RESPONSE OF AFRICAN MARIGOLD (Tagetes erecta L.) cv. ORANGE TO SEEDLING AGE, PLANTING TIME AND PINCHING

A

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RESPONSE OF AFRICAN MARIGOLD (*Tagetes erecta* L.) CULTIVAR ORANGE TO SEEDLING AGE, PLANTING TIME AND PINCHING

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A B S T R A C T

An experiment was carried out to study the 'response of African marigold (*Tagetes erecta* L.) cv. Orange to seedling age, planting time and pinching' in medium black soil of South Gujarat at the Regional Fruit Research Station, Gujarat Agricultural University, Navsari Campus, Navsari during the summer season of the year 1993-94.

Twenty four treatment combinations comprising of two seedling age viz., S_1 (30 days after sowing) and S_2 (40 days after sowing), three treatments of planting time viz., T_1 (25th January), T_2 (5th February) and T_3 (15th February) and four pinching treatments viz., P_o (no pinching), P_1 (20 days after transplanting), P_2 (30 days after transplanting) and P_3 (40 days after transplanting) were compared using split plot design with seedling age and planting time as main plot treatments and pinching as sub-plot treatment replicated thrice.

Growth characters viz., stem diameter and number of nodes on main stem were significantly influenced by seedling age. Younger seedlings (30 days) favoured the growth of plant as compared to older seedlings (40 days). Flowering behaviour characters viz., number of days required for appearance of flower bud and flower opening, yield attributing characters viz., number and yield of flowers per plant and yield per plot were also significantly influenced by different seedling age treatments. Characters viz., plant height, number of branches and plant spread before pinching and at flowering stage and all the flower characters viz., diameter and thickness of flower, peduncle length and girth, fresh and dry weight of flower and longevity of flower were not influenced significantly by different seedling age treatments. Number and yield of flowers were registered maximum under younger seedlings (30 days) treatment.

Among the three planting times, marigold planted on 25th January found superior with respect to plant height at flowering, stem diameter, number of nodes on main stem, number of days required for appearance of flower bud and opening of flower, number and yield of flowers per plant and yield of flowers per plot.

All the characters viz., plant height, number of branches and plant spread at flowering, stem diameter, number of nodes on main stem, number of days taken for appearance of flower bud and flower opening, number and yield of flowers per plant, flower yield per plot, flower diameter, flower thickness, peduncle girth and fresh and dry weight of flower were significantly influenced by different pinching treatments.

Pinching significantly increased all the characters except number of days required for flower bud appearance and flower opening, which reduced with the increased time in pinching treatments. Maximum number and yield of flowers per plant and yield of flowers per plot were recorded by P_3 (40 days after tansplanting) treatment.

Based on the results, it is indicated that the potential production from summer African marigold on medium black soil of South Gujarat can be secured by using 30 days old seedlings planted on 25th January and pinched at 40 days after transplanting.

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C E R T I F I C A T E

This is to certify that the thesis entitled 'Response of African marigold (Tagetes erecta L.) cv. Orange to seedling age, planting time and pinching' submitted by **Shri ALKESH BHIKHABHAI PATEL** in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **HORTICULTURE** of the Gujarat Agricultural University is a record of bona fide research work carried out by him under my guidance and supervision. The thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

Navsari (S.K. Dave)

Date : July 31, 1995 **Major Advisor**

D E C L A R A T I O N

This is to declare that the whole of the research work now submitted in this thesis as a partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **HORTICULTURE,** is the result of investigation done by the undersigned under the direct guidance and supervision of **Dr. S.K. Dave,** Professor of Horticulture (Pomology), ASPEE College of Forestry & Horticulture, Gujarat Agricultural University, Navsari Campus, Navsari and that no part of the work has been submitted for any other degree so far.

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Navsari,

Date : July 31 , 1995

(A.B. Patel)

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INTRODUCTION

I. INTRODUCTION

African marigold (Tagetes erecta L.) is one of the most popular and the hardiest flowers to cultivate and has wide adaptability to different soils and climatic conditions. The plant is more popular due to its attractive colour of the flower blooms which remains for a considerable long period, and due to the freshness of the cut flower which sustains for an appreciable period of time. All these favourable points make marigold one of the most important annual flowers in India for commercial cultivation as well as for garden display.

