

EFFECT OF PLANTING DATES AND SPACING ON GROWTH AND FLOWERING OF MARIGOLD

A

Thesis

by

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*Submitted in partial fulfilment of the requirements
for the degree of*

MASTER OF SCIENCE

in

HORTICULTURE

(FLORICULTURE AND LANDSCAPING)



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2011

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The assistance and help received during the course of investigations has been fully acknowledged.

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This is to certify that all the mistakes and errors pointed out by the external examiner have been incorporated in the thesis entitled, **“Effect of planting dates and spacing on the growth and flowering of marigold”** submitted to Dr Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) by **Ms. Pratibha Chauhan (H-2009-24-M)** in partial fulfillment of the requirements for the award of degree **MASTER OF SCIENCE in HORTICULTURE (FLORICULTURE AND LANDSCAPING)**.

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ACKNOWLEDGEMENTS

At this juncture, while writing acknowledgements myriads of thoughts are rushing upto my mind. But before divulging anything out let me first express my solemn reverence to the Supreme Power of the universe "God The Almighty" for bestowing me all these endowment which are required to accomplish, the venture like this.

Words are inadequate to express my limitable veneration, adoration towards my reverend parents, dadaji, dadiji, buaji, chachaji & chachiji whose constant inspiration, blessing, everlasting love and innumerable sacrifices have encouraged me in every step of my life.

I shall remain indebted to D. Y C Gupta, Professor and Head (Department of Floriculture and Landscaping), Chairman of my Advisory Committee for his admirable human guidance, constant encouragement, indispensable suggestions and constructive criticism during the course of investigation and novel dexterity in sculpturing this manuscript.

I am conscious of my loyal and venerable thanks to Dr. S D Dhiman, Dr. R K Gupta, Dr. D. Tripathi and Dr. Anju Thakur, esteemed members of my advisory committee, for their valuable help, suggestions and full cooperation throughout the course of investigation.

I owe my sincere thanks to Dr. B S Ditta, Dr. Puja Sharma, other faculty and office staff members of the department for providing necessary facilities during the work tenure. My thanks are also due to field staff and workers for their cooperation and assistance whenever required.

Emotions of my heart should find new boundaries to contain my love for my loving sisters Prabha and Monika, brothers Bunty, Rupesh and Aditya. I shall always remember the enviable company and wonderful time spent with Neeta, Babita, Geeta, Yourmi, Rishu, Vinod, Manoj, Rajkumar and many more whose personal affection and association has lightened my burden considerably. I express my personal regards to my respected seniors; Prerna di, Priyanka di, Nomita di, Kalkame di and Arvinder sir.

Last but not the least, I am thankful for direct and indirect help received from various quarters but not mentioned here because of slip of mind and pen.

Needless to say error and omissions are mine.

**Place: Nauni, Solan
Date: 7th July, 2011**

(Pratibha Chauhan)

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ABBREVIATIONS USED IN MANUSCRIT

%	:	per cent
@	:	at the rate
Ha	:	hectare
viz.	:	videlicet (namely)
et. al.	:	etalia (Coworkers)
kg	:	kilogram
kg/ha	:	kilogram per hectare
kg/m ²	:	kilogram per square meter
cm	:	centimeter
°C	:	Degree centigrade
i.e.	:	id est (that is)
NS	:	non-significant
CD	:	Critical Difference
g	:	gram
g/l	:	gram per litre
FYM	:	Farm Yard Manure
mm	:	millimeter
Sel.	:	Selection
cv.	:	cultivar
sq.m.	:	square meter

Chapter-1

INTRODUCTION

Marigold (*Tagetes sp.*) gained popularity amongst flower dealers and gardeners on account of its easy culture and wider adaptability. The generic name '*Tagetes*' has been given after 'Tages' a demigod known for its beauty. Marigold, belonging to family Asteraceae, is a native of Central and South America, especially Mexico. Three species, viz., *T. erecta* (African marigold), *T. patula* (French marigold) and *T. tenuifolia* (Striped marigold) are most common in cultivation. *Tagetes erecta* is tall (about 90cm in height) and have large sized globular flowers, single or double, of lemon yellow, golden yellow, primrose, orange, sulphur yellow or white colours, whereas, *Tagetes patula* is compact in habit (about 30-38 cm in height) and have small flower heads, single or double, and colour ranges from yellow to mahogany red.

In India, marigold is grown as an important ornamental crop for loose flowers and landscape plant. It is grown commercially in Tamil Nadu, Karnataka, Haryana, Punjab, Himachal Pradesh, Uttar Pradesh etc. In India, area under marigold cultivation is around 1, 96,00 ha (Anonymous, 2010) and in Himachal Pradesh estimated area is around 240.34 ha with the production of 8111.47 tonnes (Anonymous, 2010).

Marigold is one of the most commonly grown flowers and is extensively used in religious and social functions. It is used as a loose flower, pot plant, bedding plant and also in great demand for making garlands. Its habit of free flowering, short duration to produce marketable flowers, wide spectrum of attractive colour, shape, size and good keeping quality attracts the attention of flower growers. Besides its pristine uses, now a day's marigold is being used as a stem less cut flower for interior decoration, in hanging baskets and rock gardens, for landscaping, for decoration of mandaps and cars in marriages. Both leaves and flowers are used for medicinal purpose (Tripathy and Gupta, 1991). Leaf paste is used externally against boils and carbuncles. Leaf extract is a good

remedy for ear ache. Flower extract is considered as a blood purifier, as a cure for bleeding piles and also as a good remedy for eye diseases and ulcers. The essential oil present in *Tagetes* spp. is used in perfume industry. The world demand for its oil is about 10 tonnes annually (Naik *et al.*, 2003). All parts of *Tagetes patula* contains essential oil which has pronounced odour and act as repellent to flies (Dhingra and Dhingra, 1956). Coloured pigment, known as lutein, extracted from flowers is also used in poultry feed to intensify the yellow colour of egg yolks and broiler skin (Gupta, 1997; Sreekala & Raghava, 2003). Cultivation of marigold also helps in controlling nematode population in field (Arora, 1993).

Growth and flowering in marigold is generally governed by the day length and temperature. To meet out the increasing demand of flowers throughout the year, its staggered planting is required. Therefore, this experiment was undertaken to evaluate the effect of planting dates and spacing on growth and flowering parameters of marigold.

The experiment was carried out with following objectives:

1. To regulate the flowering with the help of planting dates.
2. To find out the most suitable planting time and spacing of marigold in the mid hill conditions of Himachal Pradesh.

Chapter-2

REVIEW OF LITERATURE

Marigold is one of the important loose flower and pot plant of India. In India, it is being grown almost in every state of country. On account of available congenial climatic conditions, Himachal Pradesh is suitable for successful cultivation of marigold both in terms of yield and quality of flowers. Therefore, standardization of planting time of both African and French marigold is of utmost importance in order to produce quality flowers along with high net returns.

Hence, a critical probe of literature on marigold and other crops has been made to pool the information under the following heads:-

- 2.1. Effect of Planting Dates
- 2.2. Effect of Spacing
- 2.3. Interaction between Planting dates and Spacing

2.1 EFFECT OF PLANTING DATES

Gowda (1990) studied the effect of time of planting on growth and flower production in China aster cv. 'Ostrich plume' and observed that July transplanted crop resulted in earlier flowering, maximum number of flowers per plant (58.82), maximum flower yield (12128 kg/ha) and longest flower peduncle (15.10 cm) as compared to March transplanted crop under the Bangalore climatic condition.

Samant (1992) studied the effect of environmental factors on germination of seeds, growth, flowering and seed yield of *Cosmos bipinnatus* and reported that the sowing of seeds on 15th July resulted in best growth and flower production and highest seed yield per plant.

Ambed and Kadam (1998) studies the effect of different planting dates on yield of pyrethrum flower (*Chrysanthemum cinerarifolium*) and they observed that the maximum flower yield was obtained when planting was done on 5th of

September to 20th of October. However, they also found that flower declined as the planting date was delayed.

Mishra (1998) conducted an experiment to study the response of French marigold (*Tagetes patula* L.) on planting in different months of year. He revealed September and October planting resulted in maximum average flower size (3.68 cm and 3.82 cm, respectively), number of flowers per plant (77.17 and 68.50) and flower yield (110.9 and 106.4 q/ha, respectively) as compared to other planting dates.

Guruprasad (1999) revealed that November planting produced tallest and sturdiest (45.50 cm and 2.71 cm) plants of China aster after 90 days of planting under the climatic conditions of Dharwad. The flower yield of August and September plantings was lowest (4.91 and 4.45 ton/ha, respectively)

Jane *et al.* (2001) studied the effect of different planting dates on flower yield of annual chrysanthemum (*Chrysanthemum coronarium*) at Akola, Maharashtra. Transplanting was done at 10 days interval, starting from 5th October to 5th January. They observed that the maximum height, peduncle length and number of branches per plant were obtained with 5th and 15th October as transplanting dates. They also recorded tallest plants with 5th October transplanting date and maximum plant spread with 15th October transplanting date.

Dhawle *et al.* (2003) conducted a field experiment in Akola, Maharashtra, to determine the suitable planting dates for higher seed yield and quality of aster (*Callistephus chinensis*). The treatments comprised of 7 different planting dates from 1st August–1st November at an interval of 15 days. They found the highest plant height (69.42cm), plant spread (31.10cm), stem diameter (1.77cm), flower diameter (7.71cm), total number of flowers per plant (48.25), total number of flowers/ha (53.61 lakhs) and seed weight/ha (155.83kg) with 1st November planting.

Rao and Reddy (2002) conducted a sequential and open-field planting experiment on African marigold cv. 'Pusa Narangi Gainda' at monthly intervals from June 2000 to March 2001 and found that June planting resulted in maximum flower and seed yield.

Sharma *et al.* (2003) conducted an experiment comprising of 12 planting dates at monthly intervals, starting from mid-January to mid-December. The highest flower yield (10.73tonnes/ha) was recorded in August planting, followed by September planting (8.48 tonnes/ha) crop and the minimum flower yield (2.61 tonnes/ha) was recorded in January planting. Highest net return (Rs 112115/ha) was obtained from August planted crop with benefit cost ratio of 3.29, followed by September planting (78380 / ha) with benefit cost ratio of 2.60.

Nagaraju *et al.* (2004) observed the significant effect of dates of planting on flowering and flower quality of China aster (*Callistephus chinensis* Nees.) cv. Kamini. They recorded maximum number of flowers per plant (29.81), flower diameter (6.65 cm) and peduncle length (32.27 cm) in May planting, whereas, minimum number of flowers (18.78) and flower diameter (5.46 cm) was observed in August planting.

Jain and Gupta (2004) while comparing the planting dates observed that planting done in February month recorded maximum flower size (6.70 cm), number of flowers per plant (53.33) and flower yield per plant (296.10g) whereas, July planting resulted maximum plant height (108.30 cm), plant spread (41.85 cm), seed yield per plant (23.12 g) and seed number per head (191.62).

Rao and Moon (2005) conducted a field experiment in Passighat from April 2003 to October 2004 to determine the effect of sowing date on the seed production and flower yield of African marigold. April, May and June sowings resulted in highest flower and seed yields. The highest flower production was recorded during September and October, which coincided with the short day length.

Raju *et al.* (2006) planted French marigold (*Tagetes patula*) Selection-2 in different month, i.e., May, June, July and August to study the effect of planting time on its growth and flowering parameters under Delhi conditions. Flower yield per plant was maximum (173g) in June planting and flower diameter (5.12cm) and weight (6.84g) were highest in August planting. However, July planting was found to be best for seed production (0.271 g/flower).

