review. J. Hort. Sci. and Biotechnol., **81** (2): 174–182.

Varadarajan, S. and Raveendran, T., 1976, Economics of flower marketing in Coimbatore city, Tamil Nadu Agric. Uni. Coimbatore, pp: 135.

Verma, S. K., Angadi, S. G., Patil, V. S., Mokashi, A. N., Mathad, J. C. and Mummigatti, U. V., 2011, Economics of chrysanthemum (*Chrysanthemum morifoliuim* Ramat.*)* cv. Raja as influenced by integrated nutrient management. Karnataka J. Agric. Sci., **24** (5): 681-683.

Wilfert, G. J., 1985, Evaluation of chrysanthemum cultivars growth as centre-disbudded plants in containers. Proc. Florida State Hort. Soc., **16**: 282-289.

*Winogrond, W., 1999, "Cut flowers on the move," The History of U. S. Floriculture, Greenhouse Grower, Meister Publishing Fall. pp: 5-7.

Yohei, H., Katsuhiko, S., Atsushi, O., Hiroshi, S. and Tamotsu, H., 2012, Day light quality affects the night-break response in the short-day plant chrysanthemum, suggesting differential phytochrome-mediated regulation of flowering. J. Plant Physiol., **169** (18): 1789-1796.

Yulian, X., Fujime, Y. and Okuda, N., 1995, Effects of day-length on growth, budding and branching of garland chrysanthemum. Tech. Bull. No. 47, Uni. Agric. Kagava.

Zawanberg, S., 1990, Trends in surveys comparing business results, chrysanthemum culture in a strong position through effective use of labour. Vakblad voor de Bloemisterij, **45** (42): 58-59.

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* Originals not found.

APPENDIX -I

Meteorological data as recorded during the period of June, 2012 to April, 2013 at Agricultural Research Station, Arabhavi.

Sl. No	Months	2012- 2013						
		Temperature (^{o}C)		Relative humidity (%)		Rainfall (mm)	Day length (hours)	Light Intensity (Lux)
		Min.	Max.	Max.	Min.			
1	June, 2012	22.80	32.42	79.00	59.00	14.00	12.57	1845.53
2	July, 2012	21.95	29.92	88.55	67.74	79.30	12.51	1774.40
3	August, 2012	21.77	29.73	88.03	69.19	27.10	12.31	1673.16
4	September, 2012	28.45	30.08	88.23	67.63	23.00	12.10	1540.00
5	October, 2012	18.19	30.39	86.35	56.52	100.00	11.39	1440.63
6	November, 2012	16.77	29.71	88.57	56.13	40.50	11.15	1451.54
7	December, 2012	11.63	30.48	88.59	39.26	Nil	11.05	1457.86
8	January, 2013	12.92	31.21	88.00	32.00	Nil	11.10	1548.46
9	February, 2013	14.05	32.53	92.07	32.93	3.60	11.30	1568.85
10	March, 2013	15.48	35.56	81.00	23.00	Nil	12.08	1498.65
11	April, 2013	19.28	38.24	72.67	30.83	6.10	12.21	1538.64

APPENDIX-II

Cost of cultivation of chrysanthemum for one hectare area.

Sl. No.	Particulars	Rate (₹.)
1.	Land preparation	
a. b. c.	Ploughing Harrowing Cleaning of land	5000.00
2.	FYM @ ₹. 2000/t	40,000.00
3.	Preparation of beds	2000.00
4.	NPK (Urea=7.00/kg, SSP=7.80/kg, MOP=17.60/kg)	3630.00
5.	Planting material (₹. 1/plant)	1,11,111.00
6.	Irrigation	3500.00
7.	Weeding	4500.00
8.	Intercultural operations	
a. b.	Pinching Fertilizer application	2100.00
9.	Plant protection chemicals	5000.00
10.	Harvesting	7800.00
11.	Packaging	2000.00
12.	Transportation charges	5000.00
	Total cost	1,91,641.00

STUDIES ON CHRYSANTHEMUM CULTIVARS FOR PHOTOPERIODIC RESPONSE UNDER NORTHERN DRY ZONE OF KARNATAKA

SAVITA BASAPPA PARIT **2013** **Dr. BALAJI S. KULKARNI**
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ABSTRACT

Chrysanthemum is one of the most important flower crops cultivated widely in temperate, tropical and subtropical regions of the globe. The improvement of chrysanthemum depends on the identification of cultivars for different agro climatic conditions. Differences in planting months would bring about a variation among the cultivars with respect to growth, yield and flower quality parameters. The present study was aimed for selection of suitable time of planting for a particular cultivar to maximize the flower yield and quality inturn to get more profit.

The performance of ten different cultivars *viz*., Dundi, Accession No. 2, Chitradurga Local, Autumn Joy, Garden Beauty, Accession No. 1, Winter Queen, Karnool, Raja and Statesman, was tested in four different planting months at two months intervals *viz.,* June, August, October and December. Planting was done starting from June, 2012 to April, 2013. The experiment was laidout by following two factorial randomized complete block design with two replications.

The results revealed that the June month planting found best to produce good quality flowers with higher yields and returns. Among the different cultivars, Automn Joy, Winter Queen, Accession No. 2, Dundi and Karnool were vigorous in vegetative growth. Dundi produced 100 per cent flowering even in December month planting also, but other cultivars were specific in flowering to a particular month. Cultivars Automn Joy, Raja and States Man cultivars did not produced flowers in December month planting. Accession No. 1 produced flowers only in June month of planting.

Flower yield was higher in June month planted Garden Beauty, Dundi and Karnool. The gross returns, net returns and B:C ratio were maximum in cultivars Accession No. 2, Raja, Dundi and Karnool. Dundi even planted in December gave comparatively more returns than other cultivars. Cultivar Dundi found better for planting from June to December months.