In popularity as a cut flower, marigold ranks next to jasmine in India. In India, the total area of production under marigold cultivation is 1994 hectares with a total production of 11953 tonnes ; whereas in Gujarat, the total area under cultivation of this crop is 120 hectares with a total production of 960 tonnes during the year 1989 (Kolavalli et al.,1989 and Swarup, 1989).

Marigold is mainly grown either for cut flowers or for loose flowers. Flowers are mostly used for making garlands. It is grown throughout the year and is extensively used in religious and social functions in India.

There are many varieties of marigold in our country, but in South Gujarat, the most widely cultivated varieties are Lemon and Orange, which belong to annuals having high thickness of flowers and attractive flower colours.

The successful commercial production of marigold flowers depends upon many factors like climate, soil fertility,

L.) cv. Orange to seedling age, planting time and pinching" at the Regional Horticultural Research Station, Gujarat Agricultural University, Navsari Campus, Navsari with the following objectives:

1. To standardise the seedling age of African marigold cv. Orange for transplanting.
2. To find out the suitable planting time for summer African marigold cv. Orange in South Gujarat condition.
3. To determine the time of pinching for African marigold cv. Orange.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

Marigold (Tagetes erecta L.) is a popular commercial flower crop grown mainly for its cut flowers which are used for making garlands and for decorative purposes. Looking to its importance more systematic research should be done in India and abroad. The limited work done on seasonal flower and vegetable crops has been cited in addition to marigold.

The available literature has been chronologically reviewed as under.

2.1 Influence of seedling age on growth, yield and flower characters

The age of seedlings at the time of transplantig is more important because it exerts profound influence on vegetative growth, flowering time, yield and quality of flowers. No information has been reported regarding the effect of seedling age on growth, flowering time, yield and quality of marigold flower and other seasonal flowering crops, so, the work done on vegetable crops has been cited.

2.1.1 Influence of seedling age on growth

Singh and Singh (1974) conducted an experiment at the Experiment Station, G. B. Pant University of Agriculture and Technology, Pantnagar during 1964-65 to determine the suitable sowing time and the age of seedlings for transplanting of Pusa Red onion. Transplanting of 5 weeks old seedlings showed better growth as compared to 6 and 7 weeks old seedlings.

Lim and Wong (1975) reported that 3-4 weeks old seedlings were more vigorous in vegetative growth than those of transplanted at 5, 6 and 7 weeks age. Likewise, Norman (1977) noted that better plant growth was obtained from Capsicum plants transplanted at 5-6 weeks age over 7 weeks age. Singh and Sharma (1981) also observed that 3-4 weeks old seedlings produced more vegetative growth as compared to 5, 6 and 7 weeks old chilli seedlings.

Adelana (1983) conducted an experiment to study the effect of age of transplants on the growth and yield of tomato. The seedlings were transplanted 3, 4, 5 and 6 weeks after sowing in the nursery. From the investigation, he reported that younger seedlings grew faster than old ones.

Mangal et al., (1987) reported that the earlier planting i.e. 5 weeks old seedlings attained more vegetative growth and development of plant than later planting i.e. 7 weeks old seedlings in cabbage.

2.1.1.1 Plant height

Singh and Singh (1974) reported that the onion seedlings transplanted at the age of 4 and 5 weeks showed increase in plant height non-significantly as compared to 6 and 7 weeks old seedlings.

Maurya and Singh (1986) found that seedlings of chilli transplanted at 25 days grew significantly taller (58.25 cm) as compared to other treatments while, 40 days old seedlings remained dwarf (44.20 cm).

Vachhani and Patel (1989) did not find any effect of age of seedlings on either plant height or number of leaves per

plant in onion.

2.1.1.2 Number of branches per plant

Adelana (1983) reported that the younger transplants (3 weeks old) produced more number of branches than older transplants (5 and 6 weeks old) in tomato.

Maurya and Singh (1986) observed more number of branches per plant in case of 25 days old seedlings over 30, 35 and 40 days old seedlings in chilli.

2.1.1.3 Plant spread

Bulthuis (1983) reported that the maximum plant spread was not significantly affected in 8 weeks old seedlings than in those of 10, 12 and 14 weeks old seedlings in eggplant.

