# IMPACT OF SEASONS AND PINCHING ON GROWTH AND FLOWERING IN AFRICAN MARIGOLD (*Tagetes erecta* L.)

**SRUTHI PRAKSH.N**

**(2013 - 12 – 116)**

**DEPARTMENT OF POMOLOGY AND FLORICULTURE**

**COLLEGE OF AGRICULTURE**

**PADANNAKKAD, KASARAGOD 671 314**

**KERALA, INDIA**

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# IMPACT OF SEASONS AND PINCHING ON GROWTH AND FLOWERING IN AFRICAN MARIGOLD (*Tagetes erecta* L.)

**by**

**SRUTHI PRAKASH.N**

**(2013 - 12 - 116)**

**THESIS**

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**DEPARTMENT OF POMOLOGY AND FLORICULTURE**
**COLLEGE OF AGRICULTURE**
**PADANNAKKAD, KASARAGOD – 671 314**
**KERALA, INDIA**

**2015**

## DECLARATION

I, hereby declare that this thesis entitled **"Impact of seasons and pinching on growth and flowering in African marigold (*Tagetes erecta* L.)"** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Padannakkad **Sruthi Prakash. N**

Date: 29-10-2015 (2013 -12-116)

## CERTIFICATE

Certified that this thesis entitled **"Impact of seasons and pinching on growth and flowering in African marigold (*Tagetes erecta* L.)"** is a record of research work done independently by Ms. Sruthi Prakash.N under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

Padannakkad
Date: 29-10-2015

**Dr. P.Anitha**
(Chairman, Advisory Committee)
Associate Professor,
Dept. of Plantation crops and Spices
College of Horticulture, Vellanikkara

## CERTIFICATE

We, the undersigned members of the advisory committee of Ms. Sruthi Prakash. N, a candidate for the degree of **Master of Science in Horticulture** with major in Pomology & Floriculture agree that the thesis entitled **"IMPACT OF SEASONS AND PINCHING ON GROWTH AND FLOWERING IN AFRICAN MARIGOLD (*Tagetes erecta* L.)"** may be submitted by Ms. Sruthi Prakash. N, in partial fulfilment of the requirement for the degree.

**Dr. P. Anitha**
(Chairman, Advisory Committee)
Associate Professor
Dept. of Plantation crops and Spices
College of Horticulture, Vellanikkara

**Dr. A. Rajagopalan**
(Member, Advisory Committee)
Professor & Head
Department of Pomology and Floriculture,
College of Agriculture
Padannakkad

**Dr. A.V. Meera Manjusha**

(Member, Advisory Committee)
Assistant Professor (Hort.)
RARS, Pilicode

**Dr. G.V. Sudarsana Rao**

(Member, Advisory Committee)
Associate Professor (Pl.Phy)
College of Agriculture, Padannakkad,

**EXTERNAL EXAMINER**

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**Sruthi Prakash.N**

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## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| % | - | Per cent |
| $^0$C | - | Degree Celsius |
| BCR | - | Benefit cost ratio |
| CD | - | Critical difference |
| cm | - | Centimetre |
| $cm^2$ | - | Square centimetre |
| *et al* | - | And others |
| Fig. | - | Figure |
| g | - | Gram |
| $ha^{-1}$ | - | Per hectare |
| Kg | - | Kilogram |
| Kg/ha | - | Kilogram per hectare |
| MAP | - | Months after planting |
| NS | - | Not significant |
| Rs. | - | Rupees |
| t $ha^{-1}$ | - | Tonnes per hectare |
| SCMR | - | Spad chlorophyll meter reading |

# INTRODUCTION

# 1. INTRODUCTION

Marigold is one of the most important annual flower crops cultivated commercially in India. It belongs to the family Asteraceae and genus Tagetes. The two main popularly grown species in marigold are *Tagetes erecta* and *Tagetes patula*, which have their origin in Mexico. *Tagetes erecta* is popularly known as "African marigold" while *Tagetes patula* as "French marigold". There are several other important species viz., *T.tenuifolia* (the striped marigold), *T.lucida* (the sweet scented marigold), *T.minuta* and *T.lacera.* Compared to other flowering annuals marigold is adaptable to wide agro climatic conditions and has fairly good keeping quality. It is propagated by seeds and comes up well in all types of soil. It is hardy annual plant attains more than 150 cm height within four to four and half months. The flowers of these species are generally large in size with bright shades, ranging from yellow to orange and are the best combination in any flower arrangement.

Marigold is commercially grown for cut flower, garlands, and wreath and has exclusive use in religious and ceremonial functions. Apart from its significance in ornamental horticulture it has been valued for other purposes too. The aromatic oil extracted from marigold, is called as "Tagetes oil". It is used for the preparation of high grade perfumes and also as insect repellent. Marigold is useful for suppressing the population of nematodes in the field. The coloured pigment extracted from its flower is used in poultry feed in order to improve the colour of egg yolk as well as broiler's skin. Wild marigold *T.minuta* is grown for extraction of superiour quality oil having medicinal properties. Flower extract have dietary carotenoids which are good blood purifier, used to treat cancer and other skin diseases. Lutein is a carotenoid pigment found mainly in marigold flower. After harvesting, flowers are silaged, dried and extracted to get lutein. Presently, its use is increasing worldwide because natural lutein is a nutritional supplement which protects skin from sun damage, prevents low density lipid cholesterol from oxidising and possesses lower risks of heart diseases. It inhibits cancer formation in various parts of body such as lung, prostrate, ovary and

breast. Lutein also prevents clogging of arteries, delays lung ageing, reduce arthritis and protect eyes by decreasing night blindness and increasing vision ability (Singh and Larky, 2006).

In India about 1,82,900 ha of area are under floriculture and marigold occupies nearly two thirds of this area. The annual production of loose flower in India is 10,20,600 million tonnes. Major states growing marigold are Karnataka, Tamil Nadu, Andhra Pradesh, West Bengal and Maharashtra. It's being produced in several other states like Himachal Pradesh, Punjab, Haryana, Rajasthan, and Uttar Pradesh ICAR (2011).

In Kerala, marigold flower have steady demand throughout the year for its use as loose flower and has huge demand during festival seasons especially Onam. But commercial cultivation in Kerala is quite low due to lack of awareness on agro techniques of the crop and scarcity of open space. In order to popularize marigold cultivation in the state of Kerala, a tested package of practices need to be developed which can be adopted by farmers.

Among the various factors that influences plant growth and development, climatic condition play an important role. It should be exposed to optimum climatic conditions during the growing period so as to get maximum flower yield. Planting during different seasons will bring about variation in growth, flowering, yield and quality of flowers due to climatic variations.

Pinching is one of the most important management practices deciding productivity of marigold. Pinching is the removal of shoot tip along with two to three opened leaves. Pinching can be helpful in achieving the twin objective of proper plant spread and more number of flowers per plant. In the case of African marigold, plants initially grow straight upward to its maximum height and later develop primary branches, which also bear flowers. Early removal of terminal portion of main shoot promotes production of large number of primary branches resulting in well spread

bushy plant and more number of good quality flowers.

In this context, the present study was undertaken with the following objectives.

1) To study the effect of planting seasons on growth, flower yield and post harvest longevity of African marigold.

2) To study the effect of pinching on growth, flower yield and post harvest longevity of African marigold.

# *REVIEW OF LITERATURE*

# 2. REVIEW OF LITERATURE

Marigold is an important annual flower crop commercially cultivated in India. It is used for making garlands and as cut flower. It is also used for floral decoration and in landscape due to its attractive flowers and wide spectrum of colours. In Kerala, there is high demand for marigold flowers during festive seasons like Onam and social functions like marriages. Since our production is very meager, the requirement is met from neighbouring states.

The investigation entitled "Impact of seasons and pinching on growth and flowering in African marigold (*Tagetes erecta* L.)" was under taken during the period from October 2013 to April 2015 at the College of Agriculture, Padannakkad, Kasaragod (Dt). The objective of the study was to investigate the effect of seasons and pinching on growth, flower yield and post harvest longevity of African marigold.

Growth and flowering in African marigold is influenced by season and pinching. The available information on the effect of season on growth and flowering in African marigold is very limited and so far no such studies were conducted in Kerala, so also the information on the effect of pinching. Therefore, literature available on above aspects in marigold and closely related crops like China aster, Chrysanthemum, Gomphrena, Carnation and Gladiolus are reviewed here under and presented in this chapter.

## 2.1 EFFECT OF SEASONS ON GROWTH PARAMETERS AND FLOWERING

Among the various factors that influence plant growth and development, climatic conditions play an important role in the performance of crops. They should be exposed to optimum climatic conditions during the growing period, so as to get maximum production of quality flowers. Difference in planting season will bring about variation in growth, flowering, yield and quality of flowers.

Tsukamoto *et al*., (1971) reported that influence of short day conditions varies with species. The maximum requirement for short days is exhibited by *T.tenuifolia* and the minimum by *T.erecta* while *T.patula* appears to be intermediate in response. They also reported that photoperiod conditions not only enhanced flowering in the main shoot but also in the secondary and tertiary shoots. Flower buds were formed under long days and short days at low temperatures but only in short days at high temperature. According to Gowda and Jayanti (1986) marigold sown in September gave the highest flower yield. Samantaray *et al*., (1999) reported that in marigold, May planting was not found beneficial as the plant continued vegetative growth for a longer period and the flower yield was very low in Bhubaneswar. On the contrary September planting was the best for maximizing the yield, closely followed by July planting. January and November plantings hastened the flower bud appearance. In marigold cv. Pusa Narangi Gainda, June planting was the best for maximum flower and seed yield. They also observed that the maximum flower production was recorded during September and October months, which coincide with short day lengths confirming that short day lengths are more congenial for flower bud induction and flowering. In the same study they observed March planting gave the highest plant dry matter but lower flower yield.

According to Rao and Reddy (2002) the number of days required for flower opening was reduced from August to February, because of short day lengths coupled with low light intensity. In African marigold, the number of days required to first flower opening was reduced from April to August sowing because of short day length coupled with low night temperature but the March sowing resulted in delayed flowering due to high variation in diurnal temperature, long day length coupled with low light intensity, frequent rains and cloudiness as reported by Rao and Moon (2003). According to Sreekanth *et al*., (2006) in marigold, October planting recorded the maximum flower diameter, yield per plant and yield per hectare. But maximum colour intensity was recorded in December planting. In marigold, seed germination,

seedling height, dry matter, vigour index, field emergence index and seedling establishment were greatest in spring planting as reported by More *et al*., (2006). Raju *et al.,* (2006) reported that in French marigold flower yield per plant was highest in June planting. But flower diameter and flower weight was higher at August planting. According to Ramesh and Singh (2008) planting dates had profound influence on growth and development of *Tagetes minuta*. Pramila *et al.,* (2011) reported that in marigold, plant height, number of primary branches, number of flowers per plant was maximum during kharif season. In French marigold, flower diameter, weight of fully opened flower, longevity of flower, length of flower stalk, yield per plant, yield per hectare were recorded maximum in July planting (Deshmane *et al*. 2012). Mohanty *et al*., (2012) reported that plant spread, number of leaves, primary and secondary branches per plant, flower diameter, flower number per plant as well weight of flowers per plot were greatest in November planted marigold. According to Ismail *et al*., (2013) in marigold, plant height, plant diameter, number of branches, fresh and dry yield of plant was significantly influenced by planting season and spacing. Lakshmi *et al*., (2014) observed that number of primary branches per plant, flower diameter, number of flowers per plant, flower yield per plant were higher in 1$^{st}$ October planting in African marigold.

Similar works in related crops are reviewed here under. According to Barman *et al*., (1993) bud appearance and flower yield had direct influence on planting dates in chrysanthemum cv. Chandrama. In chrysanthemum, Shinhakki and Choi (1996) observed that the number of axillary buds set on lateral shoot was the highest for rooted cuttings planted in December. Less number of branches was observed in June planting. Barman *et al*., (1997) reported that chrysanthemum cv. Chandrama showed significant variation in plant height, number of leaves, leaf area, length of flower stalk, number of flowers and individual flower weight according to planting season. July planting produced the greatest number of flowers with longest stems and also showed longest flowering season. According to Meher *et al*., (1999), chrysanthemum

showed maximum flower yield in May plantings and number of days for 50 per cent flowering was least observed in July planting. In chrysanthemum, April planting recorded optimum vegetative growth, more number of branches and leaf area as reported by Balaji and Reddy (2008). According to Aamir *et al*., (2009) in chrysanthemum, February planting resulted in increased plant height, more number of branches and leaves per plant. Pattanaik *et al*., (2010) reported that planting time had beneficial effect on plant height and flower bud appearance in chrysanthemum.

Similar informations are also available in china aster. According to Gowda (1990) in china aster, the maximum plant heights at flowering were obtained from July, August and September plantings, more number of leaves per plant were obtained from August and September plantings. He also reported that the longest time taken to reach 50 per cent flowering was observed in March planting. The maximum number of flowers per plant, maximum flower yield and the longest peduncle were obtained in July planting and the maximum flower diameter was obtained in August planting. Jane and Kawarkhe (2002) reported that in china aster, plant height, number of branches per plant, spread of plant, flower diameter, 100 flower weight and number of flowers per plant, stalk length and yield of flowers per plant were increased, where as the number of days required for bud initiation decreased in October planting. Date of planting of china aster had a direct influence on growth and flower yield. The tallest plants were obtained in September planting. But highest number of primary branches and secondary branches were obtained in November planting. Flower yields were highest in November and October planting in china aster as reported by Prasad and Reddy (2003). According to Kaushal *et al.,* (2014) seeds sown at 6$^{th}$ April gave best results for plant height, plant spread, number of flowering stems per plant, number of flowers per plant, and yield of flowers per stem in china aster. Likewise 5$^{th}$ June planting gave good flower size and vase life.

Studies on seasonal variation in flower yield of carnation were also reviewed. Verma and Sharma (2002) reported that in carnation, maximum plant height, stem

length, flowers per plant, and flower yield per square meter were recorded in October planted crop. They also reported that flower bud formation and flowering were earliest in February planted crop. Ditta *et al*., (2006) reported that in carnation, maximum plant height, stem length, and flower yield were recorded for crops planted in December. They also reported that flower bud formation and flowering were earliest in March planting whereas, December planting took maximum days for bud formation and flowering. According Ahsan *et al*., (2012) reported that in carnation, plant height, number of primary branches per plant, length of branches, number of leaves per plant, flower diameter and fresh weight of flower were showed best result in November planting.

Similar informations are available in gladiolus. Gladiolus showed maximum plant height, number of leaves, number of flowers per spike, floret length and number of corms per plant in September planting as reported by Dod *et al*., (1989). In gladiolus, plant height, days to spike emergence, days to first flower opening, floret size, floret longevity and spike length were significantly influenced by the planting season as reported by Shiva and Dadlani (2002). According to Sanjib and Taludkar (2002) earlier shoot emergence and first flower opening was observed in October planting in gladiolus. Salvi *et al*., (2003) reported that September planting produced greater plant height and higher number of cormels per plant in gladiolus. According to Nijasure and Ranpise (2005) planting of corms in October was found superior with respect to profuse growth, early flowering, better flower quality and higher spike yield under the agro climatic conditions of Maharashtra. Barzegar *et al*., (2006) reported that in gladiolus, tallest plant and highest corm yield was observed in May planting. According to Dalal *et al*., (2006) maximum plant height was observed in September planting in gladiolus. In gladiolus, sprouting percentage, number of leaves per plant, leaf area, plant height, diameter of corms and corms weight were greatest in February planting as reported by Ahamad *et al*., (2011). According to Rathod *et al*., (2011), October planting had significant influence on growth, flowering, quality and

yield characters of gladiolus. In gladiolus, sprouting, leaf area, number of days taken to flower emergence, number of florets per spike, length of spike, length of rachis, diameter of florets, weight of corms were significantly influenced by the planting season and growing conditions as reported by Mohammad *et al*., (2012). Growth, flowering and yield of gladiolus were significantly influenced by planting season as reported by Badge *et al.,* (2013). According to Adil *et al*., (2013) in gladiolus, different planting dates had significant effect on number of days taken for corm germination.

According to Sharma *et al*., (2007) in tuberose, April planting resulted in increased vegetative growth, yield and floral characters.

## 2.2 EFFECT OF PINCHING ON GROWTH PARAMETERS AND FLOWERING

Pinching is one of the most important management practices deciding the productivity of marigold crop. Pinching is the removal of terminal portion of stem along with two to three opened leaves. Pinching can be helpful in achieving the twin objective of proper plant spread and maximum flowering. In the case of African marigold, plants initially grow straight upward to its maximum height and later develop primary branches on the main stem, which also bear flowers. Early removal of terminal portion of main shoot promotes production of large number of primary shoots resulting in well spread bushy plant and more number of good quality flowers. Marigold is not commercially cultivated in Kerala. As such research result on effect of pinching in marigold in Kerala is not available.