Dilta *et al.* (2007) conducted an experiment at R.H.R.S, Bhota (H.P.), to study the effect of different planting dates(viz., 10th February, 10th April, 10th June and 10th August) on performance of china aster (*Callistephus chinensis* Nees.) varieties namely, Kamini, Poornima, Shashank and Violet Cushion. Maximum plant height (77.59cm) and spread (48.75cm) were found in Kamini in April plantings, whereas, maximum number of flowers per plant (54.07) and maximum flower diameter (5.49cm) were recorded in Violet Cushion when planted in June. However, maximum seed yield (1.83g/plant) was recorded in Violet Cushion when planted in August.

2.2 EFFECT OF SPACING

Jaswinder *et al.* (1980) planted *Tagetes patula* at a spacing of 40x30cm, 40x40cm and 40x50cm and pinching was done at 40, 50 and 60 days after transplanting. Flower yield per plant was greatest at the widest spacing of 40 x 50 cm and in plants pinched at 40 days after transplanting.

Ravindran *et al.* (1986) conducted an experiment with three levels of spacing (30x30cm, 45x30cm and 60x30cm) and observed maximum flower yield per hectare in closest spacing (30x30cm), followed by a spacing of 45x30 cm.

Singh and Sangma (2001) studied the response of China aster to spacing at IIHR, Hessarghatta Farm, Bangalore. There were total nine spacing viz., 40 x 40 cm, 40 x 30 cm, 30 x 30 cm, 40 x 20 cm, 30 x 20 cm, 40 x 10 cm, 20 x 20 cm, 30 x 10 cm and 20 x 10 cm. The maximum number of flowers (60.94), weight of flowers (90.84 g) and seed yield (10.94g) per plant were recorded in widest spacing (40 x 40 cm). However, the maximum weight of flowers (6.75 kg) and seed yield (627.00 g) per plot were obtained with closest spacing (20 x 10 cm).

Karavadia and Dhaduk (2002) studied the effect of spacing on annual chrysanthemum (*Chrysanthemum coronarium*) cv. 'Local White'. They obtained the maximum plant height (88.58 cm) and flower yield per ha (23958 kg/ha) in closer spacing, whereas, maximum plant spread (0.1560 cm²) and fresh weight per plant (590.00 g) were recorded in wider spacing of 30 x 40 cm.

Beniwal *et al.* (2003) conducted a field experiment in Haryana, to determine the optimum spacing and pinching requirements for *Dendranthema morifolium* cv. 'Flirt' cultivation and flower production. They tried different spacing (viz., 20x20, 20x30 and 20x40cm) and pinching stages (control, pinched at 25, 35 and 45 days after transplanting) and observed that maximum plant height (47.75 cm), highest number of branches per plant (10.21) and flower yield (3.68 kg/plot) were attained at closer spacing (20x20cm). Whereas, maximum plant spread and fresh weight of plant flowers were obtained in crop planted at 20x30 cm spacing when pinched at 25 days after transplanting.

Yadav *et al.* (2004) studied the effect of spacing and Nitrogen rate on the performance of *Tagetes erecta* in Raipur, Chattisgarh during 2001. They found highest plant height (67.13cm) under spacing of 40x30cm, whereas, the plant spread (43.82cm), number of flowers (22.89) and flower yield per plant (231.75) were obtained maximum under 60x45cm spacing. N at 120kg/ha and 180kg/ha recorded the greatest plant height (69.91 and 70.10 cm), whereas, 180kg/ha registered the greatest plant spread (48.37 cm) and fresh weight per plant (355.67g). Flower yield/ plant was highest under 45x45cm spacing with 120kg/ha and 60x45cm spacing with 180kg N/ha.

Karuppaiah and Krishna, (2005) investigated the effect of different spacing (viz., 20x30cm, 30x30cm and 30x40cm) and nitrogen levels (viz., 0, 350, 400 ad 450 kg/ha.) on growth and yield characters of French marigold (*Tagetes patula*) and concluded that a spacing of 30x30cm and 400 kg/ha of N resulted in maximum growth and yield of the flowers.

Pal and Pandey (2007) studied the effect of different plant spacing (viz., 20x10cm, 20x20cm, 20x30cm and 40x30cm) on growth and flower yield in

African marigold cv. 'Pusa Narangi Gainda'. Flowering characters, viz., number of flowers per branch, diameter of the flower, number of petals per flower and shelf life of flower were recorded maximum in spacing of 40x30cm, while plant height and flower yield per plot were maximum in spacing 20x10cm. Hence, they concluded 40x30cm spacing to be the most suitable spacing for better flower quality and growth of the plant.

2.3 INTERACTIONS BETWEEN PLANTING DATES AND SPACING

Gowda and Jayanthi (1986), in a 1-year trial with African marigold cv. 'Bangalore Local', had sown seeds at 2-month intervals starting on 1st January at 20 x 30cm, 20 x 40cm and 20 x 50 cm spacing. They found that plants that were sown in September and transplanted at 20 x 50cm gave the highest flower yield of 21.68t/ha.

Chanda and Roychaudhary (1991) conducted an experiment to standardize the time of planting and spacing for cultivation of African marigold cv. 'Siracole'. They found that plant height, plant spread and flower yield per plant were maximum at 40x40cm but the yield per hectare was maximum at a closer spacing of 30x30cm and they also advocated that for an optimum yield, planting of cuttings in the main field should be done between 15th March and 15th June with a spacing of 30x30cm.

Mohanty *et al.* (1993) planted rooted cuttings of *Tagetes erecta* cv. 'African Yellow' on 1st May, July, September and November, 1992 and 1st January, 1993 at spacing of 30x20cm, 30x30cm, 40x20cm, and 40x30cm and observed that the most profitable crop was obtained from September planting at 40x30cm spacing.

Dixit and Kesar (1994) conducted an experiment to study the effect of planting density and planting dates on growth, yield and flowering of Michaeamas Daisy at Pune. They found higher yield and better quality when seedlings of lavender and white types of *Aster amellus* were planted on 20th of March.

Kumar *et al.* (1998) studied the effect of planting dates and spacing on flower production behaviour of statice (*Limonium sinuatum*). They found that cultivar 'Forever White' produced highest stem length (30.88 cm) in November planting which was followed by 'Forever Pink' (23.11 cm) and 'Forever Purple' (18.44 cm).

Dubey *et al.* (2002) conducted a study to ascertain the effect of planting time and spacing on cosmos at PAU, Ludhiana. Experiment comprises of four planting dates, viz., 15th May, 15th June, 15th July and 15th August and four spacing (30x20cm, 30x30cm, 40x20cm and 40x30cm). Among planting dates 15th August was found to be the best in recording the maximum plant height (63.22cm), plant spread (32.87cm), duration of flowering (61.95 days), number of flowers per plant (19.78) and seed yield/m² (48.66g). Whereas, in case of spacing, plant spread (31.16cm), number of flowers per plant (20.52) and seed yield/plant (2.07g) were found maximum under widest spacing of 40x30 cm.

Poonam *et al.* (2002) conducted an experiment to study the effect of planting time and spacing on zinnia at PAU, Ludhiana. Experimental treatments comprised of four planting dates, viz., 15th March, 15th April, 15th May and 15th June and four spacing (30x20cm, 30x30cm, 40x20cm and 40x30cm). Maximum plant height (74.37cm), plant spread (40.55cm), number of branches per plant (14.44), flower duration(43.90 days), flower size (7.31cm), number of flowers per plant (24.99) and maximum seed yield/m² (29.39g) were recorded under March planting. In case of spacing, maximum plant height (52.64cm), plant spread (35.83cm), number of branches per plant (10.56), flower size (5.74cm), number of flowers per plant (2.61g) and maximum seed yield/m² were observed under 40x30cm spacing.

Sreekanth *et al.* (2006) studied the effect of planting time, spacing and nitrogen levels on yield and quality of African marigold (*Tagetes erecta* Linn.) at Herbal Garden, ANGRAU, Hyderabad during rabi season of 2004-2005. Three different dates of planting viz., October, November and December among which October planting recorded maximum flower diameter (6.53 cm), yield per plant (0.23 kg) and yield per hectare (118.29 quintal). Among different spacing used

viz., 40x30cm, 50x30cm and 60x30cm, closer spacing of 40x30cm recorded maximum flower diameter (5.75 cm), yield per plant (0.22 kg) and yield per hectare (113.21 quintal). However, among three nitrogen levels of 100, 150 and 200kg/ha, 100kg/ha of N recorded maximum flower diameter (6.59 cm), yield per plant (0.25 kg) and yield per hectare (135.30 quintal).

Chapter-3

MATERIALS AND METHODS

The present investigations entitled, “The effect of planting dates and spacing on growth and flowering of marigold”, were carried out at the experimental farm of the Department of Floriculture and Landscaping, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during March,2010 to December,2010. The details of the material used and techniques employed during the course of studies have been given below.

3.1 SITE

The experimental site is located at a latitude of 30° 52’ 02”N and at a longitude of 77° 11’ 30”E. Elevation of farm is 1276m above mean sea level and the area falls under the mid-hill zone of H.P.

3.2 CLIMATE

The climate of this area, in general, is sub-temperate to sub-tropical and is characterized by mild summer and cool winters. During the study period, (March,2010 to December,2010), mean maximum temperature (28.8⁰C) during summers and mean minimum temperature (10.5⁰C) during winters were observed, whereas, the intensity of rainfall ranges from 1.0mm – 484.6 mm (minimum in March and maximum in July). The meteorological data for the study period is given in Appendix I.

3.3 PLANTING MATERIAL

Seeds of African marigold and French marigold were available at research farm.

3.4 NURSERY RAISING

Seeds were sown in plugs of pro-trays where plugs were filled with media containing soil: sand: FYM in the ratio of 2:1:1 and each plug contained one

seed. After sowing, light irrigation was applied regularly to keep the media moist till the seeds germinated.

3.5 CULTIVATION PRACTICES

3.5.1 Preparation of the field

The field selected for experiment was thoroughly ploughed and the stubbles of previous crop and weeds were removed. The field was levelled and 15 cm raised beds were prepared.

3.5.2 Transplanting

Transplanting was done on 8 different planting dates i.e. from mid- March to mid- October. Transplanting was done during evening hours. After transplanting, crop was immediately irrigated.

3.5.3 Application of manure

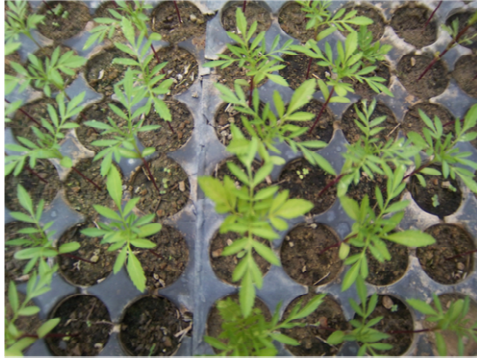
A basal dose of well rotten FYM (5kg/m²) was applied at the time of planting.

3.5.4 Irrigation

During March to May, crop was irrigated daily but from June onwards, irrigation frequency was reduced due to onset of rainy season. During October-November, irrigation was done twice a week.