2.1.1.4 Flowering time

Lim and Wong (1975) observed that chilli seedlings transplanted at 3-4 weeks after seeding were flowered and fruited earlier than those transplanted at 5, 6 and 7 weeks after seeding. Similar results were reported by Norman (1977) in hot-pepper wherein flowering was delayed by transplanting of old seedlings. Singh and Sharma (1981) also observed that 3-4 weeks old seedlings of chilli produced flower earlier than those transplanted at 5, 6 and 7 weeks age.

Adelana (1983) noted that the flowering in the younger transplants of tomato was earlier than older transplants.

2.1.2 Influence of seedling age on yield

Verma et al., (1972) reported that the highest bulb yield of onion was obtained from the transplanting of 7 weeks old seedlings whereas, the lowest yield was obtained from the transplanting of 4 weeks old seedlings. The bulb yield increased

with increase in the age of seedlings at transplanting upto 7 weeks old seedlings and then it reduced gradually. Similar results were also reported by Singh and Singh (1974) in onion.

Lim and Wong (1975) reported that the chilli seedlings transplanted 3-4 weeks after seeding produced higher yield than those transplanted at 5, 6 and 7 weeks age. Singh and Sharma (1981) also observed that 3-4 weeks old seedlings produced higher yield than 5, 6 and 7 weeks old seedlinds in chilli.

Adelana (1983) stated that the fruit yield of tomato was the highest in the 3 to 4 weeks old transplants as compared to 6 weeks old transplants. Likewise, Cooper and Morelock (1983) also noted that the highest total yield of tomato was produced by 5 weeks old transplants than those transplanted at 7, 9 or 11 weeks age. Similar results were observed by Mc Craw and Greig (1986) in pepper.

Maurya and Singh (1986) observed that the yields of chilli were highest from plants transplanted at 25 days old seedlings compared to those transplanted at 40 days old seedlings.

Mangal et al., (1987) reported that 5 to 6 weeks old cabbage seedlings produced significantly higher yield than 7 weeks old seedlings. Similar results were also observed by Vachhani and Patel (1988) in onion.

Islam et al., (1989) observed that the highest marketable yield of cabbage was obtained with 28 days old seedlings and lowest was obtained with 42 days old seedlings.

2.1.3 Influence of seedling age on flower characters

Mangal et al., (1987) found that head quality of

cabbage was significantly improved when 5 weeks old seedlings showing the minimum length of core were planted as compared to 6 and 7 weeks old seedlings.

From the above reviews, it can be recapitulated that with different age of seedlings, the growth, yield and quality varies under each crop. Using the younger seedlings, plant growth, yield and quality can be improved in comparison to older seedlings.

2.2 Influence of planting time on growth, yield attributing characters, yield and flower characters

The growth and yield are the products of interaction between genotype and environment. Considerable variation in growth and yield of marigold flower has been reported under varied agro-climatic conditions. However, no specific information is known regarding the optimum planting time under South Gujarat conditions for which this experiment was conducted. The effect of this factor on growth, yield attributes, yield and quality of flowers under distinct climatic conditions are discussed hereunder for panoramic view.

2.2.1 Influence of planting time on growth

Kiyatkin (1975) conducted an experiment to study the effect of planting date on the growth and development of chrysanthemum. Rooted chrysanthemum cuttings were planted on 30th of March, 20th of May, 2nd of June and 8th of July. From the investigation, he observed that the late plantings retarded vegetative growth but May planting resulted in vigorous growth of plants.

An experiment was conducted by Yadav and Bose (1988) to standardise the time of planting for cultivation of marigold. This crop was transplanted in main field in the first fortnight of January, February, March and April. They observed that the seedlings transplanted in January recorded better plant growth than later planting.

2.2.1.1 Plant height

Kiyatkin (1975) observed that out of four planting dates viz., 30th of March, 20th of May, 2nd of June and 8th of July, the earliest planting proved superior in increasing the plant height in chrysanthemum than those planted later.

Mukhopadhyay and Bankar (1981) observed that the height of tuberose plant comparatively increased during the planting dates of January than in other months.

The trials were conducted by Saini et al., (1988) to study the effect of planting time on gladiolus flowering and cormel production at Department of Horticulture, Haryana Agricultural University, Hissar during 1987-88. Gladiolus was planted on four different dates viz., 25th of October, 10th of November, 25th of November and 10th of December. They observed that gladiolus planted on 10th of November produced the tallest plants whereas, minimum plant height was noticed when planted on the 10th of December.