Arora and Khanna (1986) reported that in marigold, pinching 20 days after transplanting resulted in maximum reduction in plant height and produced less number of branches per plant compared to pinching at 40 days after transplanting. Bhati and Chitkara (1987) reported that plant height was significantly reduced by pinching but number of flowers was increased in marigold. Khandelwal *et al*., (2003) reported that in marigold, number of branches per plant, stem diameter were high

with early pinching than late pinching. In African marigold pinching at 30 days after transplanting significantly reduced plant height as reported by Sehrawat *et al.,* (2003). Tomar *et al.,* (2004) revealed that maximum number of flowers and seed yield due to double pinching followed by single pinching, while control recorded lower number of flowers in African marigold. Srivastava *et al.,* (2005) reported that in marigold, pinching had significant influence on number of secondary branches per plant, days taken to first flower bud initiation, duration of flowering, average size, and weight of flower, number of flowers per plant and flower yield. Chauhan *et al.,* (2005) recorded reduction in plant height and more number of branches per plant when plant pinched at 30 days after transplanting compared to no pinching in marigold cv. Pusa Narangi Gainda. They also reported that pinching at 30 days after transplanting recorded more number of flowers and flower yield in marigold compared to control. In African marigold, maximum growth and flower production were observed at pinching done at 40 days after transplanting as reported by Sharma *et al*., (2006). According to Sunitha *et al.,* (2007) in African marigold, pinching increased number of primary branches and flower yield per plant. Rajbeer *et al.,* (2009) reported that in marigold, flower yield was higher in pinched than non pinched plant. Increased stem diameter, number of primary branches, spread of plant and flower yield of African marigold was observed in pinching done after 30 days of transplanting as reported by Maharnor *et al.,* (2011).

According to Kour *et al*., (2012) in marigold, delayed pinching at 40 days after transplanting increased size and quality of flowers in mid hills of Jammu & Kashmir. Mohanty *et al.,* (2012) reported that shoot pinching at 30 days after transplanting improved the plant spread, number of leaves, weight of flowers and yield of flowers in marigold cv. Siracole. Kumar *et al.,* (2012) reported that plant height, plant spread and yield of flower per hectare were low in early pinching than late pinching in marigold. Sharma *et al.,* (2012) reported that in marigold, pinching at 30 days after transplanting recorded higher flower yield in the low hill conditions of

Himachal Pradesh. Kumar *et al*., (2013) reported that pinching at 30 days after transplanting produced promising changes in the different vegetative growth and flowering characters of chrysanthemum. According to Rajyalakshmi and Rajasekhar (2014) in African marigold, plant height, number of shoots per plant, number of flowers per plant, flower diameter, flower yield and flower weight had significant influence on pinching treatment. Badge *et al*., (2014) reported that pinching at 15 days after transplanting was found to be the best for improving vegetative growth parameter and flower yield in African marigold.

Similar works in related crops are reviewed here under. Flower yield of chrysanthemum was high with pinching on 60$^{th}$ day after planting than 30$^{th}$ day after planting (Yasin and Pappiah (1990). In chrysanthemum cv. Chandrama, pinching height had a significant influence in the bud appearance as reported by Barman *et al*., (1993). John and Paul (1995) reported that in chrysanthemum, pinching done 4 weeks after transplanting increased the number of flowers per plant. According to Ferrato *et al*., (1996) in chrysanthemum, pinching had no significant effect on stem length and inflorescence size. But pinching reduced the growth cycle of the crop. Singh and Baboo (2003) reported that in chrysanthemum, plant height, stem diameter, number of flowers per plant, number of leaves per plant, flower stalk length and flower weight were increased with delay in pinching, whereas plant height was highest in plants that pinched 8 weeks after planting. Rakesh *et al*., (2003) reported that pinching had direct influence on plant height and flower yield of chrysanthemum crop. They reported that pinching of plants generally reduced plant height compared to the control. Plant spread and number of primary branches increased with pinching at 35 days after sowing. Grawal *et al.,* (2004) reported that pinched plants took more number of days for bud break and produce more number of flowers per plant than nonpinched plants in chrysanthemum. Rakesh *et al.,* (2004) reported that in chrysanthemum, flower yield per plant was highest in plants pinched at 35 days after transplanting. But flower stalk length and flower size were highest in non pinched

plants. According to Dorajeerao and Mokashi (2012), the highest yield in terms of number of flowers per plant was recorded by pinching done at 20 days after sowing in chrysanthemum. According to Garde *et al*., (2013) in chrysanthemum, plant height, number of stems per plot, number of nodes per stem, number of inflorescence and better quality plants were significantly influenced by the pinching and different light intensities.

Similar information are also available in china aster. According to Gnyandev (2006) in china aster, pinching at 25 days after transplanting showed significant decrease in plant height and increase in number of flower bearing branches and number of flowers per plant. Pinching had significant influence in china aster cv. Poornima. Pinching reduced plant height and delayed flowering. But the flower yield was more in pinched plants than nonpinched plant as reported by Khobradge *et al.,* (2012). Suneetha *et al.,* (2014) reported that flowering span was observed minimum in double pinching at 30 and 45 days after transplanting. But the yield characters like number of flowers per plant and flower yield were recorded maximum under single pinching at 30 days after transplanting in china aster. In china aster, number of primary branches, plant spread, and stem diameter of plant were found maximum in pinching done at 30 days after transplanting as reported by Sailaja and Panchabhai (2014).

Studies on flower yield of carnation were also reviewed. Pathania *et al*., (2000) recorded significantly maximum plant height in non pinched plants compared to pinched plants in carnation. According to Kumar and Singh (2003) in carnation, plant height, leaf length, weight of flower and flower freshness were higher in non pinched than pinched plant. According to Pal and Biswas (2004) in carnation, the greatest plant height and longest flower stem were recorded in single pinching. They also reported that double pinching resulted in delayed flowering. Chavan *et al*., (2004) reported that in carnation, non pinched plant significantly recorded the maximum plant height at every growth stage. Pinching improved the flower

production. They also reported that flowers from non pinched plants recorded the longest vase life which was significantly reduced by double pinching. Ranjith *et al*., (2005) reported that in carnation maximum branches and plant spread were observed with double pinching. They also reported that flowering was delayed with increasing pinching intensity. According to Dilta *et al*., (2006) in carnation, plant height has decreased with pinching but flower production has increased. Ryagi *et al*., (2007) reported that in carnation, single pinching resulted in early flower production and double pinching resulted in late flowering.

According to John and Paul (1992) in *Gomphrena globosa*, the number and weight of flowers were significantly greater in pinched plants than in non pinched plants. Plant height was not significantly influenced by pinching.

# MATERIALS AND METHODS

## 3. MATERIALS AND METHODS

The investigation entitled "Impact of seasons and pinching on growth and flowering in African marigold (*Tagetes erecta* L.)" was carried out at the Department of Pomology and Floriculture, College of Agriculture, Padannakkad, Kasaragod during the period October 2013 to April 2015. The experimental plot is situated in the northern part of Kerala at 12° 20'N latitude and 75° 04' E longitude with an attitude of 20 m above mean sea level.

CLIMATIC CONDITION:

The monthly meteorological data on rainfall, temperature, sunshine duration and relative humidity during the crop period is presented in annexure 1. During crop period from January 2014 to December 2014 the total rainfall received was 3486.76mm. The maximum temperature varied from 34.51° C to 29.22° C (monthly mean temperature). While the minimum temperature varied from 24.56° C to 21.31° C (monthly mean temperature). The maximum and minimum relative humidity were 93.56 and 61.2 (monthly mean) respectively.

SOILS**:** The soil of the experimental site is sandy soil.

### 3.1 THE EXPERIMENTAL MATERIAL:

Two varieties of African marigold namely Pusa Basanti Gainda and Pusa Narangi Gainda were tried in the experiment. The seeds of Pusa Narangi Gainda were collected from the Division of Floriculture and Landscaping, Indian Agricultural Research Institute Pusa, New Delhi and seeds of Pusa Basanti Gainda were obtained from Dr Y.S Parmer University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during January and May 2014.

### 3.2 LAYOUT OF EXPERIMENT:

The experiment was conducted during three seasons, viz. pre monsoon in January 2014 ($S_1$), monsoon in May 2014 ($S_2$) and post monsoon in September 2014

($S_3$). Two varieties and two levels of pinching - no pinching ($P_0$) and pinching at 30 days after transplanting ($P_1$) were used in the present study. The interaction effect variety x pinching on growth and flowering was studied by using four treatments namely $T_1$, $T_2$, $T_3$, $T_4$.

$T_1=V_1P_0$ = Pusa Narangi Gainda without pinching

$T_2=V_1P_1$ = Pusa Narangi Gainda with pinching

$T_3=V_2P_0$ = Pusa Basanti Gainda without pinching

$T_4=V_2P_1$ = Pusa Basanti Gainda with pinching

The experiment was laid out in Randomized Block Design with 4 treatments and 5 replications during three seasons – pre monsoon in January 2014($S_1$), monsoon in May 2014 ($S_2$), and post monsoon in September 2014 ($S_3$).

### 3.2.1 Nursery techniques:

Seeds of the two varieties were sown in the nursery in three seasons separately. Seeds were treated with pseudomonas at 2g/kg of seed for 8 hours before sowing in all the three seasons and seeds of both varieties were sown on the same day, on 1st January 2014, 1st May 2014 and 1st September 2014 in the three seasons pre monsoon (January sown- $S_1$), monsoon (May sown- $S_2$) and post monsoon (September sown- $S_3$) respectively. The germination percentage was 94% and 89% respectively in varieties Pusa Narangi Gainda and Pusa Basanti Gainda. No pest or disease was observed in the nursery. Transplanting was done in the experimental field after three weeks.

### 3.2.2 Crop management:

The land was ploughed thoroughly and prepared with ridges and furrows. All the management practices as per KAU POP (2011) were carried out. Pinching was done 30 days after transplanting (45 DAS) as per treatment.

### 3.2.3 Harvesting:

Fully opened flowers with maximum size were harvested on alternate days during evening hours. The number of flowers and fresh weight were recorded immediately after harvest.

## 3.3 COLLECTION OF EXPERIMENTAL DATA:

**3.3.1 Sampling procedure**: 10 plants were randomly selected from each replication of all treatments and tagged with labels on 30 days after sowing. The observations were recorded at monthly interval - first month after sowing (30 days after sowing- $M_1$), second month after sowing (60 days after sowing- $M_2$) and third month after sowing (90 days after sowing- $M_3$) during the entire period in three different seasons $S_1$, $S_2$, and $S_3$. Observation on the following growth and yield parameters were recorded.

### 3.3.2 Growth parameters:

#### *3.3.2.1 Plant height (cm):*

The height of 10 randomly selected and tagged plants were measured from base of the plant to the tip of the main stem, at monthly interval. The average height was worked out and expressed in centimeters.

#### *3.3.2.2 Number of primary branches per plant:*

The number of primary branches arising on the main stem was recorded at monthly interval. The mean number of primary branches per plant were worked out and expressed as number per plant.

#### *3.3.2.3 Number of secondary branches per plant:*

The number of secondary branches arising on the primary branches were counted and recorded at monthly interval. The mean number of secondary branches per plant were worked out and expressed as number per plant.

#### *3.3.2.4 Leaf area (square centimeter per plant):*

The leaf area from all leaves of selected and tagged plants was measured and total leaf area of each selected plant was calculated by using portable leaf area meter, Model LI-3000A and expressed as square centimeter per plant.

#### *3.3.2.5 Chlorophyll content:*

Chlorophyll content was measured by using SPAD-502 chlorophyll meter, Konica Minolta, Japan at monthly interval from 30 days after transplanting and expressed as number.

### 3.3.3 Yield parameters and components:

#### *3.3.3.1 Days to first flowering:*

The number of days taken for commencement of flowering was recorded by counting the days from germination to first flower opening and expressed as number of days.

#### *3.3.3.2 Days to 50 per cent flowering:*

The number of days taken for 50 per cent flowering of each selected plants were worked by counting the days from germination to 50 per cent flowering and expressed as number of days.

#### *3.3.3.3 Days to first harvest:*

The number of days taken for first harvest in selected plants were recorded by counting the days from first germination to first harvest and expressed as number of days.

#### *3.3.3.4 Flower diameter (centimeter):*

Flower diameter of 10 randomly selected flowers from each replication was measured and expressed as centimeter (cm) per flower.

#### *3.3.3.5 Length of flower stalk (centimeter):*

Stalk length of 10 randomly selected flowers from each replication was measured and expressed as centimeters (cm) per flower.

#### *3.3.3.6 Mean flower weight (g):*

Individual flower weight of 10 randomly selected flowers from each replication was measured and expressed as gram per flower (g).

#### *3.3.3.7 Number of flowers per plant:*

The number of flowers harvested from the 10 randomly selected plants in each replication were counted and expressed as the number of flowers per plant.

#### *3.3.3.8 Flower yield per plant (g):*

Flower yield from 10 randomly selected plants in each replication was recorded and expressed as grams per plant (g).

#### *3.3.3.9 Duration of flowering:*

The number days taken from first flower opening to last flower opening of each randomly selected 10 plants in each replication were recorded and expressed as number of days.

#### *3.3.3.10 Total biomass:*

Fully flowered plants from each replication were dried separately in oven till constant weight is obtained. After complete drying, dry weight was measured and expressed as grams per plant (g).

#### *3.3.3.11 Post harvest longevity:*

10 flowers from selected plant in each replication were kept in open at ambient atmosphere in the laboratory. The number of days taken for wilting of 50% flowers of each replication were counted and expressed as number of days.

### 3.4 Pest and disease incidence

Pest and diseases occurred were observed and recorded.

### 3.5 Benefit Cost analysis

Cost of cultivation, marketable yield and return by selling flowers in the local market at Nileswar were recorded to work out the benefit cost ratio.

### 3.6 Other parameters:

Data on mean temperature, rainfall, relative humidity, sunshine hours were collected from the nearest meteorological observatory at Regional Agricultural Research Station (RARS) Pilicode, Kasaragod and monthly mean value of all the parameters were worked out and presented in Annexure 1.

### 3.7 Statistical analysis:

The data was statistically analyzed by using M-STAT C Package to find out the growth and yield performance of the varieties in the three seasons, the effect of pinching in growth and flowering of the varieties in the three seasons and the interaction effect of varieties x pinching on growth and yield.

# *RESULTS*

# RESULTS

The investigation entitled "Impact of seasons and pinching on growth and yield in African marigold (*Tagetes erecta* L.)" was undertaken in three seasons namely pre monsoon (January sown-$S_1$), monsoon (May sown-$S_2$) and post monsoon (September sown-$S_3$) with two varieties of African marigold it Pusa Narangi Gainda (PNG, $V_1$) and Pusa Basanti Gainda (PBG, $V_2$). The varieties were grown without pinching ($P_0$) and with pinching ($P_1$). The data was statistically analyzed to find out the growth and yield performance of the varieties, the effect of pinching on growth and flowering of the varieties and the interaction effect of varieties x pinching in the three seasons. Pooled analysis of data was done to find out seasonal effect on growth and flowering.