3.5.5 Weeding and hoeing

Weeding and hoeing were performed as and when required. During cultivation, prominent weeds like *Oxalis sp.*, *Cyperus rotundus*, *Gallinsoga parviflora*, *Ageratum sp.* etc. were found and were controlled manually using hand hoes. This practice not only helped in control of weed population but improved aeration as well.



African marigold cv. 'Pusa Narangi Gaiinda'



French marigold Sel. 'FM 786'

Plate 1. Nursery raising through plug technique

3.5.6 Pinching

This operation was done in African marigold in order to produce multi-stemmed plants and to encourage vegetative growth. This was done by removing 2-3 cm apical growing portion of plant after 20-25 days of transplanting.

3.5.7 Disbudding

It was performed on the French marigold by removing the growing buds to promote vegetative growth as well as to get more number of flowers.

3.6 PLANT PROTECTION MEASURES

3.6.1 Diseases

Alternaria blight greatly infested the crop especially in the months of June-August. A scheduled spray of Dithane M-45(0.2%) and Bavistin (0.1%) was given at fortnight interval to control the disease. Bacterial infestation has also been observed especially during July-August, and the scheduled sprays of Streptocyclin @ 1g/l were given at fortnight interval to control the disease.

3.6.2 Insects and Pests

Cut worms (*Agrotis sp.*) damaged the crop at seedling stage. Phorate granules were used to control the damage.

3.7 EXPERIMENTAL DETAILS

The studies included two experiments, which were conducted separately on African marigold and French marigold. Details of experiments conducted are given below.

3.7.1 Experiment I: Effect of planting dates and spacing on growth and flowering of African marigold, cv. 'Pusa Narangi Gainda'.

Planting Dates:	Eight, (as given below)
	1. March,16
	2. April,16
	3. May,16

4. June,16
5. July,16
6. August,16
7. September,16
8. October,16

Spacing : Two, (45x30cm and 45x40cm, from plant to plant and row to row)

Total treatment combinations : 8x2=16

Number of replications : 3

Number of plants/replication : 20

Design: Split plot design, keeping planting dates as main-plot and spacing as sub-plot.

Seeds of African marigold cv. 'Pusa Narangi Gainda' were sown on 8 different months and transplanting was done in their respective months as given below:

Sowing date	Germination percentage (%)	Transplanting date
3 rd February	75.20	16 th March
24 th February	81.30	16 th April
23 rd April	83.00	16 th May
25 th May	80.50	16 th June
24 th June	78.20	16 th July
22 nd July	86.76	16 th August
23 rd August	88.92	16 th September
1 st September	86.00	16 th October

Beds of about 3.3m in length and 90cm in width were made for the spacing of 45x30cm (S₁) whereas, for the spacing of 45x40cm (S₂), 4.4m long and 90cm wide beds were prepared.

3.7.2 Experiment II: Effect of planting dates and spacing on growth and flowering of French marigold, Sel. 'FM 786'.

Planting Dates: Eight, (as given below)

1. March,16
2. April,16

3. May,16
4. June,16
5. July,16
6. August,16
7. September,16
8. October,16

Spacing : Two, (30x20cm and 30x30cm, from plant to plant and row to row)

Total treatment combinations : 8x2=16

Number of replications : 3

Number of plants/replication : 20

Design : Split plot design, keeping planting dates as main-plot and spacing as sub-plot.

This study was conducting on French marigold Sel. 'FM 786'. Seeds were sowing on 8 different months and their transplanting was done in their respective months as given below:

Sowing dates	Germination percentage (%)	Transplanting
3 rd February	40.00	16 th March
24 th February	38.30	16 th April
23 rd April	66.67	16 th May
25 th May	61.67	16 th June
24 th June	55.00	16 th July
22 nd July	78.82	16 th August
23 rd August	67.44	16 th September
1 st September	72.36	16 th October

Beds of about 1.6m in length and 90 cm in width were made for the spacing of 30 x 20cm (S₁) where as for the spacing of 30 x 30cm (S₂), 2.4m long and 90cm wide beds were prepared.

3.8 OBSERVATIONS RECORDED

3.8.1 Plant height(cm)

The average height of five random plants from the base of plant to the top was measured in centimeter (cm) at the time of peak flowering.

3.8.2 Plant spread (cm)

It was measured as average of the distance between outermost side shoots in East to West direction and distance between outermost side shoots in North to South direction.

3.8.3 Days taken to bud formation

Number of days was counted on five random flowers from the date of planting to the first visible flower bud formation.

3.8.4 Days taken to flowering

Number of days was counted on five random plants from the date of planting up to the stage of harvesting.

3.8.5 Duration of flowering (days)

Days were counted on five random plants from the date of flowering to the stage when 50-60% flowers faded on plant.

3.8.6 Size of flowers (cm)

Size of five flowers on each of five random plants was recorded at the time of peak flowering as the average of distance between apices of petals in East to West direction and distance between apices of petals in North to South direction.

3.8.7 Number of flowers per plant

Total number of flowers on five random plants was counted and averaged to obtain number of flowers per plant.

3.8.8 Weight of flower per plant (g)

Fresh weight of total flowers produced from five randomly selected plants was weighed in gram (g) and averaged to obtain yield per plant.

3.8.9 Flower yield per square meter

It was worked out by recording yield of flowers on all the plants present in one square meter area.

3.9 STATISTICAL ANALYSIS

The observations recorded on various growth and flowering parameters were subjected to analysis of variance (ANOVA) using split plot design as described by Gomez and Gomez (1984) keeping planting dates as main plot and spacing as sub-plot.

Chapter-4

EXPERIMENTAL RESULTS

During the present course of investigations, the study on “Effect of planting dates and spacing on the growth and flowering of marigold” was undertaken. The studies conducted during March, 2010 - December,2010 revealed that plant growth, flowering and yield of marigold was influenced by different planting dates and spacing. The results obtained were presented as under:

4.1 EXPERIMENT I: EFFECT OF PLANTING DATES AND SPACING ON THE GROWTH AND FLOWERING OF AFRICAN MARIGOLD cv. ‘Pusa Narangi Gaiinda’

4.1.1 Plant height (cm)

The results pertaining to plant height of African marigold cv. ‘Pusa Narangi Gaiinda’ are presented in Table 1. The perusal of data clearly revealed significant differences in plant height due to the different planting dates.

In general, among different planting dates, April,16, planted crop resulted in maximum plant height (126.58 cm). There was significant reduction in plant height with every planting date after 16th of April except between July and August, and September and October planting dates. Among all planting dates, minimum plant height recorded of October,16 planted crop (32.36 cm) was found to be at par with September,16 planted crop (33.82 cm).

Though there was non-significant difference in plant height between two spacing, S₁ (45 x 30 cm) and S₂ (45 x 40 cm) (Appendix II), it was more in case of S₁ (73.88 cm) than S₂ (70.55 cm) from row to row.

As regard the interaction between planting dates and spacing, it was also found non-significant (Appendix II). However, plant height, in general, was more when planted at a spacing of 45 x 30 cm (S₁) than 45 x 40 cm (S₂) from plant to plant and row to row in all planting dates, except July, August and September

plantings. Further, like the general effect of planting dates on plant height, there was decrease in the height of plants in all plantings done after April,16.

Table 1:Effect of planting dates and spacing on plant height (cm) of African marigold cv. ‘Pusa Narangi Gainda’

Planting Dates	Spacing	Plant height (cm)		
		S ₁ (45 x 30 cm)*	S ₂ (45 x 40 cm)**	Mean
March,16		108.47	104.79	106.63
April,16		130.32	122.83	126.58
May,16		105.33	89.05	97.19
June,16		87.58	84.36	85.97
July,16		44.85	48.88	46.87
August,16		47.03	49.59	48.31
September,16		35.20	32.44	33.82
October,16		32.27	32.45	32.36
Mean		73.88	70.55	

*S₁=(45 cm from plant to plant and 30 cm from row to row)

** S₂=(45 cm from plant to plant and 40 cm from row to row)

CD_{0.05} for:

Planting dates = 6.76

Spacing = NS

Planting dates x Spacing = NS

4.1.2 Plant spread (cm)

The data pertaining to the plant spread of African marigold cv. ‘Pusa Narangi Gainda’ is presented in Table 2. The perusal of data clearly revealed the significant differences in plant spread due to different planting dates. In general, maximum plant spread (54.58 cm) was recorded in May, 16 planting which was found to be statistically at par with the April,16 planted crop (54.23 cm). In contrast, the minimum plant spread (22.17 cm) was recorded in the October, 16 planted crop which was statistically at par with the September, 16 planted crop (23.14 cm).

Though there was non-significant difference in plant spread between two spacing S₁ and S₂ (Appendix II), plant spread was more on case of wider spacing S₂ (38.78 cm) than the closer spacing S₁ (38.52 cm) from row to row.



Plate 2a. African marigold cv. 'Pusa Narangi Gaiinda'



Plate 2b. French marigold Sel. 'FM 786'

The effect of interaction between planting dates and spacing on the plant spread was found to be significant. Maximum plant height (55.54 cm) was recorded in May, 16 planted crop with the spacing of 45 x 30 cm (S₁) from plant to plant and row to row. It was found statistically at par with April,16 (54.23 cm) with the both spacing S₁ and S₂, and also with March, 16 planted crop (51.90 cm) when planted at spacing S₁ and May, 16 (53.62 cm) planted crop with the spacing S₂.

Table 2: Effect of planting dates and spacing on plant spread (cm) of African marigold cv. ‘Pusa Narangi Gainda’

Planting dates \ Spacing	Plant Spread (cm)		
	S ₁ (45 x 30 cm)*	S ₂ (45 x 40 cm)**	Mean
March,16	51.90	50.17	51.03
April,16	54.23	54.23	54.23
May,16	55.54	53.62	54.58
June,16	49.59	45.03	47.31
July,16	23.90	29.39	26.65
August,16	30.13	29.94	30.03
September,16	21.50	24.80	23.15
October,16	21.33	23.02	22.17
Mean	38.52	38.78	

*S₁=(45 cm from plant to plant and 30 cm from row to row)

** S₂=(45 cm from plant to plant and 40 cm from row to row)

CD_{0.05} for:

Planting dates	=	1.91
Spacing	=	NS
Planting dates x Spacing	=	4.1

4.1.3 Days taken to bud formation

Perusal of data regarding the effect of planting dates and spacing on days taken to bud formation have been presented in Table 3. As evident from this table it is clear that the time taken to bud formation differ significantly due to different planting dates. In general, among different planting dates, May, 16 planted crop took maximum days for bud formation (103.62 days). There was significant reduction in the number of days for bud formation with every planting date after

16th of May. Among all planting dates minimum number of days for bud formation (42.33 days) was recorded in October, 16 planted crop.

Though there was non-significant differences in the days for bud formation between two spacing, S₁, 45 x 30 cm and S₂, 45 x 40 cm, (Appendix II), more number of days for bud formation was recorded in S₂ (64.47 days) as compared to S₁ (64.36 days) from row to row.

As regards the interaction between planting dates and spacing, it was also found to be non-significant (Appendix II). However, maximum number of days for bud formation (102.55 days) was recorded in May planted crop with the spacing of 45 x 30 cm (S₁) from plant to plant and row to row. Further, like the general effect of planting dates on days for bud formation, there was decrease in the number of days for bud formation in all the plantings done after May, 16.