Dod et al., (1989) reported that the highest plant height was obtained in gladiolus planted on the earliest date (3rd September) than late dates (18th September and 3rd October).

Singh (1990) noted that the seedlings transplanted on 15th of February recorded highest plant height (129.98 cm) in

marigold than those planted on 15th of March and on 15th of April.

2.2.1.2 Number of branches

Yadav and Bose (1988) reported that the seedlings transplanted in January recorded the highest number of branches per marigold plant than those transplanted in February, March and April.

Chanda and Roychoudhury (1991) observed that the maximum number of branches per plant were found in 15th of March planting compared to planting in other months in African marigold cv. Siracole.

2.2.1.3 Plant spread

Singh (1990) found that the seedlings transplanted on 15th February recorded the maximum plant spread (59.47 x 60.64 cm) in marigold compared to those planted on the later dates of planting.

2.2.1.4 Flowering time

Arora and Sandhu (1987) reported that the early planting (3rd September) took significantly lesser days for flowering as compared to late planting (1st November) in gladiolus.

Dod et al., (1989) stated that the least number of days required to flower emergence in gladiolus planted on the earliest date compared to those planted on late date.

Gowda (1990) observed that the longest time was taken to reach 50 per cent flowering (82 days) when planted in March, and the shortest time in the July planting of china aster.

2.2.2 Influence of planting time on yield attributing characters and yield

2.2.2.1 Number of flowers

Kiyatkin (1975) found that the maximum number of flowers per plant was observed in May planting than in June and July planting of chrysanthemum.

Patil et al., (1987) observed that the transplanting of aster in October and November gave the highest number of flowers per plant than later transplanting.

Saini et al., (1988) reported that the number of spikes per plant decreased with the delayed planting. Gladiolus planted on 25th of October produced maximum number of spikes (1.67) per plant. .Similar results were also reported by Yadav and Bose (1988) in summer season marigold by early planting.

Singh (1990) found that the seedlings transplanted on 15th of February recorded the highest number of flowers (57.22) per plant in marigold than those planted on 15th March and 15th April.

2.2.2.2 Flower yield

Gowda and Jayanthi (1986) observed that the September sown plants recorded the highest flower yield (15.35 t/ha) closely followed by November sown plant (12.32 t/ha) in marigold.

Yadav and Bose (1988) reported that the maximum flower yield was obtained from January planting in marigold than those planted in February, March and April.

Singh (1990) stated that the marigold seedlings transplanted on 15th of February recorded the highest flower

yield (0.571 kg) per plot compared to those planted on 15th of March and on 15th of April.

2.2.3 Influence of planting time on flower characters

Gill et al., (1985) showed that time of planting of chrysanthemun from July to September affected the quality of flowers to a great extent with respect to stem length, size of blooms and their marketable weight. They found that such characters were not significantly decreased with every delay in planting from July onwards. Same trend was also observed by Gowda (1990) in aster.

The reviews regarding the influence of planting time to different flowering plants showed its significant role on growth, yield attributing characters and yield. The effect of time of planting was varying depending upon the agro-climatic conditions and the variety of seasonal flower. In general, the growth of summer flowering annuals was found the best by planting it in the month of January.

2.3 Influence of pinching on growth, yield attributing characters yield and flower characters

In tall cultivars of Tagetes erecta L., development of axillary branches and flower production are influenced by the presence of apical dominance. However, if the apical apicies of shoot are removed earlier, large number of axillary shoots could arise which bear more number of uniform flowers. Available relevant literature on the influence of pinching on growth, yield attributing characters, yield and flower quality is presented as under.

2.3.1 Influence of pinching on growth

2.3.1.1 Plant height

Patel and Arora (1983) reported that pinching treatments resulted in depressing effect on plant height, and it was significantly reduced in carnation by delayed pinching as compared to control and early pinching. Similar results were also observed by Chillida (1983) in carnation.

Arora and Khanna (1986) observed that pinching at 20 DAT resulted in maximum reduction in plant height as compared to pinchings at 30 and 40 DAT and no pinching in African marigold cv. Giant Double Orange.