## 4.1 EFFECT OF TIME OF PLANTING (SEASONS) ON GROWTH AND YIELD OF AFRICAN MARIGOLD

### 4.1.1 Plant height

#### *4.1.1.1 Pusa Narangi Gainda*

The plant height was recorded at 30, 60 & 90 days after sowing (Fig. 1). Maximum plant height at 30 & 60 days after sowing was observed in September sown crop (20.88, 60.94 cm). Among the three seasons, minimum plant height at 30 days after sowing was recorded in January sown crop (9.92). Minimum plant height at 60 days after sowing was observed in May sown crop (30.09). Maximum plant height at 90 days after sowing was recorded in May sown crop (124.86) and the minimum was in January sown crop (55.24 cm). Time of planting had a significant

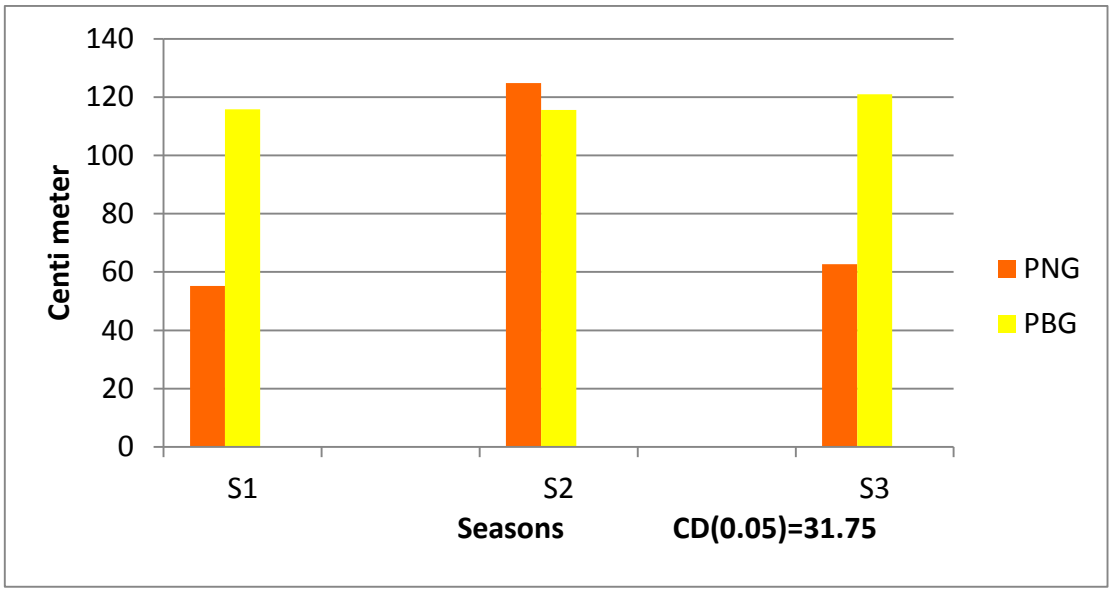


Fig.1 Effect of season (time of planting) on plant height (cm) of African marigold varieties

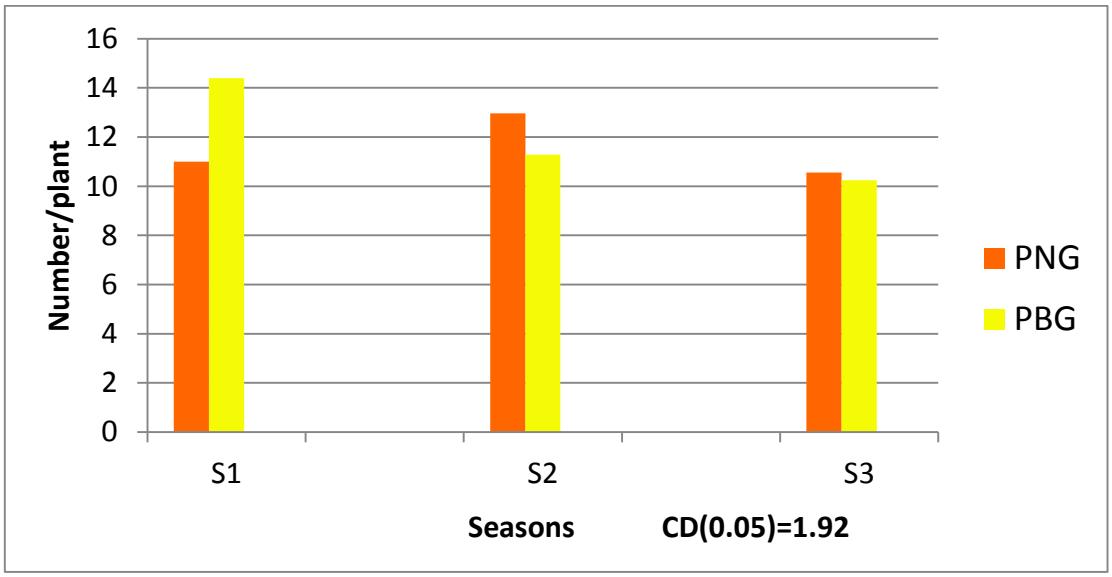


Fig.2 Effect of season (time of planting) on number of primary branches of African marigold varieties

effect on plant height at 90 days after sowing.

#### *4.1.1.2 Pusa Basanti Gainda*

Maximum plant height at 30, 60 and 90 days after sowing was observed in September sown crop (32.80, 63.54, 120.94 cm). Minimum plant height at 30 days after sowing was recorded in January sown crop (11.85). Among the three seasons, minimum plant height at 60 days after sowing was observed in May sown crop (31.01 cm). Minimum plant height at 90 days after sowing was in May sown crop (115.64 cm). Time of planting had no significant effect on plant height at 90 days after sowing in this variety.

### 4.1.2 Number of primary branches

#### *4.1.2.1 Pusa Narangi Gainda*

The number of primary branches was recorded 60 & 90 days after sowing (Fig. 2). Maximum number of primary branches at 60 & 90 days after sowing was observed in May sown crop (10.60, 12.97). Among the three seasons, minimum number of primary branches at 60 days after sowing was recorded in January sown crop (9.28). Minimum number of primary branches at 90 days after sowing was in September sown crop (10.56). Time of planting had a non significant effect on number of primary branches at 90 days after sowing.

#### *4.1.2.2 Pusa Basanti Gainda*

Maximum number of primary branches at 60 & 90 days after sowing was observed in January sown crop (12.02, 14.40). Minimum number of primary branches at 60 & 90 days after sowing was recorded in September sown crop (9.50, 10.24). Time of planting had no significant effect on number of primary branches at 90 days after sowing.

### 4.2.3 Number of secondary branches

#### *4.2.3.1 Pusa Narangi Gainda*

The number of secondary branches was recorded 60 & 90 days after sowing (Fig. 3). Maximum number of secondary branches at 60 & 90 days after sowing was observed in January sown crop (4.82, 52.18). Among the three seasons, minimum number of secondary branches at 60 days after sowing was recorded in May sown crop (1.80). Minimum number of secondary branches at 90 days after sowing was recorded in September sown crop (41.2). Time of planting had a non significant effect on number of secondary branches at 90 days after sowing.

#### *4.2.3.2 Pusa Basanti Gainda*

Maximum number of secondary branches at 60 & 90 days after sowing was observed in January sown crop (6.28, 57.60). Minimum number of secondary branches at 60 days after sowing was recorded in September sown crop (4.97). Minimum number of secondary branches was in May sown crop (43.44). Time of planting had no significant effect on number of secondary branches at 90 days after sowing.

### 4.2.4 Leaf area

#### *4.2.4.1 Pusa Narangi Gainda*

The leaf area was recorded 30, 60 & 90 days after sowing (Fig. 4). Maximum leaf area at 30 & 60 days after sowing was observed in September sown crop (71.63 $cm^2$, 404.70 $cm^2$). Among the three seasons, minimum leaf area at 30 days after sowing was recorded in May sown crop (34.76 $cm^2$). Minimum leaf area at 60 days after sowing was observed in January sown crop (177.12 $cm^2$). Maximum leaf area at 90 days after sowing was recorded in May sown crop (2891.76 $cm^2$) and

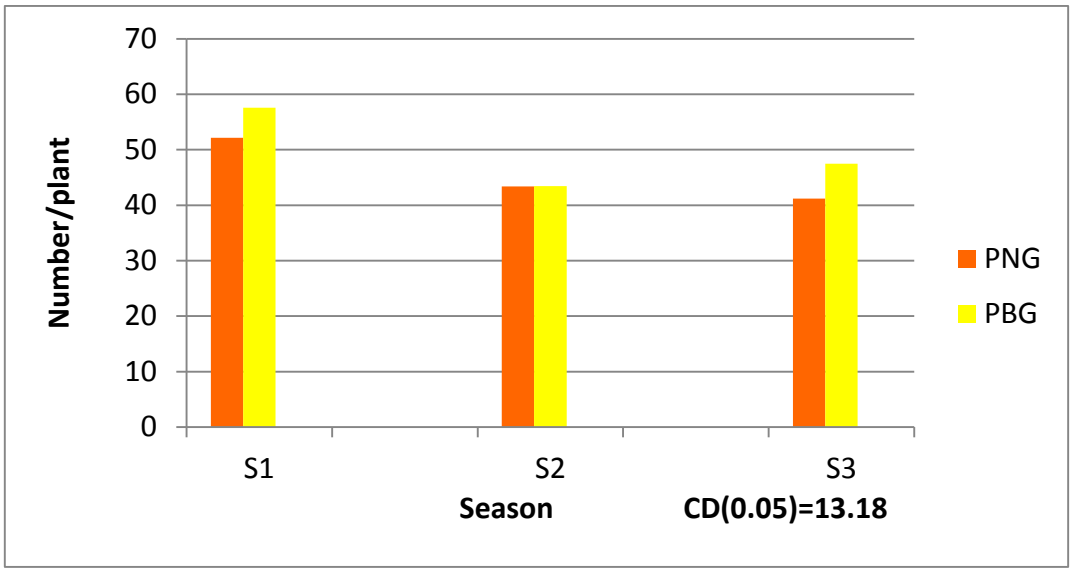


Fig. 3 Effect of season (time of planting) on number of secondary branches of African marigold varieties

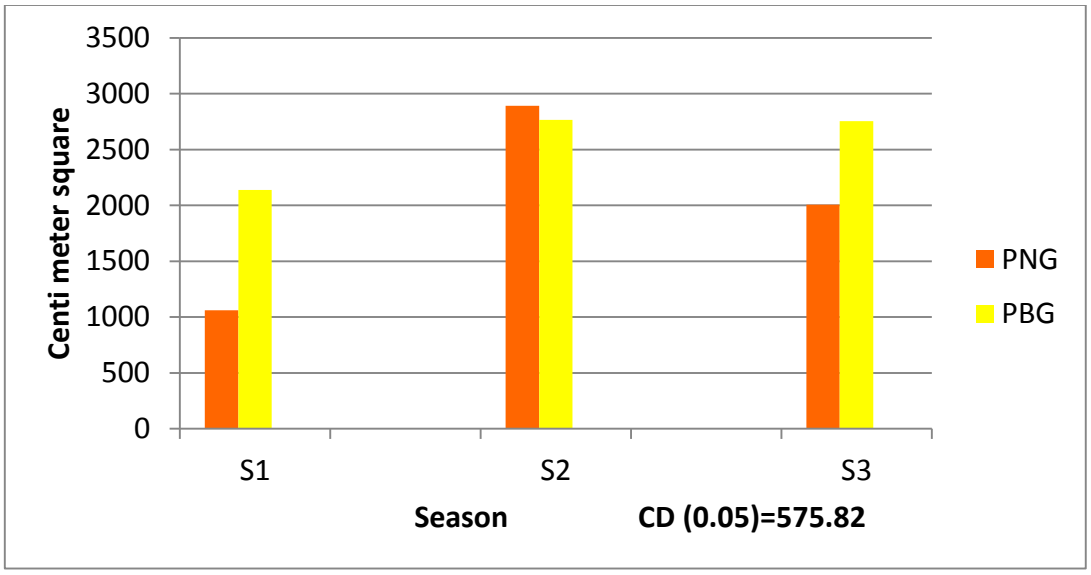


Fig. 4 Effect season (time of planting) on leaf area ($cm^2$) of African marigold varieties

the minimum was in January sown crop (1061.46 $cm^2$). Time of planting had a significant effect on leaf area at 90 days after sowing.

***4.2.4.2 Pusa Basanti Gainda***

Maximum leaf area at 30 & 60 days after sowing was observed in September sown crop (115.13 $cm^2$, 406.16 $cm^2$). Minimum leaf area at 30 days after sowing was recorded in May sown crop (30.54 $cm^2$). Among the three seasons, minimum leaf area at 60 days after sowing was observed in January sown crop (308.34 $cm^2$). Maximum leaf area at 90 days after sowing was recorded in May sown crop (2764 $cm^2$) and the minimum was in January sown crop (2136.42 $cm^2$). Time of planting had significant effect on leaf area at 90 days after sowing.

**4.2.5 Chlorophyll content (SPAD chlorophyll meter reading)**

***4.2.5.1 Pusa Narangi gainda***

The chlorophyll content (SCMR) was recorded 30, 60 & 90 days after sowing (Fig. 5). Maximum chlorophyll content at 30, 60 & 90 days after sowing was observed in January sown crop (52.52, 55.13, and 55.28). Among the three seasons, minimum chlorophyll content at 30 days after sowing was recorded in September sown crop (49.24). Minimum chlorophyll content at 60 days after sowing was observed in May sown crop (50.11). Minimum chlorophyll content was in September sown crop (50.22). Time of planting had no significant effect on chlorophyll content at 90 days after sowing.

***4.2.5.2 Pusa Basanti Gainda***

Maximum chlorophyll content at 30 days after sowing was observed in May sown crop (49.90). Minimum chlorophyll content at 30 days after sowing was recorded in September sown crop (48.00). Maximum chlorophyll content at 60 days after sowing was observed in January sown crop (54.01). Among the three seasons,

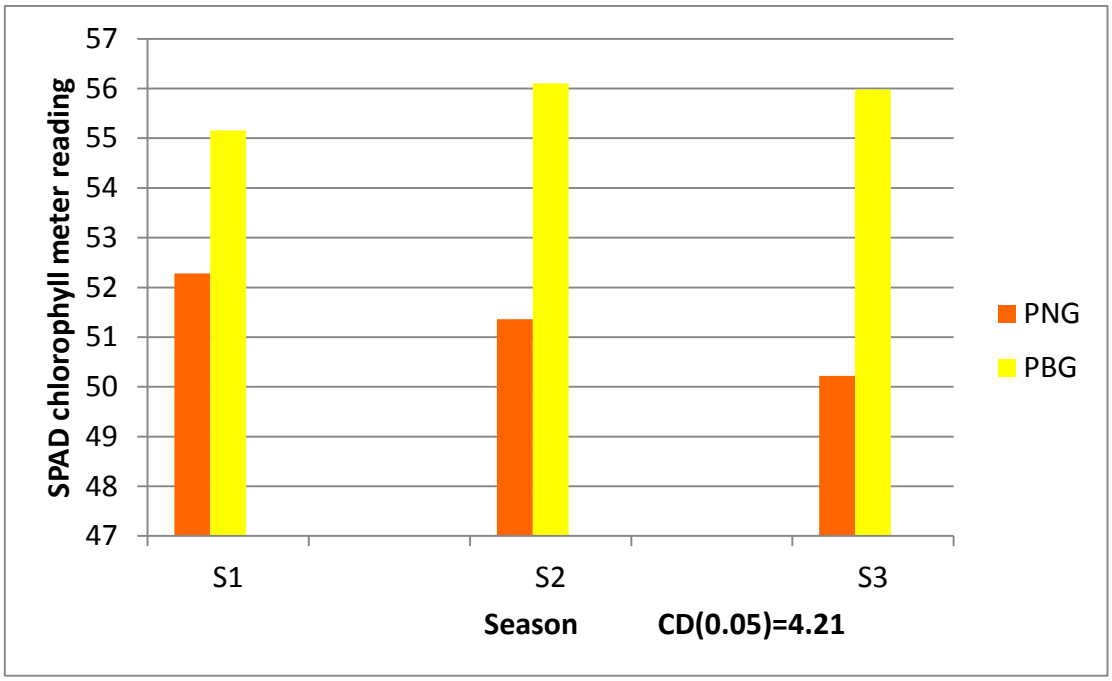


Fig. 5 Effect of season (time of planting) on SPAD chlorophyll meter reading of African marigold varieties

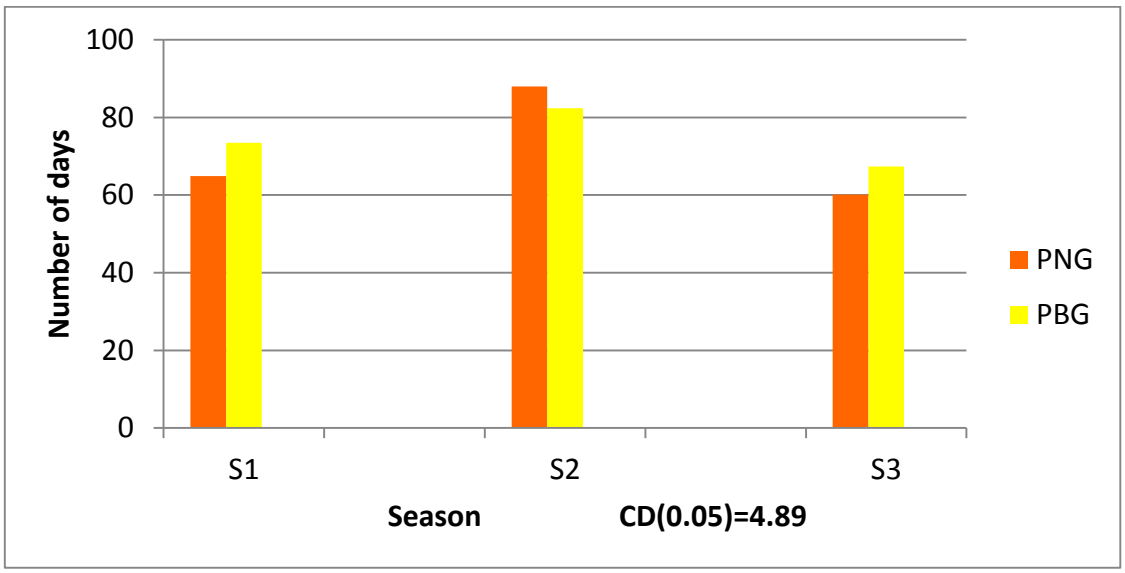


Fig.6 Effect of season (time of planting) on number of days to first flowering of African marigold varieties

minimum chlorophyll content at 60 days after sowing was observed in May sown crop (51.19). Maximum chlorophyll content at 90 days after sowing was recorded in May sown crop (56.10) and the minimum was in January sown crop (55.16). Time of planting had no significant effect on leaf area at 90 days after sowing.