Table 3: Effect of planting dates and spacing on the number of days taken to bud formation (days) on African marigold cv. ‘Pusa Narangi Gainda’

Planting dates \ Spacing	Days taken to bud formation		
	S ₁ (45 x 30 cm)*	S ₂ (45 x 40 cm)**	Mean
March,16	52.64	53.07	52.86
April,16	60.87	62.53	61.70
May,16	102.55	104.70	103.62
June,16	67.70	69.00	68.35
July,16	77.57	77.13	77.35
August,16	59.13	58.33	58.73
September,16	50.60	50.20	50.40
October,16	42.13	42.53	42.33
Mean	64.36	64.47	

*S₁ = (45 cm from plant to plant and 30 cm from row to row)

** S₂ =(45 cm from plant to plant and 40 cm from row to row)

CD_{0.05} for:

Planting dates	=	2.34
Spacing	=	NS
Planting dates x Spacing	=	NS

4.1.4 Days taken to flowering

The results pertaining to days for flowering of African marigold cv. ‘Pusa Narangi Gainda’ are presented in Table 4. The perusal of data clearly revealed the significant differences in the number of days for flowering due to planting

dates. There was significant increase in the number of days for flowering with the every planting dates from March to July, whereas, July,16 planted crop recorded maximum number of days for flowering (105.00 days) and then significant reduction was observed in the number of days for flowering with every planting date after July,16. Among all planting dates, minimum number of days for flowering (68.88 days) was recorded in October, 16 planted crop which was statistically at par with September planted crop (70.67 days).

As regards the spacing, there was non-significant difference in the number of days for flowering between two spacing, S₁ and S₂ (Appendix II), however, more number of days for flowering (82.10 days) was recorded in wider spacing S₂ (45 x 30 cm) as compared to days for flowering (81.80 days) when planted at closer spacing S₁ (45 x 40 cm) from row to row.

The effect of interaction was found to be non-significant (Appendix II). However, maximum days for flowering was recorded in July,16 planted crop with spacing S₂ (45 x 40 cm) from plant to plant and row to row. Whereas, minimum number of days for flowering (68.70 days) was recorded in October,16 planted crop with the same spacing S₂ (45 x 40 cm).

Table 4: Effect of planting dates and spacing on the number of days taken to flowering (days) on African marigold cv. ‘Pusa Narangi Gaiinda’

Planting dates \ Spacing	Days taken to flowering		
	S ₁ (45 x 30 cm)*	S ₂ (45 x 40 cm)**	Mean
March,16	72.09	73.78	72.93
April,16	77.67	76.20	76.93
June,16	96.80	96.73	96.77
July,16	104.47	105.53	105.00
August,16	82.47	83.13	82.80
September,16	70.07	71.27	70.67
October16	69.07	68.70	68.88
Mean	81.80	82.19	

*S₁=(45 cm from plant to plant and 30 cm from row to row)

** S₂=(45 cm from plant to plant and 40 cm from row to row)

CD_{0.05} for:

Planting dates	=	1.83
Spacing	=	NS
Planting dates x Spacing	=	NS

4.1.5 Flower size

Data presented in Table 5 depicts that the planting dates have a significant effect on flower size of African marigold cv. ‘Pusa Narangi Gainda. It is apparent from the table that maximum size of flower (5.17 cm) was recorded in the September,16 planted crop which was statistically at par with August,16 (5.13 cm), July,16 (5.08 cm), April,16 (5.03 cm) and march,16 (4.94 cm). In general, minimum size of flower (4.70 cm) was recorded in October,16 planting which was found statistically at par with March,16 planted crop.

Though non-significant difference was found in the size of flower between two spacing, S₁ and S₂ (Appendix II), flower size was recorded bigger (5.00 cm) in closer spacing S₁ (45 x 30 cm) as compared to the flower size (4.93 cm) observed at wider spacing S₂ (45 x 40 cm) from row to row.

Table 5: Effect of planting dates and spacing on the size of flower (cm) on African marigold cv. ‘Pusa Narangi Gainda’

Planting dates \ Spacing	Flower size (cm)		
	S ₁ (45 x 30 cm)*	S ₂ (45 x 40 cm)**	Mean
March,16	4.92	4.96	4.94
April,16	5.23	4.83	5.03
June,16	4.74	4.69	4.71
July,16	5.00	5.16	5.08
August,16	5.17	5.08	5.13
September,16	5.15	5.19	5.17
October16	4.81	4.58	4.70
Mean	5.00	4.93	

*S₁ = (45 cm from plant to plant and 30 cm from row to row)

** S₂ =(45 cm from plant to plant and 40 cm from row to row)

CD_{0.05} for:

Planting dates	=	0.26
Spacing	=	NS
Planting dates x Spacing	=	NS

The effect of interaction between planting dates and spacing was found to be non-significant (Appendix II). However, flower size, in general, recorded maximum (5.23 cm) when planting was done in 16th of April, with the closer spacing of 45 x 30 cm (S₁) followed by September,16 planted crop (5.19 cm) with the wider spacing of S₂ (45 x 40 cm) from plant to plant and row to row,

whereas, minimum size of flower (4.58 cm) was observed in October,16 planted crop with the spacing S₂.

4.1.6 Duration of flowering

The effect of planting dates and spacing on duration of flowering of African marigold cv. 'Pusa Narangi Gainda' has been presented in Table 6. A perusal of data presented in table and corresponding analysis of variance in Appendix II revealed the significant differences in the duration of flowering due to different planting dates.

In general, among different planting dates, maximum duration of flowering (30.17 days) of African marigold cv.'Pusa Narangi Gainda' recorded in April,16 planted crop, and followed by March,16 planted crop (23.93 days). Among all the planting dates, minimum duration of flowering (19.57 days) recorded for October,16 planted crop was found to be at par with June,16 planted crop (19.60 days).

Though there was non-significant difference in duration of flowering of African marigold cv.'Pusa Narangi Gainda' between two spacing, S₁ and S₂ (Appendix II), more duration of flowering (23.03 days) was recorded at closer spacing S₁ (45 x 30 cm) than the duration for flowering (22.84 days) when planted at wider spacing S₂ (45 x 40 cm) from row to row.

As regard the interaction between planting dates and spacing was also found non-significant (Appendix II). However, maximum duration of flowering (30.47 days) was recorded in April,16 planting with spacing S₁ (45 x 30 cm) which differed highly with the June,18 planted crop which have minimum duration of flowering (18.93 days) with S₂ (45 x 40 cm) from plant to plant and row to row. Duration of flowering, in general, was more when planted at a spacing of 45 x 40 cm (S₂) than 45 x 30 cm (S₁) in the all planting dates except April 16th, June 16th and August 16th planted crop.

Table 6: Effect of planting dates and spacing on the duration of flowering (days) on African marigold cv. 'Pusa Narangi Gainda'

Planting dates \ Spacing	Duration of Flowering (days)		
	S ₁ (45 x 30 cm)*	S ₂ (45 x 40 cm)**	Mean
March,16	23.33	24.53	23.93
April,16	30.47	29.87	30.17
June,16	20.27	18.93	19.60
July,16	20.90	19.68	20.29
August,16	23.87	23.93	23.90
September,16	22.87	23.27	23.07
October16	19.47	19.67	19.57
Mean	23.02	22.84	

*S₁=(45 cm from plant to plant and 30 cm from row to row)

** S₂=(45 cm from plant to plant and 40 cm from row to row)

CD_{0.05} for:

Planting dates	=	0.39
Spacing	=	NS
Planting dates x Spacing	=	NS

4.1.7 Number of flowers per plant

The data regarding the effect of planting dates and spacing on the number of flowers per plant on African marigold cv. 'Pusa Narangi Gainda' have been depicted in the Table 7.

The different planting dates exhibit significant effect on the number of flowers per plant. Among different planting dates, in general, the maximum number of flowers per plant (34.67) was recorded in March,16 planting which was statistically superior over all other treatments. There was significant reduction in the number of flowers per plant with every planting date after 16th of March except between June and July, and August, and September. Among all the planting dates, minimum number of flowers per plant (8.67) observed in October,16 planted crop and found statistically at par with the planting of July,16 as well as September,16 planted crop (10.27).

The effect of spacing (S₁ and S₂) on the number of flowers per plant was found to be non-significant (Appendix II). However, maximum number of flowers per plant was recorded at the wider spacing of S₂ (17.41) than the closer spacing of S₁ (17.35) from row to row.

Interaction between planting dates and spacing also exhibit non-significant effect on the number of flowers per plant (Appendix II). However, more number for of flowers per plant was recorded in March,16 planted crop with spacing S₂ (45 x 40 cm) in contrast with minimum number of flowers per plant (8.27) recorded in October,16 planted crop with spacing S₁ (45 x 30 cm) from plant to plant and row to row. In general, more number of flowers per plant was recorded at wider spacing.

Table 7: Effect of planting dates and spacing on the number of flowers per plant on African marigold cv. ‘Pusa Narangi Gainda’

Planting dates \ Spacing	Number of flowers per plant		
	S ₁ (45 x 30 cm)*	S ₂ (45 x 40 cm)**	Mean
March,16	33.93	35.40	34.67
April,16	25.47	27.20	26.33
June,16	16.33	13.53	14.93
July,16	10.60	9.93	10.27
August,16	17.41	16.93	17.35
September,16	10.73	9.80	10.27
October16	8.27	9.07	8.67
Mean	17.35	17.41	

*S₁ = (45 cm from plant to plant and 30 cm from row to row)

** S₂ =(45 cm from plant to plant and 40 cm from row to row)

CD_{0.05} for:

Planting dates	=	2.05
Spacing	=	NS
Planting dates x Spacing	=	NS

4.1.8 Weight of flower per plant

The results pertaining to the effect of planting dates and spacing on the weight of flowers per plant have been presented in Table 8. It is evident from the table that planting dates have a significant effect on the weight of flowers per plant of African marigold cv. ‘Pusa Narangi Gainda’.

In general, among different planting dates, maximum weight of flower per plant (142.15 g) observed in April,16th planting which was found statistically at par with March,16th planting (139.02 g). There was a significant reduction in the weight of flowers per plant with every planting date after 16th of March except,

between July and August plantings. Among all planting dates, minimum weight of flower (43.70 g) was obtained in October,16th planting and found significantly at par with September,16th (51.77 g) and July,16th (52.13 g) planted crop.

As regards the effect of spacing, the weight of flowers per plant was not significantly affected by both the spacing, S₁ and S₂ (Appendix II). However, in general, more flower weight per plant (85.41 g) was obtained at closer spacing S₁ (45 x 30 cm) as compared to the flower weight (84.13 g) recorded with wider spacing S₂ (45 x 40 cm) from row to row.

Table 8: Effect of planting dates and spacing on weight of flower per plant (g) on African marigold cv. ‘Pusa Narangi Gainda’

Planting dates \ Spacing	Weight of flower per plant (g)		
	S ₁ (45 x 30 cm)*	S ₂ (45 x 40 cm)**	Mean
March,16	144.10	133.93	139.02
April,16	131.64	152.67	142.15
June,16	92.93	71.20	82.07
July,16	54.00	50.27	52.13
August,16	77.93	87.20	82.57
September,16	53.93	49.60	51.77
October16	43.33	44.07	43.70
Mean	85.41	84.13	

*S₁ = (45 cm from plant to plant and 30 cm from row to row)

** S₂ =(45 cm from plant to plant and 40 cm from row to row)

CD_{0.05} for:

Planting dates	=	11.67
Spacing	=	NS
Planting dates x Spacing	=	11.97

The interaction effect of planting dates and spacing was found to exhibit significant effects on weight of flower per plant. In general, maximum flower weight per plant (152.67 g) recorded in April,16th planting with spacing S₂ (45 x 40 cm) was statistically at par with March,16th planting (144.10 g) with S₁ spacing (45 x 30 cm) from plant to plant and row to row. Whereas, minimum flower weight per plant (43.70 g) observed in October,16th planted crop was found statistically at par with September,16th (53.93 g) and July,16th (54.00 g) at closer spacing S₁ (45 x 30 cm) and also with the October,16th (44.07 g),

September, 16th (49.60 g) and August, 16th planted crop at wider spacing S₂ (45 x 40 cm).