Bhati and Chitkara (1987) reported that pinching reduced plant height. This effect was most marked when pinching was done at 15 DAT as compared to 30 DAT in marigold cv. African Giant Double Orange, African Giant Yellow and French Dwarf Red.

Jayanthi *et al.*, (1987) stated that the maximum plant height reduction was obtained by pinching at 27 DAS in balsam as compared to 34 and 51 DAS.

2.3.1.2 Plant spread

Singh and Arora (1980) observed that the spread of plant was increased by pinching at 40 DAT as compared to pinching at 50 and 60 DAT in marigold.

Bhati and Chitkara (1987) reported that pinching at 15 DAT recorded the maximum plant spread in marigold as compared to pinching at 30 DAT.

2.3.1.3 Number of branches

Singh and Arora (1980) observed that pinching at 40 DAT increased the number of branches in marigold whereas, pinching at

20 DAT showed reduction in the number of branches. Arora and Khanna (1986) reported that delayed pinching resulted in the increased number of branches; pinching plants at 40 DAT produced maximum (16.6) branches per plant as compared to no pinching.

Jayanthi et al., (1987) stated that the maximum number of shoots were produced by pinching at 27 DAS in balsam as compared to pinching at 20 DAS.

2.3.1.4 Flowering time

Bunt (1980) reported that the pinching treatments delayed the flowering and the delay was aggravated with increase in the severity of pinching in carnation. Thus, the control plants flowered earlier and delay pinched plants flowered later. Similar results were also observed by Singh and Arora (1980) in marigold, Groskov and Angelov (1981), Chillida (1983) and Patel and Arora (1983) in carnation.

Arora and Khanna (1986) observed that all the pinching treatments delayed flowering by 10-20 days as compared to control in marigold cv. Giant Double Orange. Similar results have also been observed by Khanna et al., (1986) in carnation that pinching delayed flowering and as the severity of pinching increased, there was progressive delay in flowering.

2.3.2 Influence of pinching on yield attributing characters and yield

2.3.2.1 Number of flowers per plant

Singh and Arora (1980) stated that the number of flowers per plant was more in plants pinched at 40 DAT than 50 and 60 DAT in African marigold cv. Giant Double Orange.

Patel and Arora (1983) observed that pinching significantly enhanced the number of flowers per plant in carnation significantly over control; but amongst the pinching treatments, no perceptible difference was observed. Similar results were reported by Chillida (1983) in carnation.

Rajasekaran et al., (1983) found that pinching done at 45 DAT produced the highest number of flowers per plant than control in gomphrena. Similar results were also observed by Khanna et al., (1986) in carnation that the flower production per plant was increased with increase in pinching time.

Bhati and Chitkara (1987) observed that the maximum number of flowers was produced by pinching at 30 DAT than those pinched at 15 DAT in marigold cv. African Giant Orange, African Giant Yellow and French Dwarf Red.

Jayanthi et al., (1987) reported that the highest number of flowers (44.10) per plant was obtained from plants pinched at 27 DAS as compared to pinching at 20 DAS in balsam.

Yassin and Pappiah (1990) obtained the maximum number of flowers in chrysanthemum when the pinching was done at 60 DAT than pinching was done at 30 DAT.

2.3.2.4 Yield of flowers

Bing (1960) reported that flower yield was increased with increase in the time of pinching in carnation. The flower yield in pinched plants was more in general, and in few treatments this was almost doubled as compared to control. Similar results were observed by Hillard and Hanon (1976) in carnation.

Singh and Arora (1980) observed that the flower yield per plant was higher in plants pinched at 40 DAT than 50 and 60 DAT in marigold. Likewise, Arora and Khanna (1986) also observed that the plants pinched at 40 days improved flower yield significantly in comparison to pinching at 20 and 30 DAT in marigold.

In marigold, Bhati and Chitkara (1987) found that flower yield per plant was maximum when pinching was done at 30 DAT compared to pinching at 15 DAT.

The highest flower yield was obtained from the plants pinched at 7 weeks after transplanting compared to pinching was done at 4, 6 and 8 weeks after transplanting in chrysanthemum (Gowda and Jayanthi, 1988).

Yassin and Pappiah (1990) recorded the maximum flower yield (253.82 g/plant) with plants pinched at 60 days after planting than 30 days after planting in chrysanthemum cv. MDU-1.