### 4.2.6 Days to first flowering

#### *4.2.6.1 Pusa Narangi Gainda*

Minimum number of days to first flowering was observed in September sown crop (60.12) and the maximum was in May sown crop (87.99). Time of planting had significant effect on days to first flowering (Fig. 6).

#### *4.2.6.2 Pusa Basanti Gainda*

Minimum number of days to first flowering was observed in September sown crop (67.40) and the maximum number of days to first flowering was observed in May sown crop (82.35). Time of planting had significant effect on days to first flowering (Fig. 6).

### 4.2.7 Days to 50 per cent flowering

#### *4.2.7.1 Pusa Narangi Gainda*

In Pusa Narangi Gainda, minimum number of days to 50 per cent flowering was recorded in September sowing (85.52) and the maximum number of days to 50 per cent flowering was observed in May sown crop (113.58). Time of planting had significant effect on days to 50 per cent flowering (Fig. 7).

In Pusa Basanti Gainda, minimum number of days to 50 percent flowering was observed in September sown crop (92.90) and maximum number of days to 50 per cent flowering was observed in May sown crop (107.85). Time of planting had significant influence on days to 50 per cent flowering (Fig. 7).

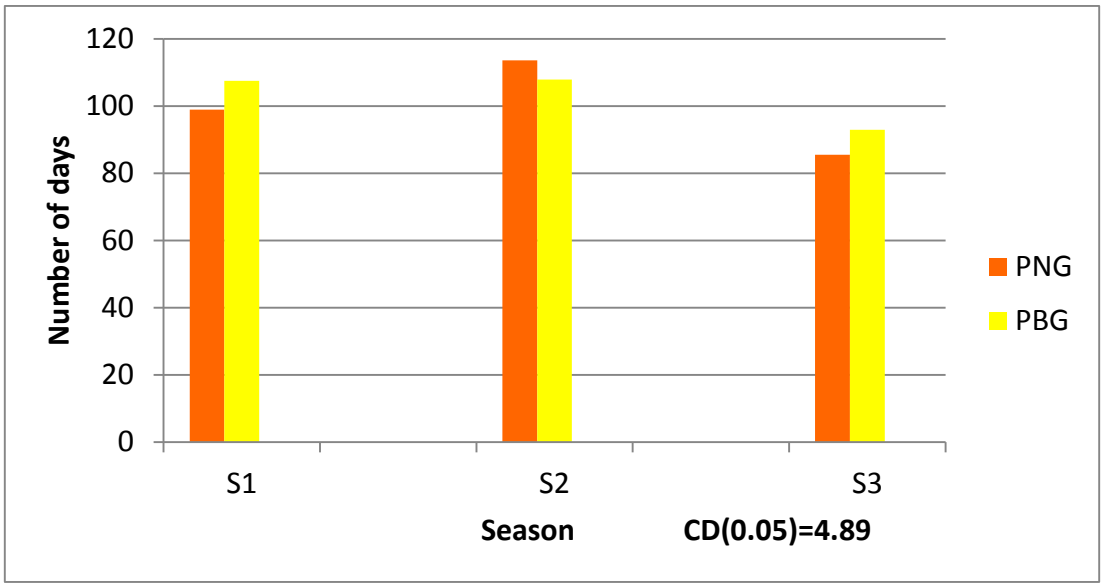


Fig.7 Effect of season (time of planting) on number of days to 50% flowering in African marigold varieties

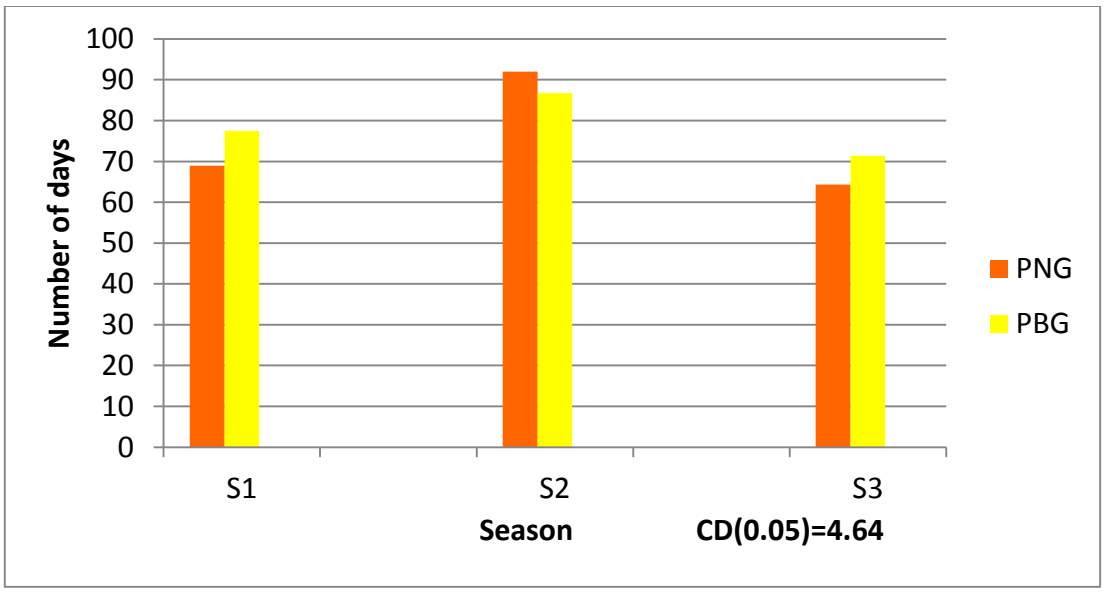


Fig.8 Effect of season (time of planting) on number of days to first harvest of African marigold varieties

### 4.2.8 Days to first harvest

#### *4.2.8.1 Pusa Narangi Gainda*

Minimum number of days to first harvest was recorded in September sown crop (64.32) and maximum number of days to first harvest was observed in May sown crop (91.99). Time of planting had significant influence on days to first harvest (Fig. 8).

#### *4.2.8.2 Pusa Basanti Gainda*

Minimum number of days to first harvest was observed in September sown crop (71.40) and maximum number of days to first harvest was observed in May sown crop (86.75). Time of planting had significant influence on days to first harvest (Fig. 8).

### 4.2.9 Flower diameter

#### *4.2.9.1 Pusa Narangi Gainda*

Maximum flower diameter recorded in May sown crop (5.04 cm) and minimum was observed in September sown crop (3.04 cm). Time of planting had no significant influence on flower diameter (Fig. 9).

#### *4.2.9.2 Pusa Basanti Gainda*

Maximum flower diameter was recorded in January sown crop (5.64 cm) and minimum was recorded in May sown crop (3.82 cm). Time of planting had no significant influence on flower diameter (Fig. 9).

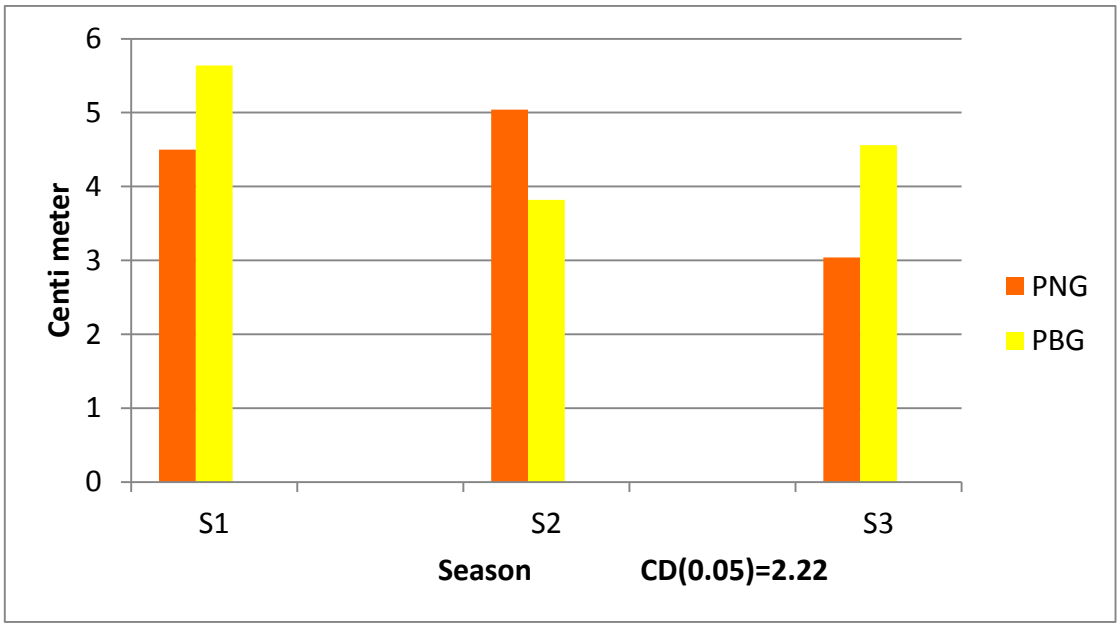


Fig. 9 Effect of season (time of planting) on flower diameter (cm) of African marigold varieties

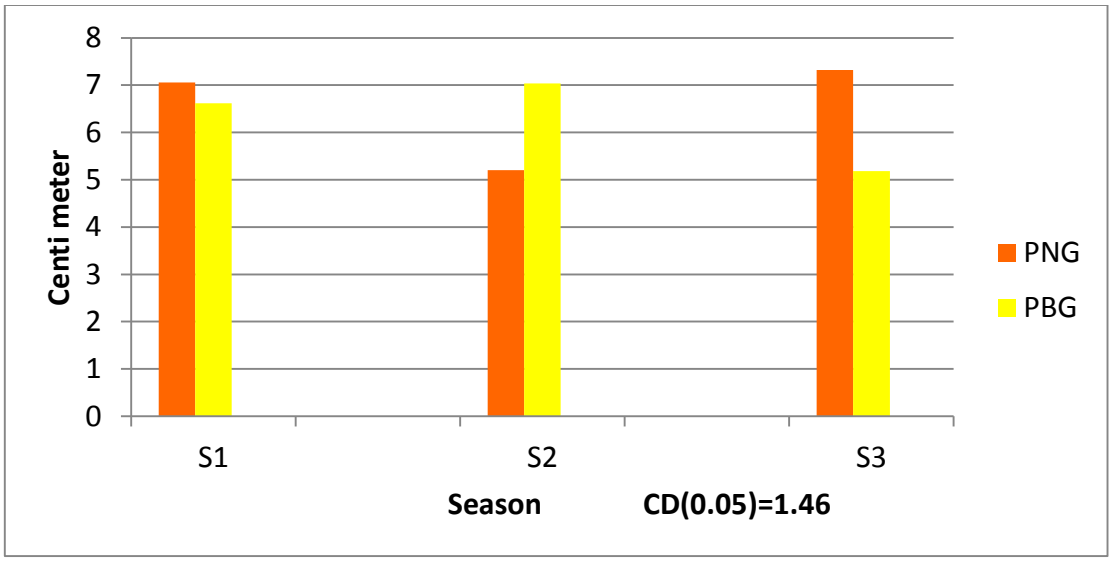


Fig. 10 Effect of season (time of planting) on length of flower stalk (cm) of African marigold varieties

### 4.2.10 Length of flower stalk

#### *4.2.10.1 Pusa Narangi Gainda*

Maximum length of flower stalk was recorded in January sown crop (7.06 cm) and minimum length of flower stalk was observed in May sown crop (5.20 cm). Time of planting had no significant influence on length of flower stalk (Fig. 10).

#### *4.2.10.2 Pusa Basanti Gainda*

Maximum length of flower stalk was observed in May sown crop (7.04 cm) and minimum length of flower stalk was observed in September sown crop (5.18 cm). Time of planting had no significant influence on length of flower stalk (Fig. 10).

### 4.2.11 Flower weight

#### *4.2.11.1 Pusa Narangi Gainda*

Maximum flower weight was observed in May sown crop (6.40 g) and minimum mean flower weight was recorded in September sown crop (3.06 g). Time of planting had significant influence on flower weight (Fig. 11).

#### *4.2.11.2 Pusa Basanti Gainda*

Maximum flower weight was recorded in January sown crop (5.52 g) and the minimum flower weight was observed in May sown crop (3.4). Time of planting had significant influence on mean flower weight (Fig. 11).

### 4.2.12 Number of flowers per plant

#### *4.2.12.1 Pusa Narangi Gainda*

Maximum number of flowers per plant was observed in January sown crop (97.00) and minimum number of flowers per pant was recorded in September sown

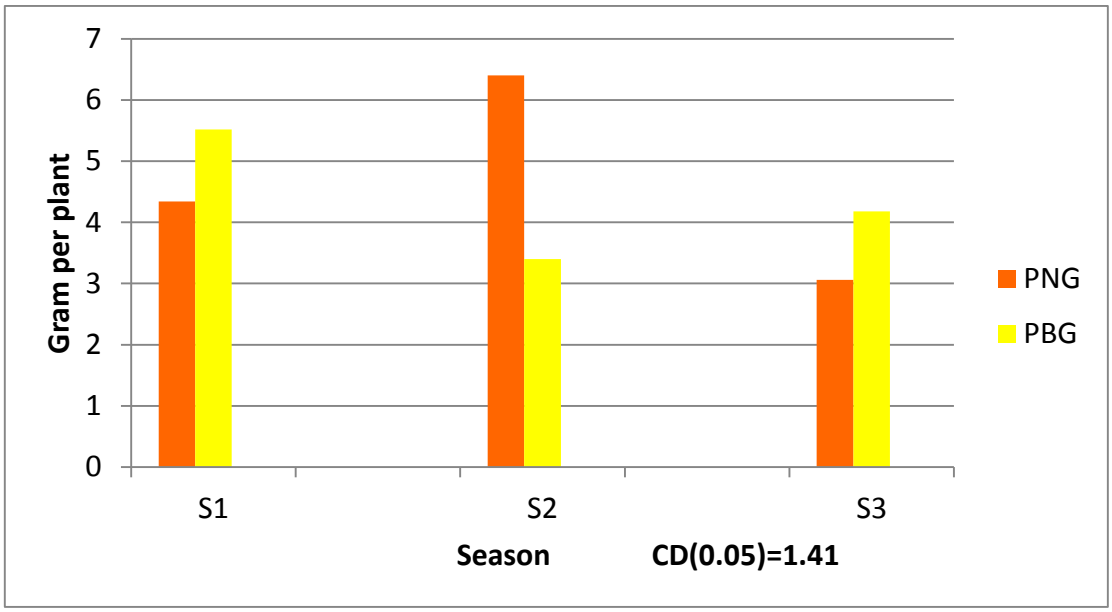


Fig. 11 Effect of season (time of planting) on flower weight (g) of African marigold varieties

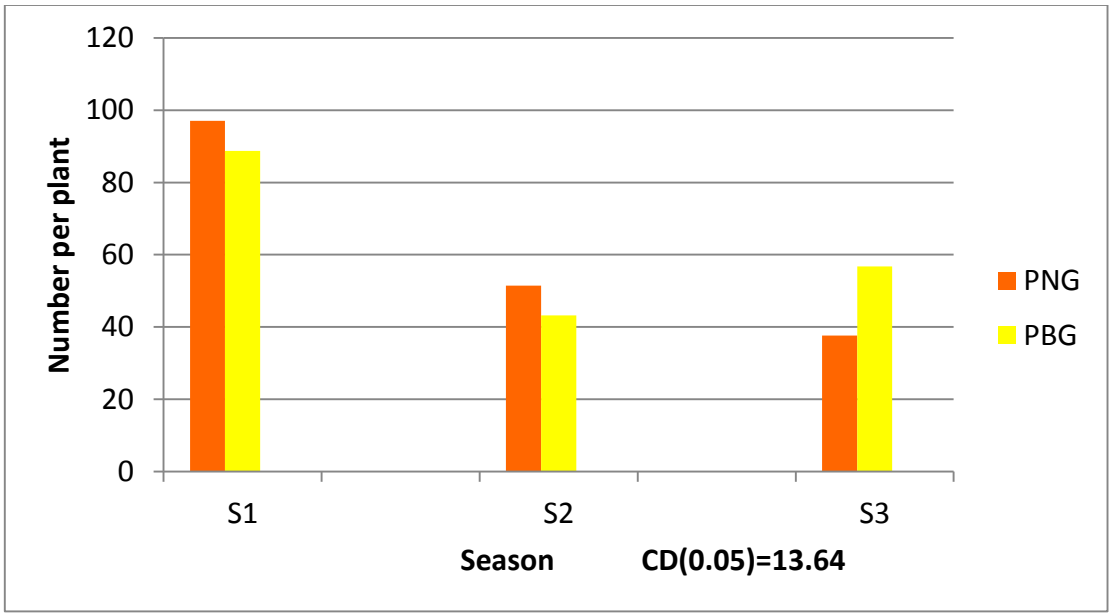


Fig. 12 Effect of season (time of planting) on number of flowers per plant of African marigold varieties

crop (37.60). Time of planting had significant influence on number of flowers per plant (Table 12).