4.2.9 Flower yield per square meter (g)

The results pertaining to flower yield per sq. m. of African marigold cv. 'Pusa Narangi Gainda' are presented in Table 9. The perusal of data presented in the given table and corresponding analysis of variance in Appendix II revealed the significant differences in flower yield per sq. m. due to the different planting dates, spacing and their interactions.

In general, among different planting dates, maximum flower yield per square meter (700.23 g) in April, 16 planted crop which was found statistically at par with March, 16 planted crop (699.87 g). There was significant reduction in the flower yield per square meter with every planting date after March, 16 except between July, 16 and August, 16 plantings. In contrast, minimum yield of flower per square meter (220.13 g) was recorded in October, 16 planted crop which was found statistically at par with July, 16 (261.93 g) and September, 16 planted crop (261.00 g).

It is evident from the data that spacing exhibit significant effect on the flower yield per square meter number of days for bud formation (Appendix II). Among spacing, higher yield per sq. m (510.11 g) was obtained from closer spacing S₁ (45 x 30 cm) as compared to the flower yield (329.05 g) recorded when planting was done at wider spacing S₂ (45 x 40 cm) from row to row.

Interaction between planting dates and spacing also exhibit significant effect on the flower weight per square meter (Appendix II). In general, maximum flower yield per sq. m (864.00 g) was obtained in March, 16 planted crop with closer spacing S₁ (45 x 30 cm) from plant to plant and row to row. In contrast, minimum flower yield (176.27 g) was recorded in October, 16 planted crop at wider spacing S₂ (45 x 40 cm) and found statistically at par with July, 16 (199.07 g) and September, 16 (198.49 g) planted crop with the same spacing.

Table 9: Effect of planting dates and spacing on flower yield per square meter (g) of African marigold cv. ‘Pusa Narangi Gainda’

Planting dates \ Spacing	Flower yield per square meter (g)		
	S ₁ (45 x 30 cm)*	S ₂ (45 x 40 cm)**	Mean
March,16	864.00	535.73	699.87
April,16	789.80	610.67	700.23
June,16	557.13	262.40	409.77
July,16	324.80	199.07	261.93
August,16	447.47	320.80	384.13
September,16	323.60	198.40	261.00
October16	264.00	176.27	220.13
Mean	510.11	329.05	

*S₁=(45 cm from plant to plant and 30 cm from row to row)

** S₂=(45 cm from plant to plant and 40 cm from row to row)

CD_{0.05} for:

Planting dates	=	63.53
Spacing	=	28.38
Planting dates x Spacing	=	75.09

4.2 EXPERIMENT II: EFFECT OF PLANTING DATES AND SPACING ON THE GROWTH AND FLOWERING OF FRENCH MARIGOLD SEL. ‘FM 786’

4.2.1 Plant height (cm)

The results pertaining to plant height of French marigold Sel. ‘FM 786’ are presented in Table 10. The perusal of data presented in the given table and corresponding analysis of variance in Appendix III revealed the significant differences in plant height due to the different planting dates, spacing and their interactions.

In general, among different planting dates, maximum plant height (64.50 cm) was recorded in June,16th planted crop and it was found statistically at par with that of May,16th planting (63.43 cm). There was significant reduction in the plant height with every planting date after 16th of July. Among all planting dates minimum plant height (17.66 cm) was recorded in October,16th planted crop.

In case of spacing, maximum plant height (42.11 cm) was obtained with the wider spacing S₂ (30 x 30 cm). In contrast, minimum plant height (40.77 cm) was recorded with the closer S₁ (30 x 20 cm) from row to row.

The interaction between planting dates and spacing, maximum plant height (65.19 cm) was recorded with spacing S₂ (30 x 20 cm) in May,16 planted crop which was statistically at par with June,16 planted crop (64.27 cm) with spacing S₂ (30 x 30 cm) from plant to plant and row to row. Minimum plant height (17.31 cm) was observed in the October,16 planted crop with the closer spacing S₁ (30 x 20 cm) which was statistically at par with plant height (18.01 cm) recorded in the same month planting when planted at the spacing S₂ (30 x 30 cm).

Table 10: Effect of planting dates and spacing on plant height (cm) of French marigold Sel. ‘FM 786’

Spacing \ Planting dates	Plant height (cm)		
	S ₁ (30 x 20 cm)*	S ₂ (30 x 30 cm)**	Mean
March,16	44.91	46.94	45.92
April,16	53.38	50.59	51.99
May,16	61.66	65.19	63.43
June,16	64.73	64.27	64.50
July,16	34.59	38.82	36.70
August,16	26.87	29.79	28.33
September,16	22.70	23.27	22.98
October,16	17.31	18.01	17.66
Mean	40.77	42.11	

*S₁=(30 cm from plant to plant and 20 cm from row to row)

** S₂=(30 cm from plant to plant and 30 cm from row to row)

CD_{0.05} for:

Planting dates	=	1.27
Spacing	=	0.80
Planting dates x Spacing	=	2.28

4.2.2 Plant spread (cm)

An acquisition of the data presented in Table 11 showed significant effect of planting dates and the interactions between planting dates and spacing on plant spread of French marigold Sel. ‘FM 786’.

Maximum plant spread (47.90 cm) was attained in June,16 planted crop which was statistically at par with that of April,16 planted crop (45.39 cm). There was significant reduction in plant spread with every planting date after 16th of

June planting. Among all planting dates, minimum plant height was obtained in October,16 planted crops (15.65 cm) which differ significantly from all other plantings.

As regard the spacing, the plant spread was not significantly affected by the spacing S₁ and S₂, (Appendix I). However, more plant spread (32.46 cm) was recorded at wider spacing S₂ (30 x 30 cm) as compared to the plant spread (31.99 cm) recorded at the closer spacing S₁ (30 x 20 cm) from row to row, irrespective of planting dates.

The effect of interaction between planting dates and spacing on the plant spread was found to be significant. June planting, with spacing S₁ (30 x 20 cm) from plant to plant and row to row, produced maximum plant spread (50.88 cm) which differed significantly plant spread (44.91 cm) recorded with S₂ (30 x 30 cm) spacing of same month. Minimum plant spread (14.9 cm) was recorded in October,16 planted crop with spacing S₂ (30 x 30 cm) which was statistically at par with the same planting month (16.40 cm) but with the spacing S₁.

Table 11: Effect of planting dates and spacing on plant spread (cm) of French marigold Sel. ‘FM 786’

Planting Dates \ Spacing	Plant spread (cm)		
	S ₁ (30 x 20 cm)*	S ₂ (30 x 30 cm)**	Mean
March,16	38.97	43.20	41.08
April,16	45.81	44.97	45.39
May,16	34.24	36.37	35.31
June,16	50.88	44.91	47.90
July,16	23.96	26.89	25.43
August,16	24.09	25.37	24.73
September,16	21.53	23.03	22.28
October,16	16.40	14.90	15.65
Mean	31.99	32.46	

*S₁=(30 cm from plant to plant and 20 cm from row to row)

** S₂=(30 cm from plant to plant and 30 cm from row to row)

CD_{0.05} for:

Planting dates	=	1.91
Spacing	=	NS
Planting dates x Spacing	=	1.69

4.2.3 Days taken to bud formation

The results pertaining to number of days for bud formation of French marigold Sel. 'FM 786' are presented in Table 12. The perusal of data presented in the given table and corresponding analysis of variance in Appendix III revealed the significant differences in number of days for bud formation due to the different planting dates, spacing and their interactions.

Data presented in the given table showed significant effect of planting dates on the number of days taken to bud formation. Among different planting dates, maximum number of days for bud formation (104.07 days) was recorded in May,16 planted crop and found to be significantly higher over all other planting dates. There was significant reduction in the number of days for bud formation with every planting dates after 16th of May, except between June,16 and July,16 plantings. Whereas, minimum number of days for bud formation (23.00 days) were registered in October,16 planted crop.

Table 12: Effect of planting dates and spacing on the number of days taken to bud formation (days) of French marigold Sel. 'FM 786'

Planting Dates \ Spacing	Number of days taken to bud formation		
	S ₁ (30 x 20 cm)*	S ₂ (30 x 30 cm)**	Mean
March,16	29.80	29.13	29.47
April,16	40.73	44.87	42.80
May,16	104.73	103.4	104.07
June,16	53.67	55.80	54.73
July,16	69.93	68.30	69.12
August,16	52.07	53.07	52.57
September,16	43.00	43.07	43.03
October,16	22.47	23.53	23.00
Mean	52.05	52.65	

*S₁=(30 cm from plant to plant and 20 cm from row to row)

** S₂=(30 cm from plant to plant and 30 cm from row to row)

CD_{0.05} for:

Planting dates	=	1.90
Spacing	=	0.39
Planting dates x Spacing	=	1.10

It is evident from the data that spacing exhibit significant effect on the number of days for bud formation (Appendix III). However, more time for bud

formation (52.65 days) was observed at wider spacing S_2 (30 x 20 cm) and found significantly at par with spacing S_1 (30 x 30 cm) from row to row.

The effect of interaction between planting dates and spacing was found to be significant. May,16 planted crop took maximum number of days for bud formation (104.73 days) with spacing S_1 (30 x 20 cm) from plant to plant and row to row, whereas, minimum number of days for bud formation (22.47 days) were recorded in October,16 planted crop with closer spacing S_1 (30 x 20 cm) which was statistically at par with the same month planting (23.54 days) but with wider spacing S_2 (30 x 30 cm).

4.2.4 Days taken to flowering

The results pertaining to days for flowering of French marigold Sel. 'FM 786' are presented in Table 13. The perusal of data presented in the given table and corresponding analysis of variance in Appendix III revealed the significant differences in number of days for flowering due to the different planting dates, spacing and their interactions.

Among different planting dates, May,16 planted crop took maximum number of days for flowering (115.93 days) which was found to be significantly higher over all other planting dates. There was significant reduction in the number of days for flowering with every planting dates after 16th of May, except between June, 16 and July,16 plantings. In contrast minimum number of days for flowering (41.20 days) was observed when planting was accomplished in October,16.

In case of spacing, significantly higher number of days for flowering (72.21 days) was recorded in spacing S_2 (30 x30 cm) as compared to minimum number of days (69.58 days) in spacing S_1 (30 x 20 cm) from row to row.