2.3.3 Influence of pinching on flower characters

2.3.3.1 Size of flower

Singh and Arora (1980) observed that the flower size in marigold was decreased with delay in pinching time. Minimum flower size was observed in plants pinched at 40 DAT than other pinching.

2.3.3.2 Flower quality

Arora and Khanna (1986) stated that the flower quality of African marigold flowers was not much altered under different pinching treatments. Similar results have also been reported in marigold by Singh and Arora (1980).

The foregoing reviews revealed that the pinching plays significant role in growth, yield attributing characters, yield and quality of flowers in seasonal flowering crops. In general, the pinched plants show significant increase in flower production and it also delay flowering over non-pinched plants.

MATERIALS AND METHODS

III. MATERIALS AND METHODS

The details of materials used and techniques adopted during the course of investigation are described in this chapter.

3.1 Experimental site

The present investigation was carried out from December, 1993 to April, 1994 in block - D, plot number 5 at the Regional Horticultural Research Station, Gujarat Agricultural University, Navsari Campus, Navsari to study the response of African marigold (Tagetes erecta L.) cv. Orange to seedling age, planting time and pinching.

3.2 Soil characteristics

The soils of Navsari Campus are known as black soil, which are very deep, rich in organic matter and potash, having good water holding capacity with fairly good drainage and are reasonably suitable for marigold cultivation.

The physico-chemical properties of soils were determined for the block-D, plot-5. The soil samples from the surface 0-30 cm strata were drawn from the experimental area before transplanting. Later, a composite sample was prepared and then analysed for physico-chemical properties. The values so obtained are presented in Table 1.

The data presented in Table 1 revealed that the soil of experimental plot was clayey in texture and slightly alkaline in reaction. The soil was found good for cultivation of marigold crop which requires a rich, well manured and moist soil.

Table 1: Physico-chemical properties of the soil of experimental plots

Sr. No.	Particulars	Value for 0-30 cm depth	Method employed
A	**Physical properties**		
1.	Sand (%)	12.8	International
2.	Silt (%)	21.3	pipette
3.	Clay (%)	65.9	Method (piper, 1950)
	Texture class	clayey	
B	**Chemical properties**		
1.	Total nitrogen (N) (%)	o.o48	Modified Kjeldahal's Method (Jackson,1967)
2.	Available nitrogen (kg/ha)	155.00	Alkaline permanganate Method (Jackson,1967)
3.	Available phosphorus (kg/ha)	41.62	Olsen et al.,(1954)
4.	Available potash (kg/ha)	363.00	Flame Photometric Method (Jackson,1967)
5.	Soil pH (1:2.5 soil water extract)	7.3	Backman's pH meter (Jackson,1967)
6.	EC (m mhos/cm at 25°C)	0.24	Solubridge Method (Jackson,1967)

3.3 Location

Navsari Campus of the Gujarat Agricultural University, where the present investigation was carried out, is situated on 20°-57' North latitude, 72°-54' East longitude and with an altitude of about 10 metre above the mean sea level. It is about 13 km away from seashore.

3.3.1 Climate (in general)

The climate of this region is typically tropical and monsoonic, characterized by fairly hot summer, moderately cold winter and more humid and warm monsoon. In general, monsoon sets on the last week of May or on the first week of June and lasts upto the second fortnight of September. The total precipitation received during the monsoon of 1993 was 1577.7 mm distributed over 48 rainy days.

The winter season sets usually by the end of October. The temperature falls down from the beginning of November. December and January are the coldest months of the year. The minimum and maximum temperatures ranged between 10.3° C to 24.1 ° C and 26.9° C to 37.8° C, respectively during the course of investigation. The summer season commences during the middle of February and ends by first week of June. The temperature starts rising from February and reaches the maximum in the month April. April and May are the hottest months of summer.

3.3.2 Weather (during the period of investigation)

The mean weekly meteorological data on maximum and minimum temperature, relative humidity and sunshine hours during the course of investigation recorded at the meteorological observatory, N.M. College of Agriculture, Gujarat Agricultural

University, Navsari Campus, Navsari are presented in Appendix-I. Data indicated that the weather parameters were favourable for the marigold cultivation.

3.4 Plant material

The African marigold cv. Orange was used in the present experiment.