***4.2.12.2 Pusa Basanti Gainda***

Maximum number of flowers per plant was observed in January sown crop (88.76) and minimum number of flowers per pant was recorded in May sown crop (43.21). Time of planting had significant influence on number of flowers per plant (Fig. 12).

**4.2.13 Flower yield per plant**

***4.2.13.1 Pusa Narangi Gainda***

Maximum flower yield per plant was recorded in January sown crop (420.85 g) and minimum flower yield per plant was recorded in September sown crop (113.54 g). Time of planting had significant influence on flower yield per plant (Fig. 13).

***4.2.13.2 Pusa Basanti Gainda***

Maximum flower yield per plant was observed in January sown crop (490.90 g) and minimum flower yield per plant was recorded in May sown crop (144.97 g). Time of planting had significant influence on flower yield per plant (Fig. 13).

**4.2.14 Duration of flowering**

***4.2.14.1 Pusa Narangi Gainda***

Maximum duration of flowering was observed in January sown crop (69.20) and minimum flowering duration was observed in September sown crop (45.80). Time of planting had significant influence on duration of flowering (Fig. 14).

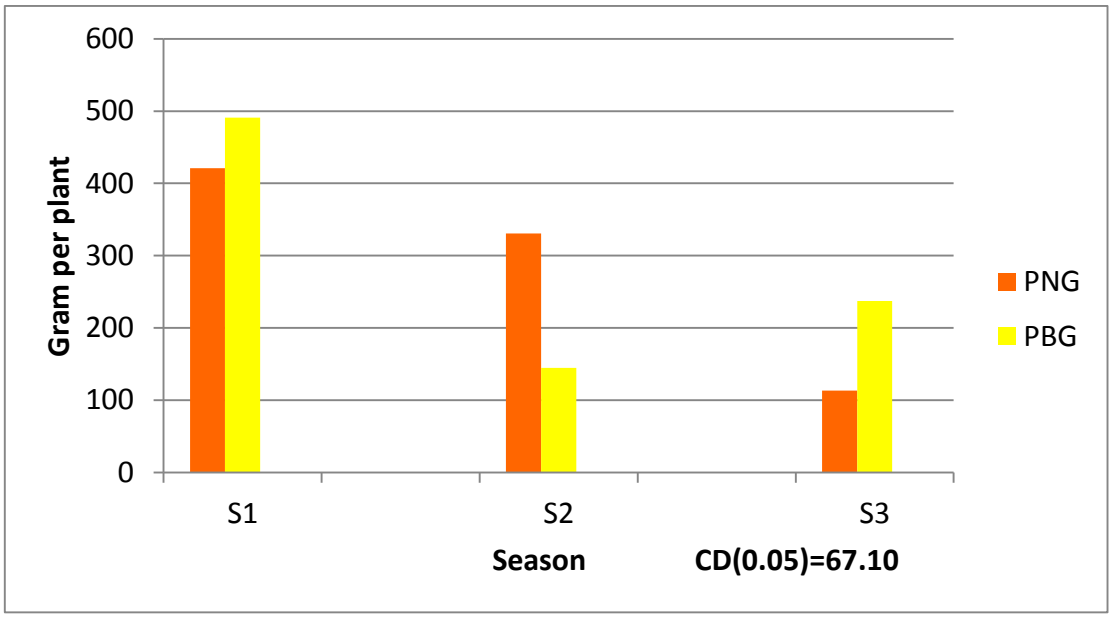


Fig. 13 Effect of season (time of planting) on flower yield (g) per plant of African marigold varieties

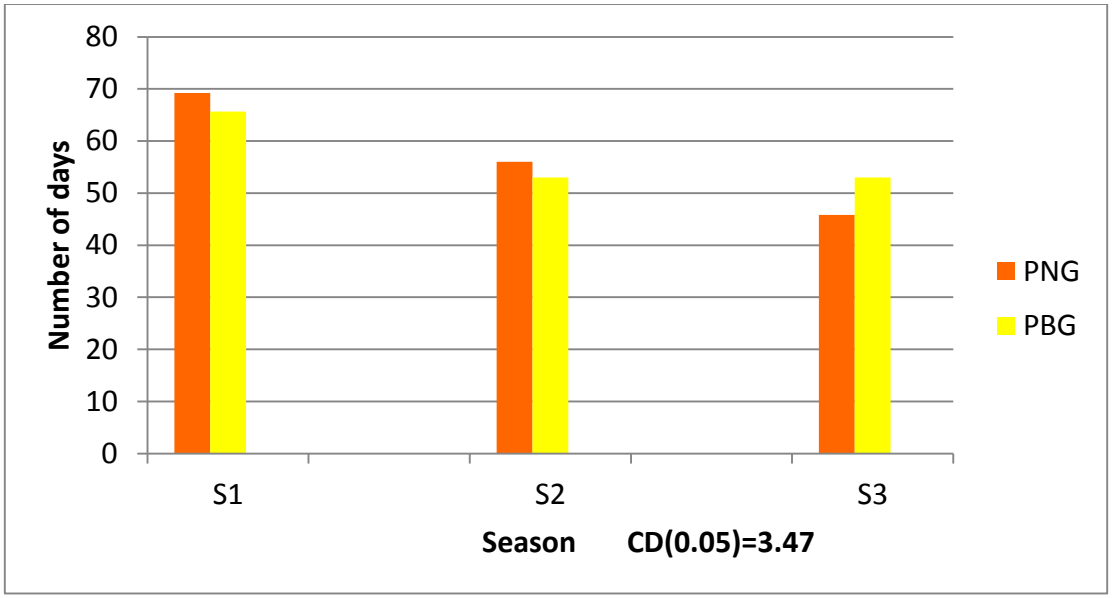


Fig. 14 Effect of season (time of planting) on duration of flowering of African marigold varieties

#### *4.2.14.2 Pusa Basanti Gainda*

Maximum duration of flowering was recorded in January sown crop (65.64). Duration of flowering in May sowing and September sowing was on par with each other (Table14).

### 4.2.15 Total biomass

#### *4.2.15.1 Pusa Narangi Gainda*

Highest total biomass was recorded in May sown crop (105.84) and lowest total biomass was recorded in September sown crop (66.18 g). Time of planting had significant influence on total biomass (Fig. 15).

#### *4.2.15.2 Pusa Basanti Gainda*

Highest total biomass was recorded in May sown crop (117.54g) and lowest total biomass was recorded in January sown crop (92.08 g). Time of planting had no significant influence on total biomass (Fig. 15).

### 4.2.16 Post harvest longevity

#### *4.2.16.1 Pusa Narangi Gainda*

Maximum post harvest longevity of flowers was observed in May sown crop (5.80) and minimum was observed in January sown crop (3.14). Time of planting had no significant influence on post harvest longevity (Fig. 16).

#### *4.2.16.2 Pusa Basanti Gainda*

Maximum post harvest longevity was observed in May sown crop (5.96) and minimum was observed in January sown crop (3.8). Time of planting had no significant influence on post harvest longevity of flowers (Fig. 16).

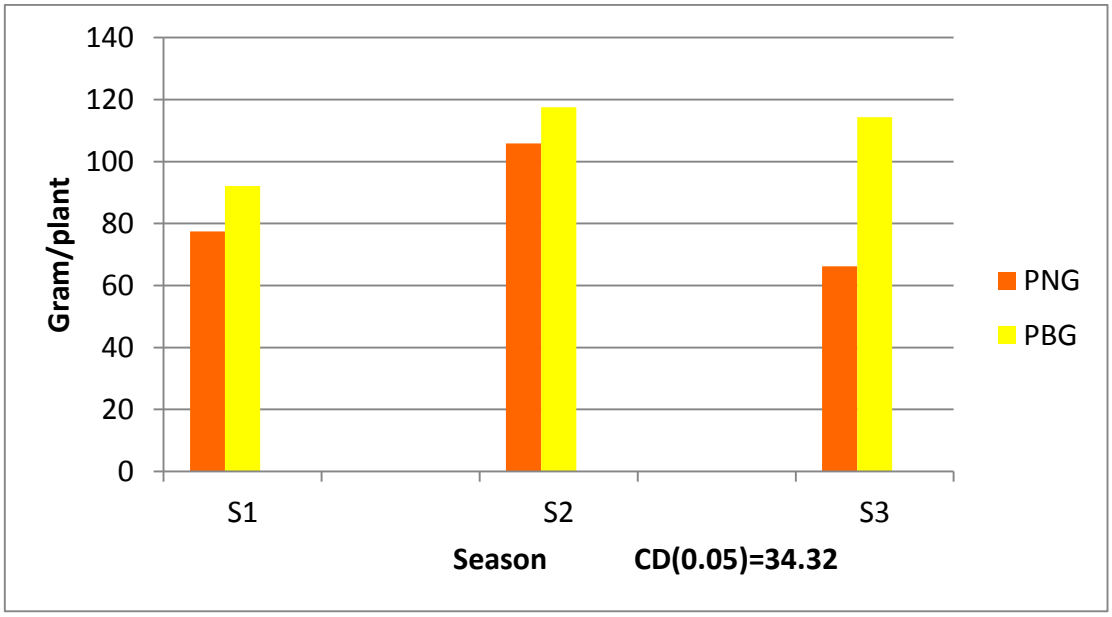


Fig. 15 Effect of season (time of planting) on total biomass (g) of African marigold varieties

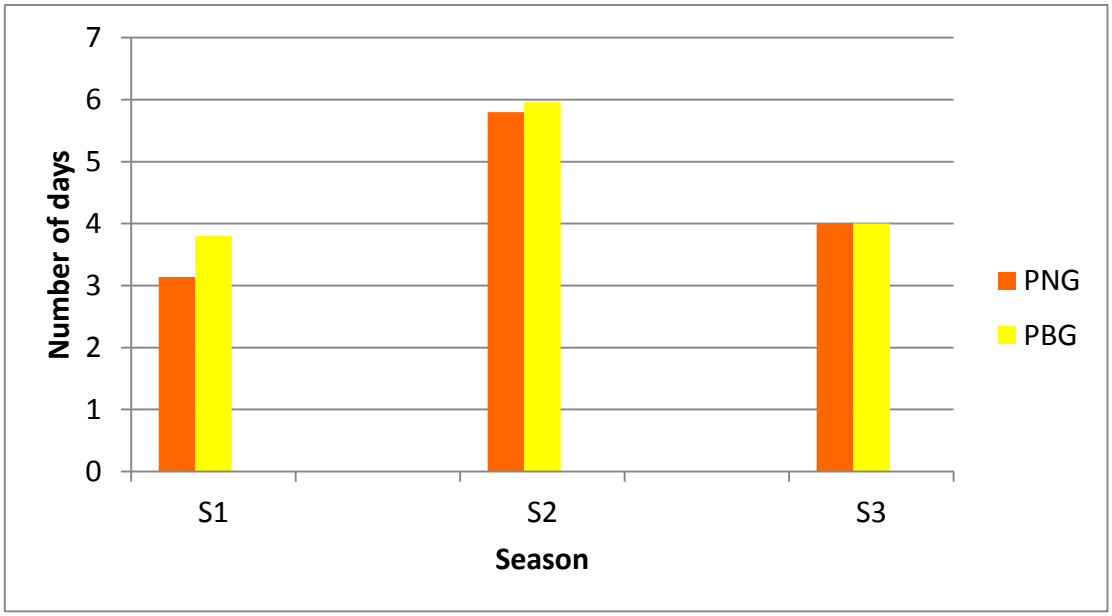


Fig. 16 Effect of season (time of planting) on post harvest longevity of African marigold varieties

## 4.2 EFFECT OF PINCHING ON GROWTH AND YIELD OF AFRICAN MARIGOLD

### 4.2.1 Plant height

#### *4.2.1.1 Pusa Narangi Gainda*

The plant height was 42.38 cm without pinching and 34.76 cm with pinching at 60 days after sowing in January sown crop. Plant height at 90 days after sowing was 55.24 cm without pinching and 38.28 cm with pinching.

In May sown crop, the plant height was 30.09 cm without pinching and 29.80 with pinching at 60 days after sowing. Plant height at 90 days after sowing was 124.86 cm without pinching and 114.30 cm with pinching.

The plant height was 60.94 cm without pinching and 57.34 cm with pinching at 60 days after sowing in September sown crop. Plant height at 90 days after sowing was 62.74 cm without pinching and 58.76 cm with pinching (Table 1).

#### *4.2.1.2 Pusa Basanti Gainda*

The plant height was 58.36 cm without pinching and 43.88 cm with pinching at 60 days after sowing in January sown crop. Plant height at 90 days after sowing was 115.76 cm without pinching and 107.93 cm with pinching.

In May sown crop the plant height was 31.01 cm without pinching and 35.65 cm with pinching at 60 days after sowing. Plant height at 90 days after sowing was 115.64 cm without pinching and 96.41 cm with pinching.

The plant height was 63.54 cm without pinching and 63.56 cm with pinching at 60 days after sowing in September sown crop. Plant height at 90 days after sowing was 120.94 cm without pinching and 120.84 cm with pinching (Table 1).

Table 1: Effect of pinching on plant height of African marigold varieties

| | $S_1$ | | | $S_2$ | | | $S_3$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | $M_1$ | $M_2$ | $M_3$ | $M_1$ | $M_2$ | $M_3$ | $M_1$ | $M_2$ | $M_3$ |
| Pinching | | | | | | | | | |
| $P_0$ | 10.88 | 50.37 | 85.5 | 12.35 | 30.56 | 120.25 | 26.84 | 62.24 | 91.79 |
| $P_1$ | 10.87 | 39.33 | 73.10 | 11.99 | 32.75 | 105.36 | 28.17 | 60.45 | 89.85 |
| CD (0.05) | NS | S | S | NS | NS | S | S | S | S |
| Variety x Pinching | | | | | | | | | |
| $T_1$ ($V_1P_0$) | 9.92 | 42.38 | 55.24 | 11.85 | 30.09 | 124.86 | 20.88 | 60.94 | 62.74 |
| $T_2$ ($V_1P_1$) | 11.03 | 34.76 | 38.28 | 10.7 | 29.80 | 114.30 | 23.07 | 57.34 | 58.76 |
| $T_3$($V_2P_0$) | 11.85 | 58.36 | 115.76 | 12.86 | 31.01 | 115.64 | 32.80 | 63.54 | 120.94 |
| $T_4$($V_2P_1$) | 10.70 | 43.88 | 107.93 | 13.28 | 35.65 | 96.41 | 33.27 | 63.56 | 120.84 |
| CD (0.05) | 3.10 | 6.77 | 6.26 | 2.66 | 3.08* | 12.86 | 1.77 | 1.37 | 1.47 |

Pooled analysis revealed that, there was significant difference in plant height at 60 & 90 days after sowing in January sown crop. In May sown crop, significant difference was observed at 90 days after sowing. There was significant difference in plant height at 30, 60 & 90 days after sowing in September sown crop.

### 4.2.2 Number of primary branches

#### *4.2.2.1 Pusa Narangi Gainda*

The number of primary branches was 9.28 without pinching and 9.48 with pinching at 60 days after sowing in January sown crop. Number of primary branches at 90 days after sowing was 11.0 without pinching and 14.08 with pinching.

In May sown crop the number of primary branches was 10.60 without pinching and 10.84 with pinching at 60 days after sowing. Number of primary branches at 90 days after sowing was 12.97 without pinching and 11.33 with pinching.

The number of primary branches was 8.24 without pinching and 10.84 with pinching at 60 days after sowing in September sown crop. Number of primary branches at 90 days after sowing was 10.56 without pinching and 11.59 with pinching (Table 2).

#### *4.2.2.2 Pusa Basanti Gainda*

The number of primary branches was 12.02 without pinching and 8.98 with pinching at 60 days after sowing in January sown crop. Number of primary branches at 90 days after sowing was 14.40 without pinching and 16.44 with pinching. In May sown crop, the number of primary branches was 10.24 without pinching and 11.06 with pinching at 60 days after sowing. Number of primary branches at 90 days after sowing was 11.28 without pinching and 16.00 with pinching.