Among interaction between planting dates and spacing, maximum number of days for flowering was observed in May, 16 planted crop (117.20 days) with wider spacing S_2 (30 x 30 cm) from plant to plant and row to row. Whereas,



Plate 3a. General view of March and April planting of African and French Marigold

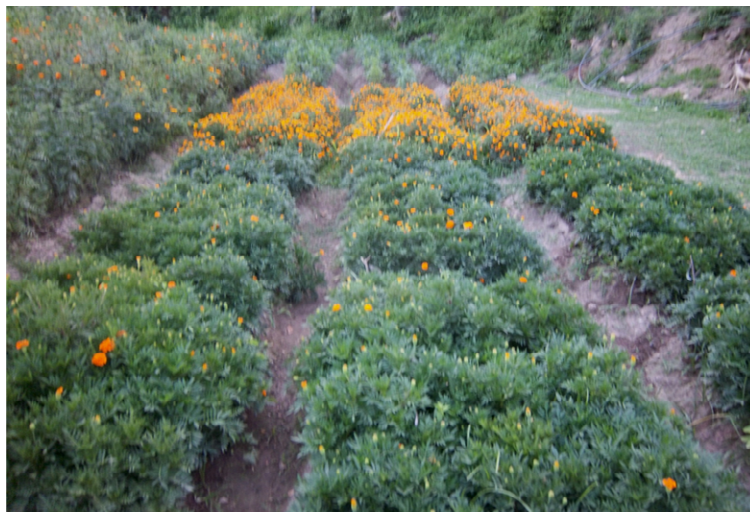


Plate 3b. Overall view of the experiment

statistically similar number of days (41.20 days) were recorded for flowering in both spacing when the crop was planted in October,16.

Table 13: Effect of planting dates and spacing on the number of days taken to flowering (days) of French marigold Sel. ‘FM 786’

Planting Dates \ Spacing	Days taken to flowering		
	S ₁ (30 x 20 cm)*	S ₂ (30 x 30 cm)**	Mean
March,16	46.27	45.73	46.00
April,16	61.33	62.87	62.10
May,16	114.67	117.20	115.93
June,16	81.13	81.73	81.43
July,16	87.13	86.73	86.93
August,16	64.67	66.73	65.70
September,16	60.27	59.47	59.87
October,16	41.20	41.20	41.20
Mean	69.58	70.21	

*S₁=(30 cm from plant to plant and 20 cm from row to row)

** S₂=(30 cm from plant to plant and 30 cm from row to row)

CD_{0.05} for:

Planting dates	=	1.10
Spacing	=	0.39
Planting dates x Spacing	=	0.96

4.2.5 Flower size (cm)

The results pertaining to size of flower of French marigold Sel. ‘FM 786’ are presented in Table 14. The perusal of data clearly revealed significant differences in flower size due to the different planting dates.

Among different planting dates, maximum flower diameter (4.37 cm) was recorded with April,16 planted crop which was statistically superior over all other treatments. Whereas, minimum flower size (3.16 cm) was produced in July,16 planted crop which was statistically at par with August,16 planted crop (3.27 cm).

As regard the effect of spacing, the flower size was not significantly affected by the spacing, S₁ and S₂ (Appendix III). However, bigger size of flower (3.72 cm) was recorded in wider spacing S₂ (30 x 30 cm) as compared to the

flower size (3.68 cm) obtained in closer spacing S₁ (30 x 20 cm) from row to row, irrespective of planting dates.

The interaction between planting dates and spacing was found to exhibit significant effects on the size of flower. Among interaction, in general, the maximum size of flowers (4.44 cm) was recorded in April,16 planted crop with wider spacing S₂ (30 x 30 cm), from plant to plant and row to row, which was found statistically at par with flower size (4.30 cm) obtained at closer spacing S₁ (30 x 20 cm) of same planting month. In contrast, minimum flower diameter (3.10 cm) was obtained in July planted crop with wider spacing of S₂ and found to be at par with August,16 planted crop when planted at same spacing and also with July,16 (3.21 cm) and August,16 (3.28 cm) planted crop at spacing S₁.

Table 14: Effect of planting dates and spacing on the size of flower (cm) of French marigold Sel. ‘FM 786’

Planting Dates \ Spacing	Flower size (cm)		Mean
	S ₁ (30 x 20 cm)*	S ₂ (30 x 30 cm)**	
March,16	3.75	3.79	3.77
April,16	4.30	4.44	4.37
May,16	3.41	3.53	3.47
June,16	3.62	3.64	3.63
July,16	3.21	3.10	3.16
August,16	3.28	3.26	3.27
September,16	3.67	3.97	3.82
October,16	4.17	4.05	4.11
Mean	3.68	3.72	

*S₁=(30 cm from plant to plant and 20 cm from row to row)

** S₂=(30 cm from plant to plant and 30 cm from row to row)

CD_{0.05} for:

Planting dates	=	0.15
Spacing	=	NS
Planting dates x Spacing	=	0.18

4.2.6 Duration of flowering

An acquisition of data in Table 15 shows the effect of planting dates and spacing on the duration of flowering (days) of French marigold Sel. ‘FM 786’. The perusal of data revealed that the different planting dates exhibited significant effect on duration of flowering.

In general, among all planting dates, maximum duration of flowering (31.41 days) was recorded with April,16 planted crop which was found statistically superior over all other planting dates. There was significant reduction in the duration of flowering with every planting date after 16th of April except between July,16 and August,16, and September,16 and October,16 plantings. However, minimum duration of flowering (19.10 days) was found in July planted crop which was statistically at par with October planting (21.57 days).

Though there was non-significant difference in the duration of flowering between two spacing, S₁ and S₂,(Appendix III).However, more number of days for flowering (24.54 days) was recorded in S₁ (30 x 20 cm) as compared to the number of days (24.38 days) recorded in spacing S₂ (30 x 30 cm) from row to row.

As regard the interaction between planting dates and spacing, it was also found statistically non-significant (Appendix III). However, maximum duration of flowering (31.80 days) was attained in April,16 planted crop with wider spacing S₂ (30 x 30 cm) and minimum duration of flowering (18.73 days) recorded in June,16 planted crop when the crop was planted at closer spacing S₁ (30 x 20 cm) from plant to plant and row to row.

Table 15: Effect of planting dates and spacing on the duration of flowering (days) of French marigold Sel. ‘FM 786’

Planting Dates \ Spacing	Duration of flowering (days)		
	S ₁ (30 x 20 cm)*	S ₂ (30 x 30 cm)**	Mean
March,16	24.60	24.60	24.60
April,16	31.02	31.80	31.41
May,16	25.47	24.23	24.85
June,16	22.13	21.47	21.80
July,16	18.73	19.47	19.10
August,16	24.13	24.20	24.17
September,16	20.40	20.73	20.57
October,16	29.87	28.53	29.20
Mean	24.54	24.38	

*S₁=(30 cm from plant to plant and 20 cm from row to row)

** S₂=(30 cm from plant to plant and 30 cm from row to row)

CD_{0.05} for:

Planting dates	=	1.54
Spacing	=	NS
Planting dates x Spacing	=	NS

4.2.7 Number of flowers per plant

The results pertaining to number of flowers per plant of French marigold Sel. 'FM 786' are presented in Table 16. The perusal of data presented in the given table and corresponding analysis of variance in Appendix III revealed the significant differences in number of days for bud formation due to the different planting dates.

Among different planting dates, March planted crop recorded significantly maximum number of flowers per plant (63.57) which was followed by April,16 planted crop (36.67 cm). In contrast, minimum number of flowers per plant (12.53) was recorded in May,16 planted crop and was found to be statistically similar with October,16 planted crop.

Though there was non-significant difference on the number of flowers between two spacing, S₁ and S₂ (Appendix III), the more number of flowers per plant (26.88) was obtained at the wider spacing S₂ (30 x 30 cm) as compared to the number of flowers (26.07) recorded at closer spacing S₁ (30 x 20 cm) from row to row.

Table 16: Effect of planting dates and spacing on the number of flowers per plant of French marigold Sel. 'FM 786'

Planting Dates \ Spacing	Number of flowers per plant		
	S ₁ (30 x 20 cm)*	S ₂ (30 x 30 cm)**	Mean
March,16	62.73	64.40	63.57
April,16	36.93	36.40	36.67
May,16	12.27	12.80	12.53
June,16	24.97	25.73	25.35
July,16	16.40	19.13	17.77
August,16	27.80	23.87	25.83
September,16	15.93	19.13	17.53
October,16	11.53	13.53	12.53
Mean	26.07	26.88	

*S₁=(30 cm from plant to plant and 20 cm from row to row)

** S₂=(30 cm from plant to plant and 30 cm from row to row)

CD _{0.05} for:

Planting dates	=	4.16
Spacing	=	NS
Planting dates x Spacing	=	NS

The effect of interactions between the planting dates and spacing on the number of flowers per plant was also found statistically non-significant (Appendix III). However, maximum flowers number per plant (64.40) were obtained when the planting was accomplished in 16th of March with spacing S₂ (30 x 30 cm) whereas, minimum number of flowers per plant (11.53) was recorded in October,16 planted crop with spacing S₁ (30 x 20 cm) from plant to plant and row to row.

4.2.8 Weight of flowers per plant (g)

An acquisition of data in Table 17 shows the effect of planting dates and spacing on the weight of flower per plant of French marigold Sel. 'FM 786'. The perusal of data revealed that the different planting dates exhibited significant effect on duration of flowering.

It is apparent from the table that among different planting dates, March,16 planted crop resulted in maximum flower weight per plant (151.73 g) which was found to be highly significant over all other treatments. There was significant reduction in weight of flower per plant with every planting dates after 16th of March except between April,16 and May, 16, and July,16 and August,16 plantings. Minimum flower weight per plant (23.70 g) was recorded in October,16 planted crop which was statistically at par with the planting of July,16 (30.80 g), September,16 (31.80 g) and October,16 (31.80 g).

As regard the spacing, the weight of flowers per plant was not significantly affected by the spacing, S₁ and S₂ (Appendix III). However, more flower weight per plant (58.42 cm) was recorded at wider spacing S₂ (30 x 30 cm) as compared to minimum weight of flowers (26.07g) observed at spacing S₁ (30 x 20 cm) from row to row.

The effect of interaction between the planting dates and spacing on the weight of flowers per plant was also found non-significant (Appendix III). However, maximum weight of flowers per plant (58.65g) was recorded from March,16 planted crop with wider spacing S₂ (30 x 30 cm) whereas, minimum

weight of flowers per plant (19.87 g) was recorded in May,16 planted crop at closer spacing S₁ (30 x 20 cm) from plant to plant and row to row .

Table 17: Effect of planting dates and spacing on weight of flower per plant (g) of French marigold Sel. ‘FM 786’

Planting Dates \ Spacing	Weight of flower per plant (g)		
	S ₁ (30 x 20 cm)*	S ₂ (30 x 30 cm)**	Mean
March,16	144.80	158.65	151.73
April,16	94.27	92.07	93.17
May,16	20.80	19.87	20.33
June,16	59.73	60.20	59.97
July,16	29.13	32.47	30.80
August,16	45.13	41.87	43.50
September,16	27.47	36.13	31.80
October,16	22.73	24.67	23.70
Mean	55.51	58.24	

*S₁=(30 cm from plant to plant and 20 cm from row to row)

** S₂=(30 cm from plant to plant and 30 cm from row to row)

CD_{0.05} for:

Planting dates	=	15.33
Spacing	=	NS
Planting dates x Spacing	=	NS

4.2.9 Flower yield per square meter

The results pertaining to flower yield per sq. m. of French marigold Sel. ‘FM 786’ are presented in Table 18. The perusal of data presented in the given table and corresponding analysis of variance in Appendix III revealed the significant differences in flower yield per sq. m. due to the different planting dates, spacing and their interactions.

In general, among different planting dates, maximum flower yield per square meter (1999.55 g) in March,16 planted crop which was found statistically at par with April,16 planted crop (1116.37 g). There was significant reduction in the flower yield per square meter with every planting date after March,16 except between May,16 and June,16, and July,16 and August,16 plantings. In contrast, minimum yield of flower per square meter (244.07 g) was recorded in May,16 planted crop which was found statistically at par with July,16 (348.30 g) September,16 (339.20 g)and October,16 (279.68 g) planted crop.