The African marigold var. Orange possess the following charactristics.

1. Plants are medium to tall growing (30 to 90 cm).
2. Plants have a large size leaves and more number of branches.
3. Plants have large globular double flowers (5 to 7 cm).
4. The flower head is orange coloured with fully double blooms.
5. Flower has a mild fragrance and good keeping quality.

3.5 Experimental details

The details of the experiment are given as under.

3.5.1 Experimental site

Block-'D', plot-5 at the Regional Horticultural Research Station, Gujarat Agricultural University, Navsari Campus, Navsari.

3.5.2 Design of the experiment

The experiment was laid out in a split plot design with three replications.

3.5.3 Treatments

Three factors were included in this experiment as detailed below :

(A) Main plot treatments : (S x T)

(a) Age of seedlings at transplanting : Two

S_1 = 30 days after sowing (DAS)

S_2 = 40 days after sowing (DAS)

(b) Time of planting : Three

T_1 = 25th January, 1994

T_2 = 5th February, 1994

T_3 = 15th February, 1994

(B) Sub-plot treatments :

Pinching : Four

P_o = No pinching

P_1 = 20 days after transplanting (DAT)

P_2 = 30 days after transplanting (DAT)

P_3 = 40 days after transplanting (DAT)

Thus, the experiment had twenty four treatment combinations.

3.5.4 Plot size

(a) Gross : 2.30 m x 1.85 m

(b) Net : 1.80 m x 1.35 m

3.5.5 Number of replications

Three

3.5.6 Total number of plots

72

3.5.7 Total experimental area

12.20 m x 42.80 m

= 522.16 m^2

3.5.8 Planting distance

(a) Spacing : 45 cm x 45 cm

(b) Total plants per plot : 20

(c) Total number of plots : 72

3.5.9 Pinching

Pinching of plants was done by removing the terminal buds alongwith 2-5 cm growing stem by hand at four times, (i) no pinching, (ii) at 20 days after transplanting (DAT), (iii) at 30 days after transplanting (DAT) and (iv) at 40 days after transplanting (DAT).

3.6 Cultural operations

The details of cultural operations are given here under.

3.6.1 Land preparation

The experimental area was cross ploughed with the help of tractor drawn implements followed by discing to break the clods, levelling and planking.

3.6.2 Manures and Fertilizers

Farm yard manure was applied at the rate of 20 t/ha to all the plots uniformly and was incorporated into the soil at the time of land preparation, while fertilizer was applied at the rate of 120-60-60 NPK kg/ha.

Phosphorus and potash were applied as a basal dose uniformly to all the plots at the rate of 60 kg/ha.

Nitrogen was applied in two split doses, half of N as a basal and the remaining half was applied one month after transplanting the crop. Immediately after fertilizer application, irrigation was given to the crop. Nitrogen, phosphorus and potash were applied in the form of urea, single super phosphate and murate of potash, respectively.

3.6.3 Raising of seedlings and transplanting

As detailed in treatments, the seeds were sown on the

rasied nursery beds on 26th of December, 1993, 6th of January, 1994 and 16th of January, 1994 and it was transplanted on the 25 th of January, 1994, 5th of February, 1994 and 15th of February, 1994, respectively, to obtain regularly thirty days old seedlings.

Likewise, for getting forty days old seedlings, the seeds were sown in the raised nursery beds on 16th December, 1993, 25th December, 1993 and 6th January, 1994 and the same were transplanted on 25th January, 1994, 5th February, 1994 and 15th February, 1994, respectively.

3.6.4 After care

Irrigation was given twice a week at initial stage and later, the interval was extended to seven to eight days depending upon the soil moisture condition.

Weeding and hoeing were done at 15 days interval to keep the plots clean and free from weeds. Necessary plant protection measures were adopted. No serious pests and diseases were observed on this crop during the crop period.

Pinching operation was done as and when needed according to the treatments.

3.6.5 Harvesting

Fully opened blooms were harvested without stalks in the morning hours and the weight of flowers was recorded immediately.

Total of 16 pickings were carried out at an interval of 5 days. Thus, a total harvesting period of 30 days was required to complete harvesting operation.

3.7 Observations recorded

The observations recorded during the course of invesigation are given below, with the procedure adopted.