Table 2: Effect of pinching on number of primary branches of African marigold varieties.

| | $S_1$ | | $S_2$ | | $S_3$ | |
|---|---|---|---|---|---|---|
| | $M_2$ | $M_3$ | $M_2$ | $M_3$ | $M_2$ | $M_3$ |
| Pinching | | | | | | |
| $P_0$ | 10.65 | 12.70 | 10.40 | 12.12 | 10.40 | 8.87 |
| $P_1$ | 9.23 | 15.26 | 10.95 | 13.67 | 10.95 | 13.89 |
| CD (0.05) | S | S | NS | S | NS | S |
| Variety x Pinching | | | | | | |
| $T_1(V_1P_0)$ | 9.28 | 11.00 | 10.60 | 12.97 | 8.24 | 10.56 |
| $T_2(V_1P_0)$ | 9.48 | 14.08 | 10.84 | 11.33 | 10.84 | 11.59 |
| $T_3(V_2P_0)$ | 12.02 | 14.40 | 10.24 | 11.28 | 9.50 | 10.24 |
| $T_4(V_2P_1)$ | 8.98 | 16.44 | 11.06 | 16.00 | 11.06 | 16.20 |
| CD (0.05) | 1.77 | 1.65 | 1.89 | 1.20 | 1.89 | 0.67 |

The number of primary branches was 9.50 without pinching and 11.06 with pinching at 60 days after sowing in September sown crop. Number of primary branches at 90 days after sowing was 10.24 without pinching and 16.20 with pinching (Table 2)

There was significant difference in number of primary branches at 60 & 90 days after sowing in January sown crop. In May sown crop and September sown crop, significant difference was observed at 90 days after sowing as per the pooled analysis.

### 4.2.3 Number of secondary branches

#### *4.2.3.1 Pusa Narangi Gainda*

The number of secondary branches was 4.82 without pinching and 5.98 with pinching at 60 days after sowing in January sown crop. Number of secondary branches at 90 days after sowing was 52.18 without pinching and 62.20 with pinching.

In May sown crop, the number of secondary branches was 1.80 without pinching and 2.14 with pinching at 60 days after sowing. Number of secondary branches at 90 days after sowing was 43.38 without pinching and 81.11 with pinching.

The number of secondary branches was 4.12 without pinching and 5.76 with pinching at 60 days after sowing in September sown crop. Number of secondary branches at 90 days after sowing was 41.2 without pinching and 57.98 with pinching (Table 3).

#### *4.2.3.2 Pusa Basanti Gainda*

Table 3: Effect of pinching on number of secondary branches of African marigold varieties.

| | $S_1$ | | $S_2$ | | $S_3$ | |
|---|---|---|---|---|---|---|
| | $M_2$ | $M_3$ | $M_2$ | $M_3$ | $M_2$ | $M_3$ |
| Pinching | | | | | | |
| $P_0$ | 5.55 | 54.89 | 3.35 | 43.41 | 4.19 | 44.35 |
| $P_1$ | 5.17 | 60.84 | 3.83 | 82.05 | 5.99 | 69.49 |
| CD (0.05) | NS | NS | NS | S | S | S |
| Variety x Pinching | | | | | | |
| $T_1$ ($V_1P_0$) | 4.82 | 52.18 | 1.80 | 43.38 | 4.12 | 41.2 |
| $T_2$ ($V_1P_1$) | 5.98 | 62.20 | 2.14 | 81.11 | 5.76 | 57.98 |
| $T_3$($V_2P_0$) | 6.28 | 57.60 | 4.9 | 43.44 | 4.27 | 47.50 |
| $T_4$($V_2P_1$) | 4.36 | 59.48 | 5.52 | 83.00 | 6.22 | 81 |
| CD (0.05) | 1.45 | 12.21 | 0.68 | 3.42 | 0.35 | 3.39 |

The number of secondary branches was 6.28 without pinching and 4.36 with pinching at 60 days after sowing in January sown crop. Number of primary branches at 90 days after sowing was 57.60 without pinching and 59.48 with pinching.

In May sown crop, the number of secondary branches was 4.9 without pinching and 5.52 with pinching at 60 days after sowing. Number of primary branches at 90 days after sowing was 43.44 without pinching and 83.00 with pinching. The number of secondary branches was 4.27 without pinching and 6.22 with pinching at 60 days after sowing in September sown crop. Number of primary branches at 90 days after sowing was 47.50 without pinching and 81 with pinching (Table 3).

As per the pooled analysis significant difference was observed in number of secondary branches at 90 days after sowing in May and September sown crop. Maximum number of secondary branches was observed in Pusa Basanti Gainda with pinching in May sown crop.

### 4.2.4 Leaf area

#### *4.2.4.1 Pusa Narangi Gainda*

The leaf area was 177.12 $cm^2$ without pinching and 229.84 $cm^2$ with pinching at 60 days after sowing in January sown crop. Leaf area at 90 days after sowing was 1061 $cm^2$ without pinching and 1452 $cm^2$ with pinching. In May sown crop the leaf area was 367.42 $cm^2$ without pinching and 428.30 $cm^2$ with pinching at 60 days after sowing. Leaf area at 90 days after sowing was 2891 $cm^2$ without pinching and 4398 $cm^2$ with pinching.

The leaf area was 404.70 $cm^2$ without pinching and 721.36 $cm^2$ with pinching at 60 days after sowing in January sown crop. Leaf area at 90 days after sowing was 2006.36 $cm^2$ without pinching and 2796.8 $cm^2$ with pinching (Table 4).

Table 4: Effect of pinching on leaf area ($cm^2$) of African marigold varieties.

| | $S_1$ | | | $S_2$ | | | $S_3$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | $M_1$ | $M_2$ | $M_3$ | $M_1$ | $M_2$ | $M_3$ | $M_1$ | $M_2$ | $M_3$ |
| Pinching | | | | | | | | | |
| $P_0$ | 40.75 | 242.73 | 1598.94 | 32.65 | 380.06 | 2878.08 | 93.38 | 405.43 | 2380.34 |
| $P_1$ | 40.39 | 289.15 | 2017.28 | 33.37 | 423.71 | 4475.48 | 102.75 | 770.58 | 3011.26 |
| CD (0.05) | NS | S | S | NS | S | S | S | S | S |
| Variety x Pinching | | | | | | | | | |
| $T_1$ ($V_1P_0$) | 40.36 | 177.12 | 1061.46 | 34.76 | 367.42 | 2891.76 | 71.63 | 404.70 | 2006.36 |
| $T_2$ ($V_1P_1$) | 43.92 | 229.84 | 1452.66 | 34.49 | 428.30 | 4398.03 | 80.45 | 721.36 | 2796.8 |
| $T_3$($V_2P_0$) | 41.14 | 308.34 | 2136.42 | 30.54 | 392.70 | 2764.40 | 115.13 | 406.16 | 2754.32 |
| $T_4$($V_2P_1$) | 36.86 | 348.47 | 2581.90 | 32.24 | 419.72 | 4552.94 | 125.06 | 819.81 | 3225.72 |
| CD (0.05) | 7.28 | 32.84 | 267.85 | 7.04 | 48.84 | 428.36 | 7.28 | 11.78 | 256.84 |

#### *4.2.4.2 Pusa Basanti Gainda*

The leaf area was 308.34 $cm^2$ without pinching and 348.47 $cm^2$ with pinching at 60 days after sowing in January sown crop. Leaf area at 90 days after sowing was 2136 $cm^2$ without pinching and 2581 $cm^2$ with pinching.

In May sown crop the leaf area was 392.70 $cm^2$ without pinching and 419.72 $cm^2$ with pinching at 60 days after sowing. Leaf area at 90 days after sowing was 2764.40 $cm^2$ without pinching and 4552.94 $cm^2$ with pinching.

The leaf area was 406.16 $cm^2$ without pinching and 819.81 $cm^2$ with pinching at 60 days after sowing in September sown crop. Leaf area at 90 days after sowing was 2754.32 $cm^2$ without pinching and 3225.72 $cm^2$ with pinching (Table 4).

Pooled analysis revealed that, there was significant difference in number of primary branches at 60 & 90 days after sowing in January and May sown crop. In September sown crop, significant difference was observed at 30, 60 & 90 days after sowing. Maximum leaf area was recorded in Pusa Basanti Gainda with pinching in May sown crop.

### 4.2.5 Chlorophyll content (SCMR)

#### *4.2.5.1 Pusa Narangi Gainda*

The chlorophyll content was 55.13 without pinching and 51.63 with pinching at 60 days after sowing in January sown crop. Chlorophyll content at 90 days after sowing was 55.28 without pinching and 52.55 with pinching.

In May sown crop, chlorophyll content was 50.11 without pinching and 49.86 with pinching at 60 days after sowing. Chlorophyll content at 90 days after sowing was 51.36 without pinching and 54.70 with pinching.

Table 5: Effect of pinching on chlorophyll content (SCMR) of African marigold varieties.

| | $S_1$ | | | $S_2$ | | | $S_3$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | $M_1$ | $M_2$ | $M_3$ | $M_1$ | $M_2$ | $M_3$ | $M_1$ | $M_2$ | $M_3$ |
| Pinching | | | | | | | | | |
| $P_0$ | 50.62 | 54.57 | 55.22 | 49.69 | 50.65 | 53.73 | 48.62 | 51.62 | 53.10 |
| $P_1$ | 50.22 | 54.37 | 53.94 | 50.64 | 50.70 | 54.65 | 52.39 | 54.86 | 53.14 |
| CD (0.05) | NS | NS | NS | NS | NS | NS | S | S | NS |
| Variety x Pinching | | | | | | | | | |
| $T_1$ ($V_1P_0$) | 52.52 | 55.13 | 55.28 | 49.48 | 50.11 | 51.36 | 49.24 | 51.98 | 50.22 |
| $T_2$ ($V_1P_1$) | 50.34 | 51.63 | 52.55 | 54.16 | 49.86 | 54.70 | 51.52 | 53.80 | 52.00 |
| $T_3$($V_2P_0$) | 48.72 | 54.01 | 55.16 | 49.90 | 51.19 | 56.10 | 48.00 | 51.26 | 55.98 |
| $T_4$($V_2P_1$) | 50.11 | 57.12 | 55.32 | 47.12 | 51.54 | 55.23 | 53.26 | 55.92 | 54.28 |
| CD (0.05) | 4.70 | 5.23 | 4.20 | 8.47 | 4.98 | 3.64 | 3.53 | 5.22 | 5.63 |

The chlorophyll content was 51.98 without pinching and 53.80 with pinching at 60 days after sowing in September sown crop. Chlorophyll content at 90 days after sowing was 50.22 without pinching and 52.00 with pinching (Table 5).

#### *4.2.5.2 Pusa Basanti Gainda*

The chlorophyll content was 54.01 without pinching and 57.12 with pinching at 60 days after sowing in January sown crop. Chlorophyll content at 90 days after sowing was 55.16 without pinching and 55.32 with pinching.

In May sown crop the chlorophyll content was 51.19 without pinching and 51.54 with pinching at 60 days after sowing. Chlorophyll content at 90 days after sowing was 56.10 without pinching and 55.23 with pinching.

The chlorophyll content was 51.26 without pinching and 55.92 with pinching at 60 days after sowing in September sown crop. Chlorophyll content at 90 days after sowing was 55.98 without pinching and 54.28 with pinching (Table 5).

No significant difference was observed in chlorophyll content as per pooled analysis.

### 4.2.6 Number of days to first flowering

#### *4.2.6.1 Pusa Narangi Gainda*

Days to first flowering were 64.92 without pinching and 70.10 with pinching in January sown crop. In general may sown crop with pinching recorded maximum number of days to first flowering (91.55). Days to first flowering were 87.99 with pinching. September sown crop recorded minimum number of days to first flowering (60.12) without pinching. Days to first flowering were 67.42 with pinching (Table 6). September sown crop recorded minimum number of days to first flowering (60.12) without pinching. Days to first flowering were 67.42 with pinching (Table 6).

Table 6: Effect of pinching on number of days to first flowering and 50% of African marigold varieties.

| | Days to first flowering | | | Days to 50% flowering | | |
|---|---|---|---|---|---|---|
| Seasons | $S_1$ | $S_2$ | $S_3$ | $S_1$ | $S_2$ | $S_3$ |
| Pinching | | | | | | |
| $P_0$ | 69.20 | 85.18 | 63.76 | 103.19 | 110.70 | 89.21 |
| $P_1$ | 72.15 | 89.58 | 69.61 | 106.17 | 115.00 | 95.11 |
| CD (0.05) | NS | S | S | NS | S | S |
| Variety x Pinching | | | | | | |
| $T_1$ ($V_1P_0$) | 64.92 | 87.99 | 60.12 | 98.9 | 113.58 | 85.52 |
| $T_2$ ($V_1P_1$) | 70.10 | 91.65 | 67.42 | 104.14 | 117.13 | 92.92 |
| $T_3$($V_2P_0$) | 73.48 | 82.35 | 67.40 | 107.48 | 107.85 | 92.90 |
| $T_4$($V_2P_1$) | 74.20 | 87.52 | 71.80 | 108.20 | 113.04 | 97.30 |
| CD (0.05) | 5.73 | 1.28 | 1.19 | 5.73 | 1.29 | 1.20 |

***4.2.6.2 Pusa Basanti Gainda***

Days to first flowering were 73.48 without pinching and 74.20 with pinching in January sown crop. In general May sown crop with pinching recorded maximum number of days to flowering (87.52). Days to first flowering were 82.35 without pinching. September sown crop recorded minimum number of days to first flowering (67.40) without pinching. Days to first flowering were 71.80 with pinching. Pinching had significant influence on days to first flowering (Table 6).

The data subjected to pooled analysis showed that, pinching had a significant influence number of days to first flowering in May and September sown crop. Minimum number of days to first flowering was recorded in Pusa Narangi Gainda without pinching in September sown crop.

**4.2.7 Number of days to 50 per cent flowering**

***4.2.7.1 Pusa Narangi Gainda***

Days to 50 per cent flowering were 98.90 without pinching and 104.14 with pinching in January sown crop. In general May sown crop with pinching recorded maximum number of days to 50 per cent flowering (117.13). Days to 50 per cent flowering were 113.58 without pinching. September sown crop recoded minimum number of days to first flowering (85.52) without pinching. Days to 50 per cent flowering were 92.92 with pinching (Table 6).

***4.2.7.2 Pusa Basanti Gainda***

Days to 50 per cent flowering were 107.48 without pinching and 108.20 with pinching in January sown crop. In general May sown crop with pinching recorded maximum number of days to 50 per cent flowering (113.04). Days to 50 per cent flowering were 107.85 without pinching. September sown crop recorded minimum

number of days to 50 per cent flowering (92.90) without pinching. Days to 50 per cent flowering were 97.30 with pinching (Table 6).

Pooled analysis revealed that pinching had significant influence on days to 50 per cent flowering in May and September sown crop. Minimum number of days 50 per cent flowering was recorded in Pusa Narangi gainda without pinching in September sown crop.

### 4.2.8 Number of days to first harvest

#### *4.2.8.1 Pusa Narangi Gainda*

Days to first harvest were 68.91 without pinching and 74.10 with pinching in January sown crop. In general May sown crop with pinching recorded maximum number of days to first harvest (95.65). Days to first harvest were 91.99 without pinching. September sown crop recorded minimum number of days to first harvest 64.32 without pinching. Days to first harvest were 71.42 with pinching (Table 7).

#### *4.2.8.2 Pusa Basanti Gainda*

Days to first harvest were 77.48 without pinching and 78.20 with pinching in January sown crop. In general May sown crop with pinching recorded maximum number of days to first harvest (92.32). Days to first harvest were 86.75 without pinching. September sown crop recorded minimum number of days to first harvest 71.40 without pinching. Days to first harvest were 75.80 with pinching (Table 7).

Pinching had significant influence on days to first harvest in May and September sown crop as per the pooled analysis. Pusa Narangi Gainda without pinching recorded the minimum number of days to first harvest in September sown crop.

Table 7: Effect of pinching on number of days to first harvest and flower diameter of African marigold varieties.

| | Days to first harvest | | | Flower diameter (cm) | | |
|---|---|---|---|---|---|---|
| Seasons | $S_1$ | $S_2$ | $S_3$ | $S_1$ | $S_2$ | $S_3$ |
| Pinching | | | | | | |
| $P_0$ | 73.19 | 89.37 | 67.86 | 5.07 | 4.43 | 3.80 |
| $P_1$ | 76.15 | 93.98 | 73.61 | 5.19 | 4.40 | 3.60 |
| CD (0.05) | NS | S | S | NS | NS | NS |
| Variety x Pinching | | | | | | |
| $T_1$ ($V_1P_0$) | 68.91 | 91.99 | 64.32 | 4.50 | 5.04 | 3.04 |
| $T_2$ ($V_1P_1$) | 74.10 | 95.65 | 71.42 | 4.90 | 4.82 | 2.90 |
| $T_3$($V_2P_0$) | 77.48 | 86.75 | 71.40 | 5.64 | 3.82 | 4.56 |
| $T_4$($V_2P_1$) | 78.2 | 92.32 | 75.8 | 5.48 | 3.97 | 4.42 |
| CD (0.05) | 5.72 | 1.83 | 1.32 | 0.42 | 0.55 | 0.42 |

### 4.2.9 Flower diameter

#### *4.2.9.1 Pusa Narangi Gainda*

Flower diameter was 4.50 cm without pinching and 4.90 cm with pinching in January sown crop. In general May sown crop without pinching recorded maximum flower diameter (5.04 cm). Flower diameter was 4.82 cm with pinching. In September sown crop minimum flower diameter was recorded 2.90 with pinching. Flower diameter was 3.04 cm without pinching (Table 7).