It is evident from the data that spacing exhibit significant effect on the flower yield per square meter number of days for bud formation (Appendix III). Among spacing, higher yield per sq. m (843.25 g) was obtained from closer spacing S₁ (30 x 20 cm) as compared to the flower yield (574.16 g) recorded when planting was done at wider spacing S₂ (30 x 30 cm) from row to row.

Table 18: Effect of planting dates and spacing on flower yield per square meter (g) of French marigold Sel. 'FM 786'

Planting Dates \ Spacing	Flower yield per sq. m		
	S ₁ (30 x 20 cm)*	S ₂ (30 x 30 cm)**	Mean
March,16	2172.00	1827.10	1999.55
April,16	1414.00	818.73	1116.37
May,16	312.00	176.13	244.07
June,16	1076.00	555.13	815.57
July,16	404.40	292.20	348.30
August,16	677.00	376.80	526.90
September,16	353.20	325.20	339.20
October,16	337.40	221.97	279.68
Mean	843.25	574.16	

*S₁=(30 cm from plant to plant and 20 cm from row to row)

** S₂=(30 cm from plant to plant and 30 cm from row to row)

CD_{0.05} for:

Planting dates = 218.47

Spacing = 80.33

Planting dates x Spacing = 227.20

Interaction between planting dates and spacing also exhibit significant effect on the flower weight per square meter (Appendix III). In general, maximum flower yield per sq. m (2172.00g) was obtained in March,16 planted crop with closer spacing S₁ (30 x 20 cm) from plant to plant and row to row. In contrast, minimum flower yield (221.97 g) was recorded in October,16 planted crop at wider spacing S₂ (30 x 30 cm) followed by July,16 planted crop (292 .20 g) with the same spacing.

Chapter-5

DISCUSSION

Experimental results obtained during the course of the investigation to elucidate the effect of planting dates and spacing on growth and flowering of marigold have been presented in the preceding chapter.

In this chapter, an attempt has been made to examine and critically evaluate the data computed on some important observations in terms of cause and effect relationship of planting time and plant density on growth and flowering of marigold for commercialization. In the present investigation, both African as well as French marigold were planted on eight different dates at monthly intervals from March, 2010 to October, 2010 with different spacing i.e., (45 x 30 cm) and (45 x 40 cm) for African marigold and (30 x 20 cm) and (30 x 30 cm) for French marigold, respectively. The experiment was conducted under mid hill conditions of Solan-Nauni area to find out the most suitable planting time and spacing of marigold vis a vis to see their effect on flower regulation. Various vegetative and flowering parameters were observed to assess quality and quantity of produce along with the regulation of flowering.

The results obtained have been discussed in this chapter in the light of available literature and classical knowledge.

5.1 Plant height (cm)

In African marigold cv. 'Pusa Narangi Gaiinda', maximum plant height was obtained in April planting followed by March planting, irrespective of the spacing. This might be due to the availability of congenial growing conditions for growth of marigold plants during March-June and subsequently the plants could put up more vegetative growth.

However, shorter plants were produced when planting was commenced in October followed by September, July and August. This may be ascribed to the

unfavourable temperature for the growth of plants during September and October and experiencing of heavy rains particularly for July planted plants. These results are in confirmation with the findings of Chanda and Roychoudhary (1991). They observed that planting between March and June, in general, showed higher growth of the plant as compared with planting between September to October.

In French marigold Sel. 'FM 786', maximum plant height was recorded in June planting followed by May planting. The plants of May and June plantings got exposure to considerably longer day lengths and higher temperatures and hence, higher temperature cause elongation of internodes so the plants grew taller. The results are in close conformity with the findings of Raju *et al.* (2006). Whereas, the shorter plants were produced when planting was done in October. This may be ascribed to the season that October planted crop could not get the requisite temperature for its vegetative growth and hence resulted in the stunted growth.

Similar results have also been obtained in other floricultural crops. Ditta *et al.* (2007) also reported more plant height in all the cultivars of China aster (*viz.*, Kamini, Poornima, Shashank and Violet Cushion) when planted in April under Bhotia (Hamirpur) conditions.

5.2 Plant spread (cm)

The plant spread was significantly influenced by planting dates and spacing in both types of marigold. The maximum plant spread in African marigold cv. 'Pusa Narangi Gaiinda' was observed in May planting. This might be due to favourable growing conditions which have resulted in luxuriant growth of the plants. Similar results were observed by Nair *et al.* (1985) and Mohanty *et al.* (1993).

Maximum plant spread was observed in wider spacing of 45 x 40 cm followed by 45 x 30 cm. This might be due to the availability of more space for growth of roots and shoots as well as utilization more nutrients by the plants. (Singh and Arora, 1988; Bhati and Chitkara, 1987; Maiti, 1987 and Chanda and Roychoudhary, 1991). Similar trends in the reduction of plant spread with the

closer spacing had also been reported by Dhemre et al. (1998) in China aster cv. 'White Powder Puff'.

In case of French marigold Sel. 'FM 786', maximum plant spread was recorded in June planting followed by April planting. It may be due to congenial growing environment that led to more vegetative growth besides the delay in bud initiation and flowering as well. Therefore, higher temperature promotes vegetative growth and delay flowering in marigold. The results are in conformity with the findings of Raju *et al.* (2006).

5.3 Days taken to bud formation

In African marigold cv. 'Pusa Narangi Gainda', the maximum time for bud formation was recorded in May planting whereas, minimum numbers of days to bud formation were observed in October planting. The reason might be that long day conditions experienced by the May plants produced more vegetative growth and hence flowering was delayed. Whereas, during October onwards, there were short days conditions that resulted in the formation of flower buds in lesser time period. These results corroborate the findings of Singh and Arora, (1988) and Samantaray *et al.* (1999) who observed that apical flower- bud formation was hastened in marigold plants when planted after September and before March mainly due to short day conditions.

Similarly, in French marigold Sel. 'FM 786', May planting has took the maximum time for flower bud initiation and minimum number of days for bud initiation was recorded in October planting. This might be due to the occurrence of long days available for May planted crop and shortening in days length when planting was commenced in October that results in early bud initiation. The results are in accordance with the findings of Raju *et al.* (2006).

5.4 Days taken to flowering

In African marigold cv. 'Pusa Narangi Gainda' earliest flowering was observed in October planting followed by September and March planting whereas, maximum number of days for flowering was recorded in July planting.

The reason might be that plants grown under October planting experienced short day conditions resulted in less vigorous plants which entered the reproductive phase within a short time. Therefore, the development of flower buds into full bloom stage took less time. However, crop planted during June-July was exposed to long day conditions which produced more vegetative growth and hence flowering was delayed.

These results are in close conformity with the findings of Singh and Arora, (1988) and Mohanty *et al.* (1993) who observed that flowering of marigold was hastened when planted after September and before March. However, in May planted crop, copious raining and high relative humidity during August–September caused rotting of flower buds and ultimately buds failed to bloom. Similar results have also been obtained by El-Gamassy *et al.* (1965) in *Tagetes erecta*, *Zinnia elwgans* and *Cosmos sulphureus*.

Plants under wider spacing (45 x 40 cm) were found to flower late than planted at a spacing of 45 x 30 cm (Chanda and Roychoudhary, 1991).

Similarly, in French marigold Sel. 'FM 786', July planting recorded maximum number of days for flowering and October planting had taken minimum number of days for flowering. This might be due to occurrence of long days during May-June which delayed flowering, whereas, shortening in day length during October has resulted in early flowering (Raju *et al.*, 2006).

5.5 Flower size (cm)

Flower size of African marigold cv. 'Pusa Narangi Gainda' was significantly influenced by planting dates, whereas, effect of spacing and the interactions between spacing and planting dates on flower size was found to be non-significant.

The maximum flower size was attained in September planting followed by August and July planting whereas; minimum flower diameter was recorded in October planting. Moderate temperature prevailing during the crop period might have been become favourable for the production of bigger size flowers in

September and July planted crops. Plants under October planting were less vigorous and entered the reproductive phase within a short time, besides, the development of flower buds to full bloom stage also took less time.

This finding is in consonance with Singh and Arora, 1988; Chanda and Roychoudhary (1991); Mohanty *et al.* (1993).

5.6 Duration of flowering (days)

Maximum duration of flowering was recorded in April planting and minimum duration was recorded when crop was planted in the month of October. This might be due to the optimal climatic conditions during its vegetative as well as flowering stage available for crop planted in April. Whereas, October planted crop could not experience congenial environment conditions hence exhibited lesser duration of flowering under Nauni Solan conditions. Chanda and Roychoudhary (1991) also reported similar findings.

However, plant spacing and the interactions between planting dates and spacing showed very little variation in days required for longevity of flowers.

5.7 Number of flowers per plant

In the present experiment, planting dates showed significant effect on number of flowers per plant. Maximum number of flowers per plant was obtained from March planting for both African as well as French marigold and minimum number of flowers per plant was recorded in October planting in case of African marigold cv. 'Pusa Narangi Gainda' and October and May planting in French marigold Sel. 'FM 786', respectively. This might be due to the reason that March planted crop could have put more vegetative growth that have produced more number of flower bud which ultimately contributed for more yield in both types of marigold.

The spacing had also influenced the number of flowers per plant. African marigold cv. 'Pusa Narangi Gainda' recorded maximum number of flowers per plant in wider spacing of 45 x 40 cm as compared to closer spacing of 45 x 30 cm. Similarly, in French marigold Sel. 'FM 786', maximum number of flowers

per plant was recorded in wider spacing of 30 x 30 cm than the closer spacing (30 x 20 cm). This might be due to the reason that at wider spacing, plants grew more luxuriantly by uptaking nutrients and so could spread largely than as compared to the plants grown at closer spacing where there was less availability of nutrients and space. Therefore, the maximum number of flowers per plant could be attributed to the increase in plant spread and number of branches. It was also observed that with the increase in plant density the number of flowers per plant decreased significantly. Chanda and Roychoudhary (1991) reported the similar results for marigold.

5.8 Weight of flower per plant (g)

The weight of flowers per plant has been influenced by various planting dates and spacing. In African marigold cv. 'Pusa Narangi Gainda', weight of flowers per plant was recorded maximum in April planting followed by March planting and minimum weight of flowers per plant was obtained from October planting. In French marigold Sel. 'FM 786', maximum flower weight per plant was observed in March planting and minimum weight of flower per plant was recorded in May planting.

This could be attributed to the existence of congenial climatic conditions during the crop growth period and enabled them to produce increased amount of photosynthates and intern resulted in more dry matter accumulation. Whereas, due to unfavourable climatic conditions existed during the July-September planted crops, it failed to produce optimum vegetative growth and better flowering. Similar variation was also observed by Guruprasad (1999) and Nagarjun *et al.* (2004).

The spacing had also influenced the flower yield and maximum yield of flowers per plant was recorded under wider spacing in African marigold cv. 'Pusa Narangi Gainda' whereas French marigold Sel. 'FM 786' could yield more when planted at closer spacing. This might be due to the difference in the response genotypes to the growing environment as well as their growth habit.