#### *4.2.9.2 Pusa Basanti Gainda*

In general January sown crop without pinching was recorded maximum flower diameter (5.64 cm). Flower diameter was 5.42 cm with pinching. May sown crop recorded minimum flower diameter was 3.82 cm without pinching. Flower diameter was 3.97 cm with pinching. In September sown crop flower diameter was 4.56 cm without pinching and 4.42 cm with pinching (Table 7).

Pinching had no significant influence on flower diameter as per the pooled analysis.

### 4.2.10 Length of flower stalk

#### *4.2.10.1 Pusa Narangi Gainda*

Length of flower stalk was 7.06 cm without pinching and 6.62 cm with pinching in January sown crop. In general May sown crop recorded minimum flower diameter (4.92 cm) with pinching. Length of flower stalk was 5.20 cm without pinching. September sown crop recorded maximum length of flower stalk (7.32 cm) without pinching. Length of flower stalk was 7.30 cm with pinching (Table 8).

#### *4.2.10.2 Pusa Basanti Gainda*

Length of flower stalk was 6.62 cm without pinching and 6.84 cm with pinching in January sown crop. In May sown crop length of flower stalk was 7.04 cm

Table 8: Effect of pinching on flower weight and length of flower stalk of African marigold varieties.

| | Length of flower stalk (cm) | | | Flower weight (g) | | |
|---|---|---|---|---|---|---|
| Seasons | $S_1$ | $S_2$ | $S_3$ | $S_1$ | $S_2$ | $S_3$ |
| Pinching | | | | | | |
| $P_0$ | 6.84 | 6.12 | 6.25 | 4.93 | 4.9 | 3.62 |
| $P_1$ | 6.73 | 5.83 | 6.24 | 4.71 | 4.3 | 3.62 |
| CD (0.05) | NS | NS | NS | NS | NS | NS |
| Variety x pinching | | | | | | |
| $T_1$ ($V_1P_0$) | 7.06 | 5.20 | 7.32 | 4.34 | 6.40 | 3.06 |
| $T_2$ ($V_1P_1$) | 6.62 | 4.92 | 7.3 | 4.31 | 4.8 | 3.12 |
| $T_3$($V_2P_0$) | 6.62 | 7.04 | 5.18 | 5.52 | 3.4 | 4.18 |
| $T_4$($V_2P_1$) | 6.84 | 6.73 | 5.18 | 5.11 | 3.7 | 4.12 |
| CD (0.05) | 0.98 | 0.48 | 0.09 | 0.51 | 1.22 | 0.29 |

without pinching and 6.73 cm with pinching. In September sown crop length of flower stalk was 5.18 cm without pinching and 5.18 cm with pinching. Pinching had no significant influence on length of flower stalk (Table 8).

Pooled analysis revealed that pinching had no significant influence on length of flower stalk.

**4.2.11Flower weight**

***4.2.11.1 Pusa Narangi Gainda***

Flower weight was 4.34 cm without pinching and 4.31 cm with pinching in January sown crop. In May sown crop mean flower weight was 6.40 cm without pinching and 4.8 cm with pinching. In September sown crop mean flower weight was 3.06 cm without pinching and 3.12 cm with pinching. Pinching had no significant influence on mean flower weight (Table 8).

***4.2.11.2 Pusa Basanti Gainda***

In Pusa Basanti Gainda, mean flower weight was 5.52 cm without pinching and 5.11 cm with pinching in January sown crop. In May sown crop mean flower weight was 3.4 cm without pinching and 3.7 cm with pinching. In September sown crop mean flower weight was 4.18 cm without pinching and 4.12 cm with pinching. Pinching had no significant influence on mean flower weight (Table 8).

Data subjected to pooled analysis showed that pinching had no significant influence on flower weight.

**4.2.12 Number of flowers per plant**

***4.2.12.1 Pusa Narangi Gainda***

In general maximum number of flowers was recorded in January sown crop (125.16) with pinching. Number of flowers per plant was 97.00 without pinching. In

Table 9: Effect of pinching on numbers of flowers per plant and floweryield per plant African marigold varieties.

| | Number of flowers per plant | | | Flower yield per plant (g) | | | % increase in yield due to pinching | | |
|---|---|---|---|---|---|---|---|---|---|
| Seasons | $S_1$ | $S_2$ | $S_3$ | $S_1$ | $S_2$ | $S_3$ | $S_1$ | $S_2$ | $S_3$ |
| Pinching | | | | | | | | | |
| $P_0$ | 92.88 | 47.35 | 47.20 | 455.88 | 237.80 | 175.49 | 28% | 14% | 15% |
| $P_1$ | 123.82 | 63.45 | 55.14 | 583.60 | 271.37 | 203.14 | | | |
| CD (0.05) | S | S | S | S | NS | S | | | |
| Variety x Pinching | | | | | | | | | |
| $T_1$ ($V_1P_0$) | 97.0 | 51.46 | 37.6 | 420.85 | 330.63 | 113.54 | 28.43% | 1.2% | 34.04% |
| $T_2$ ($V_1P_1$) | 125.16 | 69.34 | 48.4 | 540.53 | 334.69 | 151.2 | | | |
| $T_3$($V_2P_0$) | 88.76 | 43.21 | 56.8 | 490.9 | 144.97 | 237.44 | 27.65% | 43.5% | 7.4% |
| $T_4$($V_2P_1$) | 122.48 | 57.56 | 61.8 | 626.66 | 208.04 | 255.09 | | | |
| CD (0.05) | 8.49 | 6.27 | 2.59 | 66.36 | 80.13 | 21.80 | | | |

May sown crop number of flowers per plant was 51.46 without pinching and 69.34 with pinching. Minimum number of flowers was recorded in September sown crop (37.60) without pinching. Number of flowers per plant was 48.40 with pinching (Table 9).

***4.2.12.2 Pusa Basanti Gainda***

In general January sown crop was recorded maximum number of flowers (122.48) with pinching. Number of flowers per plant was 88.76 without pinching. May sown crop without pinching was recorded minimum number of flowers per plant (43.21). Number of flowers per plant was 57.56 cm with pinching. In September sown crop number of flowers per plant was 56.80 without pinching and 61.8 with pinching (Table 9)

Pinching had significant influence on number of flowers per plant as per pooled analysis. Maximum number of flowers was recorded in Pusa Narangi Gainda with pinching in January sown crop.

**4.2.13 Flower yield**

***4.2.13.1 Pusa Narangi Gainda***

In general January sown crop recorded maximum flower yield (540.53 g) with pinching. Flower yield was 420.85 g without pinching. In May sown crop flower yield was 330.63 g without pinching and 334.70 g with pinching. September sown crop recorded minimum flower yield (113.54 g). Flower yield was 151.2 g with pinching (Table 9).

**4.2.14 Duration of flowering**

***4.2.14.1 Pusa Narangi Gainda***

Maximum duration of flowering was observed in January sown crop (69.20) without pinching. Duration of flowering was 65.46 with pinching. In May sown crop

duration of flowering was 53.00 without pinching and 52.60 with pinching. Minimum duration of flowering was observed in September sown crop (45.80) without pinching. Duration of flowering was 45.80 without pinching and 46.60 with pinching (Table 10).

#### *4.2.13.2 Pusa Basanti Gainda*

In general January sown crop recorded maximum flower yield (626.66 g) with pinching. Flower yield was 490.90 g without pinching. Minimum flower yield was recorded in May sown crop (144.97) without pinching. Flower yield was 208.04 g with pinching. In September sown crop flower yield was 237.44 g without pinching and 255.09 g with pinching.

Pinching had no significant influence on duration of flowering as per the pooled analysis (Table 10).

### 4.2.15 Total biomass

#### *4.2.15.1 Pusa Narangi Gainda*

Total biomass was 77.48 g without pinching and 80.16 g with pinching in January sown crop. Maximum total biomass was observed in May sown crop (120.52 g) with pinching. Total biomass was 105.84 g without pinching. Minimum total biomass was observed in September sown crop (66.18 g) without pinching. Total biomass was 89.12 g with pinching (Table 10).

#### *4.2.15.2 Pusa Basanti Gainda*

Minimum total biomass was observed in January sown crop (92.08) without pinching. Total biomass was 92.08 g without pinching and 112.74 g with pinching in January sown crop. In May sown crop total biomass was 117.54 g without pinching and 123.34 g with pinching. Maximum total biomass was recorded in September sown crop (123.40 g) with pinching. Total biomass was 114.30 g without pinching.

Table 10: Effect of pinching on duration of flowering and total biomass of African marigold varieties.

| Parameter | Duration of flowering | | | Total Biomass (g) | | |
|---|---|---|---|---|---|---|
| Seasons | $S_1$ | $S_2$ | $S_3$ | $S_1$ | $S_2$ | $S_3$ |
| Pinching | | | | | | |
| $P_0$ | 67.42 | 53.0 | 49.4 | 84.78 | 111.69 | 90.24 |
| $P_1$ | 64.64 | 53.3 | 48.9 | 96.45 | 121.93 | 106.26 |
| CD (0.05) | S | NS | NS | S | S | S |
| Variety x pinching | | | | | | |
| $T_1$ ($V_1P_0$) | 69.20 | 53.0 | 45.8 | 77.48 | 105.84 | 66.18 |
| $T_2$ ($V_1P_1$) | 65.46 | 52.6 | 46.6 | 80.16 | 120.52 | 89.12 |
| $T_3$($V_2P_0$) | 65.64 | 53.0 | 53.0 | 92.08 | 117.54 | 114.30 |
| $T_4$($V_2P_1$) | 63.82 | 54.0 | 51.2 | 112.74 | 123.34 | 123.40 |
| CD (0.05) | 3.34 | 0.78 | 1.98 | 5.97 | 7.14 | 1.98 |

The data subjected to pooled analysis revealed that pinching had significant influence on total biomass. Maximum total biomass was recorded in Pusa Basanti Gainda with pinching in May sown crop (Table 10).

**4.2.16 Post harvest longevity**

***4.2.16.1 Pusa Narangi Gainda***

In Pusa Narangi Gainda, post harvest longevity was 3.14 without pinching and 3.18 with pinching in January sown crop. In May sown crop post harvest longevity was 5.80 without pinching and 6.0 with pinching. In September sown crop post harvest longevity was 4 without pinching and 4 with pinching. Pinching had no significant influence on post harvest longevity (Table 11).

***4.2.16.2 Pusa Basanti Gainda***

In Pusa Basanti Gainda, post harvest longevity was 3.8 without pinching and 4.2 with pinching in January sown crop. In May sown crop post harvest longevity was 5.96 without pinching and 5.8 with pinching. In September sown crop post harvest longevity was 4 without pinching and 4 with pinching.

Pinching had no significant influence on post harvest longevity as per the pooled analysis (Table 11).

**4.3 Pest and disease incidence**

Irrespective of varieties and pinching in January sown crop mild incidence of mosaic disease was observed. In May sown crop, attack of thrips was observed. Bacterial wilt was also observed. Mite attack was observed in September sown crop.

**4.4 Benefit cost analysis**

Benefit Cost ratio was maximum for Pusa Basanti Gainda with pinching in January sown crop (3.2) compared to all other treatments. In May sown crop BCR was maximum in Pusa Narangi Gainda with pinching (2.5). Compared to the other two seasons, BCR was low in September sown crop.

Table 11: Effect of pinching on post harvest longevity of African marigold varieties.

| Parameter | Post harvest longevity | | |
|---|---|---|---|
| Seasons | $S_1$ | $S_2$ | $S_3$ |
| Pinching | | | |
| $P_0$ | 3.47 | 5.88 | 4 |
| $P_1$ | 4.00 | 5.9 | 4 |
| CD (0.05) | NS | NS | NS |
| Variety x Pinching | | | |
| $T_1$ | 3.14 | 5.80 | 4 |
| $T_2$ | 3.8 | 6.0 | 4 |
| $T_3$ | 3.8 | 5.96 | 4 |
| $T_4$ | 4.2 | 5.8 | 4 |
| CD (0.05) | 1.29 | 0.34 | NS |

Table 12. Benefit Cost Analysis ($ha^{-1}$)

| Parameters | $S_1$ | | | | $S_2$ | | | | $S_3$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $V_1P_0$ | $V_1P_1$ | $V_2P_0$ | $V_2P_1$ | $V_1P_0$ | $V_1P_1$ | $V_2P_0$ | $V_2P_1$ | $V_1P_0$ | $V_1P_1$ | $V_2P_0$ | $V_2P_1$ |
| Land preparations | 42,600 | 42,600 | 42,600 | 42,600 | 42,600 | 42,600 | 42,600 | 42,600 | 42,600 | 42,600 | 42,600 | 42,600 |
| Cost of seed | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 |
| Nursery raising | 7400 | 7400 | 7400 | 7400 | 7400 | 7400 | 7400 | 7400 | 7400 | 7400 | 7400 | 7400 |
| Transplanting | 3800 | 3800 | 3800 | 3800 | 3800 | 3800 | 3800 | 3800 | 3800 | 3800 | 3800 | 3800 |
| Cost of manures&fertilizers | 66958 | 66958 | 66958 | 66958 | 66958 | 66958 | 66958 | 66958 | 66958 | 66958 | 66958 | 66958 |
| Irrigation | 3000 | 3000 | 3000 | 3000 | 1000 | 1000 | 1000 | 1000 | 1500 | 1500 | 1500 | 1500 |
| Weeding | 2500 | 2500 | 2500 | 2500 | 4000 | 4000 | 4000 | 4000 | 1500 | 1500 | 1500 | 1500 |
| Plant protection+pinching | 1000 | 1000+ 5400 | 1000 | 1000+ 5400 | 1000 | 1000+ 5400 | 1000 | 1000+ 5400 | 1000 | 1000+ 5400 | 1000 | 1000+ 5400 |
| Staking | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 |
| Harvesting | 42000 | 42000 | 42000 | 42000 | 42000 | 42000 | 42000 | 42000 | 42000 | 42000 | 42000 | 42000 |
| Transportation | 15000 | 15000 | 15000 | 15000 | 15000 | 15000 | 15000 | 15000 | 15000 | 15000 | 15000 | 15000 |
| Total cost | 186158 | 191558 | 186158 | 191558 | 185658 | 191058 | 185658 | 191058 | 183658 | 189058 | 183658 | 189058 |
| Marketable yield(Kg/ha) | 6441.57 | 7517.4 | 8855.7 | 10227 | 5497.54 | 6205.3 | 4026.83 | 4528.72 | 3153.8 | 4199.8 | 6595.3 | 7085.6 |
| Return @60/kg (Rs) | 386494 | 451044 | 531342 | 613620 | @80/kg 439803.9 | 496428 | 322146.5 | 362298.1 | @60/kg 189228 | 251992 | 395722.2 | 425138 |
| BCR | 2.07:1 | 2.3:1 | 2.8:1 | 3.2:1 | 2.3:1 | 2.5:1 | 1.7:1 | 1.8:1 | 1.0:1 | 1.3:1 | 2.1:1 | 2.2:1 |

# DISCUSSION

# 5. DISCUSSION

In Kerala, marigold flower have good demand throughout year; however, commercial cultivation is quite low due to lack of knowledge on agro techniques of the crop and lack of open space. In order to popularize marigold cultivation in Kerala, a tested package of practices need to be developed, which can be adopted by farmers. So the present study entitled "Impact of seasons and pinching on growth and flowering in African marigold (*Tagetes erecta* L.)" was carried out at the Department of Pomology and Floriculture, College of Agriculture, Padannakkad, Kasaragod, during the period from October 2013 to April 2015. The observations on the effect of three seasons and pinching on growth and yield of African marigold are briefly discussed here under.

## 5.1 EFFECT OF TIME OF PLANTING (SEASONS) ON GROWTH AND YIELD OF AFRICAN MARIGOLD

### 5.1.1 Effect on plant height

In Pusa Narangi Gainda, maximum plant height at 90 days after sowing was recorded in May sown crop and the minimum was in January sown crop. This might be due to the fact that plant height was influenced by genotype x environment interaction. Similar results were reported by Pramila *et al*., (2011) and Ismail *et al*., (2013) in marigold; Barman *et al*., (1997) in chrysanthemum. They reported that during monsoon season, plant exhibited a tendency for continued vegetative growth for a longer period.

### 5.1.2 Effect on number of primary branches

The varieties exhibited different pattern in the production of primary branches during the three seasons. Similar observations were reported by Pramila *et al*.,

**January sown**

**May sown**

**September sown**

Plate 1. Layout of the experimental plot at different planting time.

(2011) and Lakshmi *et al.,* (2014) in marigold and Jane and Kawarkhe (2002) and Prasad and Reddy (2003) in chrysanthemum

### 5.1.3 Effect on number of secondary branches

In Pusa Narangi Gainda and Pusa Basanti Gainda maximum number of secondary branches was observed in January sown crop. In Pusa Narangi Gainda minimum was observed in September sown crop, in Pusa Basanti Gainda minimum number of secondary branches was observed in May sown crop. The above results are in line with the findings of Mohanty *et al*., (2012) in marigold and Aamir *et al*., (2009) in chrysanthemum.

### 5.1.4 Effect on leaf area

Maximum leaf area was recorded in May sown crop in Pusa Narangi Gainda and Pusa Basanti Gainda and the minimum was in January sown crop. Time of plating had significant effect on leaf area. This was confirmed in chrysanthemum (Barman *et al*., 1997, Aamir *et al*., 2009), in china aster (Gowda. 1990), in gladiolus (Dod *et al*., 1989, Ahamad *et al*., 2011, Mohammad *et al*., 2012).

### 5.1.5 Effect on chlorophyll content (SCMR Reading)

In Pusa Narangi Gainda, maximum chlorophyll content was recorded in January sown crop and the minimum in September sown crop. In Pusa Basanti Gainda, maximum chlorophyll content was observed in May sown crop and the minimum was in January sown crop.

### 5.1.6 Effect on days to first flowering

Minimum number of days to first flowering was observed in September sown crop in both the varieties and the maximum number of days to first flowering in May sown crop. This early flowering might be due to the shorter days. Similar results were

reported by Samantaray *et al*., (1999), Rao and Reddy (2002) and Rao and Moon (2003) in marigold.

### 5.1.7 Effect on days to 50 per cent flowering

In Pusa Narangi Gainda and Pusa Basanti Gainda, minimum number of days to 50 per cent flowering was observed in September sown crop and the maximum number of days to 50 per cent flowering was observed in May sown crop. Time of planting had significant effect on days to 50 per cent flowering. These results were similar with the findings of Meher *et al.,* (1999) in chrysanthemum and Gowda (1990) in china aster.

### 5.1.8 Effect on days to first harvest

In both the varieties, minimum number of days to first harvest was observed in September sown crop and the maximum number of days to first harvest was observed in May sown crop. This is an accordance with the findings of Samantaray *et al*., (1999) and Rao and Reddy (2002) in marigold and Sanjib and Talukdar (2002), Nijasure and Ranpise (2005) in gladiolus.

### 5.1.9 Effect on flower diameter

Maximum flower diameter was recorded in May sown crop and minimum was observed in September sown crop in Pusa Narangi Gainda. But in Pusa Basanti Gainda, maximum flower diameter was observed in January sown crop and minimum flower diameter was recorded in May sown crop. Similar works were reported by Raju *et al*., (2006) in French marigold, Mohanty *et al*., (2012) and Lakshmi *et al*., (2014) in African marigold.

### 5.1.10 Effect on length of flower stalk

In Pusa Narangi Gainda, maximum length of flower stalk was recorded in January sown crop and minimum length of flower stalk was recorded in May sown

crop. In Pusa Basanti Gainda maximum length of flower stalk was recorded in May sown crop and minimum length of flower stalk was recorded in September sown crop. These findings are in close conformity with the results of Deshmane *et al*., (2012) in French marigold and Barman *et al.,* (1997) in chrysanthemum.

### 5.1.11 Effect on flower weight

Pusa Narangi Gainda recorded maximum flower weight in May sown crop and minimum in September sown crop. In Pusa Basanti Gainda, January sown crop recorded maximum flower weight and May sown crop recorded minimum flower weight. Varietal variation in flower weight according to season was observed. This is an accordance with the findings of Raju *et al*., (2006), Deshmane *et al*., (2012) in French marigold; Barman *et al*., (1997) in chrysanthemum; Jane and Kawarkhe (2002) in china aster.

### 5.1.12 Effect on number of flowers per plant

January sown crop recorded the maximum number of flowers per plant in Pusa Narangi Gainda and Pusa Basanti Gainda. Pusa Narangi Gainda recorded the minimum number of flowers in September sown crop. But in Pusa Basanti Gainda, minimum number of flowers was recorded in May sown crop. These results were similar with the findings of Samantaray *et al*., (1999) and Pramila *et al.,* (2011) in African marigold.

### 5.1.13 Effect on flower yield per plant

In Pusa Narangi Gainda and Pusa Basanti Gainda maximum flower yield was recorded in January sown crop. Minimum flower yield was recorded in September sown crop in Pusa Narangi Gainda and in May sown crop in Pusa Basanti Gainda.

Pusa Narangi Gainda

Pusa Basanti Gainda

Plate 2 African marigold varieties at flowering stage

Similar results were reported in African marigold (Samantaray *et al*., (1999); in carnation (Ditta *et al*., (2006); in gladiolus (Mohammad *et al*., (2012).

### 5.1.14 Effect on duration of flowering

Maximum duration of flowering was observed in January sown crop in both the varieties. In Pusa Narangi Gainda, September sown crop recorded the minimum duration of flowering and in Pusa Basanti Gainda, minimum duration of flowering was recorded in May sown crop.

### 5.1.15 Effect on total biomass

Highest biomass was recorded in May sown crop in both the varieties. But in Pusa Narangi Gainda minimum biomass was recorded in September sown crop. In Pusa Basanti Gainda, January sown crop recorded the minimum biomass. These results were close conformity with the findings of Samantaray *et al.*, (1999) in African marigold.

### 5.1.16 Effect on post harvest longevity

May sown crop recorded the maximum post harvest longevity and January sown crop recorded the minimum post harvest longevity in both the varieties.

## 5.2 EFFECT OF PINCHING ON GROWTH AND YIELD OF AFRICAN MARIGOLD

### 5.2.1 Effect on plant height

Pinching treatment had significant difference on plant height. Irrespective of season, non pinched plants recorded maximum plant height in both the varieties. This might be due to the arrest of apical dominance by way of pinching which stopped further plant growth. These results are in close conformity with the findings of Arora and Khanna (1986), Bhati and Chitkara (1987), Sehrawat *et al*., (2003), Chauhan *et*

*al*., (2005), Kumar *et al*., (2012) in African marigold; Singh and Baboo (2003), Rakesh *et al*., (2003) in chrysanthemum; Pathania *et al*., (2000), Chavan *et al*., (2004), Ditta *et al*., (2006) in carnation; Gnyandev (2006), Khobradge *et al*., (2012) in china aster.

### 5.2.2 Effect on number of primary branches

Number of primary branches was significantly influenced by pinching. Pinched plants recorded highest number of primary branches in both the varieties irrespective of the season. This might be due to the arrest of apical dominance by way of pinching which stopped further plant growth and induced more number of primary branches. Similar results were reported by Arora and Khanna (1986), Khandelwal *et al*., (2003), Chauhan *et al*., (2005), Sunitha *et al*., (2007), Rajbeer *et al*., (2009) in African marigold; Rakesh *et al*., (2003) in chrysanthemum; Ranjith *et al*., (2005) in carnation; Sailaja and Panchabhai (2014) in china aster.

### 5.2.3 Effect on number of secondary branches

As per the pinching treatment, the number of secondary branches was found to be increased. Highest number of secondary branches was observed in pinched plants in all the three seasons in both the varieties. By the way of arresting apical dominance, pinching induced more number of secondary branches. This is accordance with findings of Srivastava *et al*., (2005) in African marigold.

### 5.2.4 Effect on leaf area

Leaf area had direct influence with respect to pinching treatment. Pinched plants recorded maximum leaf area than non pinched plants in both the varieties irrespective of the season. Similar result was reported in African marigold by Mohanty *et al*., (2012).

### 5.2.5 Effect on chlorophyll content

No significant difference was observed in chlorophyll content as per the pinching treatment.

### 5.2.6 Effect on days to first flowering

In general pinching treatment delayed the first flowering in marigold. Non pinched plants recorded minimum number of days to first flowering in both the varieties irrespective of the season. This might be due to the fact that pinched plants took more time to become physiologically mature enough to enter into reproductive phase. These results are in close conformity with the findings of Srivastava *et al*., (2005) in African marigold; Grawal *et al*., (2004) in chrysanthemum; Gnyandev (2006) in china aster.

### 5.2.7 Days to 50 per cent flowering

Pinching had a significant difference in number of days to 50 per cent flowering. Non pinched plants recorded minimum number of days to 50 per cent flowering in both the varieties irrespective of the season. This might be due to the fact that by removing the apical position, the plant continued vegetative phase and the new shoot took longer time to physiologically mature, which in turn bears flowers, and thus resulted in delayed initiation of flower bud and 50 per cent flowering in plants subjected to late pinching.

### 5.2.8 Effect on days to first harvest

Number of days to first harvest was significantly influenced by pinching. Non pinched plants took more number of days to first harvest in both the varieties irrespective of the season.

### 5.2.9 Effect on flower diameter

Pinching had no significant influence on flower diameter in both the varieties irrespective of the season. However varietal variation in flower diameter was observed.

### 5.2.10 Effect on length of flower stalk

No significant difference was observed in length of flower stalk with respect to pinching. Similar finding was reported by Ferrato *et al*., (1996) in chrysanthemum.

### 5.2.11 Effect on flower weight

Flower weight had not influenced by pinching treatment in both the varieties.

### 5.2.12 Effect number of flowers per plant

As per the pinching treatment number of flowers was found to be increased. Pinched plants recorded maximum number of flowers per plant in both the varieties irrespective of the season. This is an accordance with the findings of Bhati and Chitkara (1987), Tomar *et al*., (2004), Srivastava *et al*., (2005), Chauhan *et al*., (2005), Rajyalakshmi and Rajasekhar (2014) in African marigold; John and Paul (1995), Singh and Baboo (2003), Grawal *et al*., (2004), Dorajeerao and Mokashi (2012) in chrysanthemum; Ryagi *et al*., (2007), Gnyandev (2006), Suneetha *et al*., (2014) in china aster.

### 5.2.13 Effect on flower yield per plant

Flower yield per plant was significantly influenced by pinching. Highest flower yield was recorded in pinched plants in both the varieties in all the three seasons. Similar results were reported by Srivastava *et al*., (2005), Chauhan *et al*., (2005), Rajbeer *et al.,*(2009), Mohanty *et al*., (2012), Sharma *et al*., (2012), Rajyalakshmi and Rajasekhar (2014) in African marigold.

### 5.2.14 Effect on duration of flowering

Pinching had no significant influence on duration of flowering in both the varieties.

### 5.2.15 Effect on total biomass

Total biomass of the plant was significantly influenced by pinching. Maximum total biomass was recorded in pinched plants in both the varieties irrespective of the season. This might be due to the increased production of primary and secondary branches.

### 5.2.16 Effect on post harvest longevity

Post harvest longevity of flower mainly depends on the length of flower stalk and climatic condition. Pinching had no significant influence on post harvest longevity in both the varieties.

## 5.3 Benefit cost ratio analysis

In general maximum BCR was recorded in January sown cop. In Kerala condition pre monsoon season (January-April) can be recommended for commercial cultivation of African marigold varieties. Compared to all other two season BCR was low in September sown crop.

# *SUMMARY*

# 6. SUMMARY

Effect of season and pinching on growth and yield of African marigold varieties, Pusa Narangi Gainda and Pusa Basanti Gainda on growth and yield were investigated at Department of Pomology and Floriculture, College of Agriculture, Padannakkad, Kasaragod during the period from October 2014 to April 2015. The study revealed the following results.

- Plant height was significantly influenced by season and pinching in African marigold varieties. Pusa Narangi Gainda recorded maximum plant height in May sown crop and Pusa Basanti Gainda recorded maximum plant height in September sown crop. Pinched plants showed minimum plant height than non pinched plants irrespective of the season and varieties.
- Season had no direct influence on number of primary branches and secondary branches in both the varieties. Pinched plants recorded maximum number of primary branches irrespective of the season and varieties.
- The effect of season and pinching on leaf area was also significant. In both the varieties May sown crop recorded maximum leaf area. Irrespective of the season and varieties pinched plants recorded more leaf area than non pinched plants.
- Chlorophyll content was not significantly influenced by season and pinching.
- The number of days to first flowering, days to 50 per cent flowering and days to first harvest was significantly influenced by season and pinching. Minimum number of days was recorded in September sown crop without pinching.
- Flower diameter, length of flower stalk and flower weight was not significantly influenced by season and pinching.
- Both the varieties recorded maximum number of flowers in January sown crop. Pinched plants produced more number of flowers per plant.

- Flower yield per plant was maximum in January sown crop. Pinched plants recorded more flower yield in both the varieties.
- January sown crop recorded maximum total biomass in both the varieties, irrespective of season and varieties pinched plants recorded highest total biomass.
- The effect of season and pinching was not significant with respect to post harvest longevity.
- Highest B: C ratio was observed in Pusa Basanti Gainda with pinching in January sown crop.

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# IMPACT OF SEASONS AND PINCHING ON GROWTH AND FLOWERING IN AFRICAN MARIGOLD (*Tagetes erecta* L.)

**by**

**SRUTHI PRAKASH N.**

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**DEPARTMENT OF POMOLOGY AND FLORICULTURE**
**COLLEGE OF AGRICULTURE**
**PADANNAKKAD, KASARAGOD – 671 314**
**KERALA, INDIA**

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## ABSTRACT

The study entitled "Impact of seasons and pinching on growth and flowering in African marigold (T*agetes erecta* L.)" was undertaken at the College of Agriculture, Padannakkad during 2013-2015. The experiment was conducted in three seasons namely, premonsoon (January 2014), monsoon (May 2014) and postmonsoon season (September 2014).The experiment consisted of two varieties ($V_1$- Pusa Narangi Gainda, $V_2$- Pusa Basanti Gainda) and two levels of pinching ($P_0$- no pinching, $P_1$- pinching at 30 days after transplanting). The interaction effect of variety x pinching on growth and yield was also studied.

Pinching had significant influence on growth and flowering of two African marigold varieties. Growth parameters like plant height, number of primary branches, number of secondary branches, leaf area and total biomass varied with pinching during three seasons. In both the varieties maximum number of primary branches was observed in January sown crop with pinching. In both the varieties, May sown crop recorded maximum number of secondary branches with pinching. Leaf area and total biomass was found maximum in May sown crop for both the varieties with pinching. Early flowering was observed in September sown crop. Flower diameter, length of flower stalk and flower weight was not influenced by season and pinching.

Maximum number of flowers and flower yield was observed in January sown crop in both the varieties with pinching. Among the varieties, Pusa Basanti Gainda can be recommended for cultivation during premonsoon season (Jan- April). In monsoon season, Pusa Narangi Gainda can be recommended for cultivation to meet the demand during Onam season.

# *APPENDIX*

## APPENDIX

1. Monthly weather data during the crop period

| Period | Monthly weather data during the crop period | | | | | |
|---|---|---|---|---|---|---|
| | Temperature (°C) | | Relative humidity (%) | | Total Rainfall (mm) | Sunshine hours |
| | Max | Min | Max | Min | | |
| January | 32.59 | 20.30 | 91.68 | 58.81 | 0.00 | 8.34 |
| February | 32.92 | 21.36 | 91.75 | 61.21 | 0.00 | 7.48 |
| March | 33.24 | 22.19 | 86.87 | 61.42 | 0.00 | 7.69 |
| April | 34.51 | 24.56 | 82.50 | 66.10 | 50.43 | 6.46 |
| May | 33.04 | 24.17 | 86.26 | 69.53 | 250.24 | 6.21 |
| June | 31.18 | 23.57 | 90.43 | 77.26 | 576.18 | 2.48 |
| July | 29.22 | 22.94 | 92.18 | 84.60 | 1456.38 | 0.66 |
| August | 29.22 | 22.92 | 93.56 | 79.46 | 754.55 | 2.06 |
| September | 31.00 | 23.34 | 90.38 | 71.39 | 144.74 | 4.44 |
| October | 31.51 | 23.13 | 89.05 | 69.82 | 168.58 | 3.28 |
| November | 32.30 | 21.31 | 88.54 | 63.09 | 83.65 | 4.49 |
| December | 32.39 | 21.65 | 89.78 | 59.39 | 0.00 | 4.37 |