The reason for maximum yield per plant might be due to more spreading of plant and production of more secondary branches which resulted in the conversion of more number of vegetative buds into flower buds and hence increased the yield. Favourable conditions like availability of more nutrients, sunlight and soil moisture to individual plant at wider spacing might have increased the flower yield (Rao *et al.*, 1992). Thus, the findings of present study are in conformity with the work of Ravindran *et al.* (1986) and Mohanty *et al.* (1993).

5.9 Flower yield per sq. m

The flower yield per sq. m has been influenced by various planting dates and spacing. In African marigold cv. 'Pusa Narangi Gaiinda', flower yield per sq. m was recorded maximum in April planting followed by March planting when planted at closer spacing of 45 x 30 cm and minimum weight of flowers per plant was obtained from October planting with wider spacing (45 x 40 cm). Similarly in French marigold Sel. 'FM 786', maximum flower yield per sq. m was observed in March planting with closer spacing of 30 x 20 cm and minimum in May planting when crop was planted at wider spacing of 30 x 30 cm.

The reason for maximum yield per sq. m might be due to more number of plants per unit area accommodated at the closer spacing which led to increased yield per unit area. These results are in close conformity with the findings of Ravindran *et al.* (1986); Bhati and Chitkara, 1987 and Mohanty *et al.* (1993)

Chapter-6

SUMMARY AND CONCLUSION

“Effect of planting dates and spacing on the growth and flowering of marigold” were carried out at the experimental farm of Department of Floriculture and landscaping of Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, H.P. during 2010. Experiment on eight different planting dates of African marigold cv. ‘Pusa Narangi Gaiinda’ and French marigold were laid out separately in open field. Experiment was comprised of four spacing, viz., 45 x 30 cm and 45 x 40 cm for African marigold and 30 x 20 cm and 30 x 30 cm for French marigold, respectively.

The results obtained are summarized below:

- In African marigold cv. ‘Pusa Narangi Gaiinda’, maximum plant height (126.58 cm) was recorded in April planting as compared to other planting dates. However, plant height was not affected by spacing and the interaction between planting dates and spacing.

Similarly, in French marigold Sel. ‘FM 786’, maximum plant height (64.50 cm) was recorded in June planting. In case of spacing, maximum plant height (42.11 cm) was obtained with spacing S₂ (30 x 30 cm). Whereas, among interaction, maximum plant height (65.19 cm) was recorded in May planting with S₂ (30 x 30 cm).

As regards the plant spread, in case of African marigold, maximum plant spread (54.58 cm) was attained in May planting. The effect of spacing on plant spread was found to be non-significant. However, among interactions, maximum plant spread was observed with spacing S₁ (45 x 30 cm) when planting was accomplished in May.

In case of French marigold Sel. ‘FM 786’, maximum plant spread (47.90 cm) was attained in June planting. However, the effect of spacing on plant spread

was found to be significant. Whereas, in case of interactions, June planting with spacing S₂ produced maximum plant spread (50.88 cm).

- Minimum number of days taken to bud formation (42.33 days) were recorded in October planting of African marigold cv. 'Pusa Narangi Gainda' whereas, maximum number of days for bud formation (103.62 days) was observed in May planting. However, spacing and interactions did not affect the number of days for bud formation. However, in French marigold, planting dates, spacing as well as interactions between planting dates and spacing had non-significant effect on the number of days for bud formation.

Minimum number of days for bud formation (23.00 days) was registered in October planting and maximum number of days (104.07 days) in May planting. Maximum time for bud formation (52.65 days) was observed at wider spacing S₂ (30 x30 cm) as compared to closer spacing S₁. Among interactions, May planting took maximum number for bud formation (104.73 days) with spacing S₁ (30 x 20 cm) and minimum number for bud initiation (22.47 days) was recorded in October planting with spacing S₁ (30 x 20 cm).

- In case of African marigold cv. 'Pusa Narangi Gainda', earliest flowering (68.86 days) was recorded in October planting, whereas, July planting took maximum number of days for flowering (105 days). However, spacing as well as interaction did not show any significant effect on the days taken to flowering.

In case of French marigold, minimum number of days for flowering (41.20 days) was recorded from October planting where as in case of spacing, maximum number of days for flowering (72.21 days) was recorded in S₂ (30 x 30 cm). Among interactions, minimum number of days (41.20 days) were recorded for flowering in both the spacing (S₁ and S₂) when the crop was planted in October.

- African marigold cv. 'Pusa Narangi Gainda' maximum flower size (5.17 cm) was recorded in September planting. Whereas, the effect of spacing and the interactions on flower size was found to be non-significant.

In case of French marigold Sel. 'FM 786', maximum flower size (4.37 cm) was recorded with April planting July planting recorded minimum flower size (3.16 cm). Non significant effect was found within the spacing. However, among interactions, maximum size of flower (4.44 cm) was obtained in April planting with S₂ (30 x30 cm).

- Among African marigold cv. 'Pusa Narangi Gainda', duration of flowering was maximum (30.17 days) in April planting and minimum duration for flowering (19.57 days) was recorded in October planting whereas, spacing and the interactions produce non-significant effect on the duration of flowering

In case of French marigold, maximum duration of flowering (31.41 days) was recorded with April planting, whereas, minimum duration of flowering (19.10 days) was observed in October planting. Effect of spacing and their interaction exhibited non-significant effect on the duration of flowering of French marigold Sel. 'FM 786'.

- In African marigold, maximum number of flowers per plant (34.67) was recorded in March planting and minimum number of flowers per plant (8.67) was found in October planting. However, the effect of spacing and interactions produce non-significant effect on the number of flowers per plant.

In French marigold Sel. 'FM 786', March planting recorded maximum number of plants per plant (63.57) whereas, minimum number of flowers (12.53) was observed in May and October planting. The effect of spacing and interactions on the number of flowers per plant was found to be non-significant.

- In case of African marigold cv. 'Pusa Narangi Gainda', maximum weight of flowers per plant (142.15 g) was observed in April planting and minimum weight of flowers per plant was recorded in October planting. As regards with the effect of spacing, the weight of flowers per plant was not significantly affected by spacing. However, among interactions, maximum flower weight per plant (152.67 g) was recorded in April planting with spacing S₂ (45 x 30 cm) and minimum flower weight (43.33 g) with spacing S₁ (45 x 30 cm).

In French marigold, maximum flower weight per plant (151.73 g) was recorded in March planting and minimum flower weight per plant (23.70 g) was recorded in October planting. However, effect of spacing and their interaction exhibited non-significant effect on the weight of flowers per plant.

CONCLUSION

Marigold is considered one of the major flower crops of Himachal Pradesh occupying 240.3 ha area. Marigold flowers are generally sold for making flowers garlands mostly in plains of India.

- The present investigations on planting dates and spacing revealed that African marigold cv. 'Pusa Narangi Gainda' gave the longest flowering duration and flower yield when the planting was done on 16th of April with closer spacing of 45 x 30 cm. Whereas, maximum flower size was obtained in September planted crop.
- In French marigold Sel. 'FM 786', March planting recorded maximum number of flowers per plant and flower yield when planted at closer spacing of 30 x 20 cm. However, maximum size of flower was recorded in April planted crop.

Chapter-7

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No. of pages in Thesis : 59+III
No. of words in Abstract : 196

ABSTRACT

The present piece of research entitled “Effect of planting dates and spacing on growth and flowering of marigold” was carried out at experimental farm of Department of Floriculture and Landscaping, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) during March, 2010-December, 2010. The experiment was laid out in split plot design comprising of eight different planting dates on African marigold with two spacing, (viz., 45 x 30 cm and 45 x 40 cm) and French marigold with two spacing, (viz., 30 x 20cm and 30 x 30 cm) at monthly intervals from mid March, 2010 to mid October, 2010. In case of African marigold cv. ‘Pusa Narangi Gaiinda’, maximum flower size was recorded for September planted crop and maximum number of flowers per plant was observed in March planted crop. However, April planting gave best results for plant height and flower yield at a closer spacing of 45 x 30 cm. In French marigold Sel. ‘FM 786’, maximum plant height and flower size was recorded in April planted crop, whereas, March planting recorded maximum number of flowers per plant and flower yield when planted at closer spacing of 30 x 20 cm.

Signature of the Major Advisor

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APPENDIX-I

Meteorological data observed during the year 2010

Month	Temperature (⁰ C)			Relative humidity (%)	Rainfall (mm)
	Max	Min	Mean		
March	26.8	9.3	18.1	49.2	1.0
April	31.8	13.8	22.8	41.4	2.7
May	32.5	16.3	24.4	43.2	48.2
June	39.3	18.3	28.8	54.4	168.8
July	27.7	20.5	22.4	82.0	484.6
August	27.7	20.2	24.0	82.4	171.4
September	26.8	17.3	22.1	82.2	346.6
October	27.0	10.5	18.75	61	41.7
November	24.4	6.1	15.25	56	28.8
December	19.9	1.2	10.55	58	70.2

Source: Meteorological Observatory, Department of Soil Science and Water Management, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (H P) – 173230 INDIA

APPENDIX-II

Analysis of Variance (ANOVA)

Analysis of variance for characters under study as influenced by planting dates and spacing

Source of variance	df	Character mean sum of square		
		Plant height	Plant spread	Days taken to bud formation
Replication	2	557.6804	1007147	64.54094
Planting dates	7	7910.865*	8141205*	2209.086*
Main plot error	14	29.82521	53042.72	3.529401
Spacing	1	133.2	3429.517	0.136533
Planting dates x Spacing	7	61.38033	76322.55*	2.215224
Error	16	33.43013	23700.84	2.274744

* Significant

Analysis of variance for characters under study as influenced by planting dates and spacing

Source of variance	df	Character mean sum of square					
		Days taken to flowering	Size of flower	Duration of flowering	Number of flowers per plant	Weight of flower per plant	Weight of flower per sq. m
Replication	2	9892.543	0.556688	8.58375	44.80381	1154.199	28789.29
Planting dates(D)	6	8132.633*	0.222716*	83.69728*	562.8152*	10088.83*	248458.7*
Main plot error	12	9000.961	0.043758	0.089306	2.650476	85.97209	2548.078
Spacing	1	9090.486	0.058688	0.352917	0.034286	17.12649	344243.9*
Planting dates x Spacing	6	9092.27	0.052283	1.256806	3.892063	281.3816*	13111.26*
Error	14	9095.565	0.021733	0.40875	2.375238	46.93801	1846.834

*Significant

APPENDIX-III

Analysis of Variance (ANOVA)

Analysis of variance for characters under study as influenced by planting dates and spacing

Source of variance	df	Character mean sum of square								
		Plant height	Plant spread	Days taken to bud formation	Days taken to flowering	Size of flower	Duration of flowering	Number of flowers per plant	Weight of flower per plant	Weight of flower per sq. m
Replication	2	56.32011	414243.9	29.90271	19.05583	0.352638	14.95376	132.0502	886.707	187049.2
Planting dates	7	1925.856*	3986797*	3878.172*	3528.229*	1.007187*	104.5439*	1736.458*	12211.64*	2179985*
Main plot error	14	1.049854	25122.15	2.353185	0.790119	0.014945	1.159526	11.31021	153.1493	31119.71
Spacing	1	21.58742*	2844.688	4.260208*	4.6875*	0.025025	0.325052	7.760208	89.54403	868923.9*
Planting dates x Spacing	7	8.036457*	98240.92*	5.534494*	2.434167*	0.028978*	1.027195	7.702113	51.16689	64413.3*
Error	16	1.730002	12713.28	0.402708	0.308333	0.010431	0.43539	2.511875	21.89103	17228.35

*Significant

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