Five plants in each plot were randomly selected from the net plot of each treatment and tagged for reducing the number of observations.

3.7.1 Plant height

Height of the plants (in centimetres) was recorded twice i.e. (i) before pinching and (ii) at flowering stage by measuring from the base of stem at ground level to the growing tip of the plant.

3.7.2 Number of branches

The number of main branches, arising from the main stem were counted twice i.e. (i) before pinching and (ii) at flowering stage in tagged plants and the average value was recorded.

3.7.3 Spread of the plant

The maximum spread of the plant N-S, E-W was recorded in Sq.m. at the middle portion of the plant at two stages i.e. (i) before pinching and (ii) at flowering stage.

3.7.4 Main stem diameter

The main stem diameter was measured in centimetres at flowering stage with the help of a vernier calliper. The portion between first and second node, from the base of stem was measured for stem diameter.

3.7.5 Number of nodes on main stem

Average number of nodes on the main stem was recorded at the final harvesting stage of the crop.

3.7.6 Number of days taken for flower bud appearance

The number of days, from transplanting to flower bud initiation were counted to record this observation.

3.7.7 Number of days taken for flower opening

The number of days were counted from the flower bud differentiation to the complete opening of the flower.

3.7.8 Number of flowers per plant

Five plants were selected at random from the experimental plot of each treatment and the total number of flowers per plant were recorded. Finally, average number of flowers per plant was calculated.

3.7.9 Yield of flowers per plant

From the five randomly selected plants, the fresh weight of flowers was recorded and later the average yield of flowers per plant in gram was calculated.

3.7.10 Yield of flowers per plot

The yield of flowers per plot (in kg) was recorded on the basis of fresh weight of harvested flowers from each experimental plot.

3.8 Flower characters

Five marketable flowers, alongwith stalks from each experimental plot, were selected at random and used for recording the following observations.

3.8.1 Flower diameter (size of flower)

Maximum breadth across the flower was taken as diameter of the flower and was measured in centimetres by using a vernier callipers.

3.8.2 Thickness of flower

The measurement from the base of the flower to the tip was taken as thickness of flower and was measured in centimetres by means of a vernier callipers.

3.8.3 Peduncle length

The length of the stalk of flower was taken as peduncle length and was measured in centimetres.

3.8.4 Peduncle girth

The diameter of the lower most point, from the base of the flower was taken as peduncle girth and was measured with a vernier callipers.

3.8.5 Fresh weight of flowers

Five marketable flowers, taken from the fresh harvest were weighed and average was calculated for each treatment in grams.

3.8.6 Dry weight of flowers

Five marketable flowers were taken for dry weight of flower. The dry weight was recorded after oven drying the fresh flowers at 60°C till constant weight.

3.8.7 Longevity of flowers

Five fully opened flowers were selected and were kept as such on plant to determine the longevity of flowers. The longevity was experssed as number of days from complete opening of the flowers till to the flowers were no longer fit to be sold in the market.

3.9 Statistical analysis

The data on the characters studied were subjected to statistical analysis through procedure appropriate to the

design of experiments. The treatment differences were tested with 'F' test. Critical differences at 5 per cent level have also been worked out wherever the treatment effects were significant.

EXPERIMENTAL RESULTS

IV. EXPERIMENTAL RESULTS

The present investigation, to study the 'response of African marigold (Tagetes erecta L.) cv. Orange to seedling age, planting time and pinching' was conducted during summer season of 1993-94 at the Regional Fruit Research Station, Gujarat Agricultural University, Navsari Campus, Navsari. The data so collected were analysed statistically and the main effects and only significant interactions are being presented in succeeding paragraphs.

4.1 Growth attributes

4.1.1 Plant height

The mean data on plant height recorded at two stages i.e. before pinching and at flowering stage as influenced by seedling age, planting time and pinching are presented in Table 2.

4.1.1.1. Plant height before pinching

The data presented in Table 2 revealed that the plant height before pinching was not significantly influenced by the seedling age. Likewise, the planting time also did not influence the plant height significantly.

Data further revealed that the pinching did not reflect significant difference in the plant height. The mean plant height recorded at this stage were 10.90, 11.01, 11.21 and 11.36 cm under P_0, P_1, P_2 and P_3 treatments, respectively.

4.1.1.2 Plant height at flowering stage

The data presented in Table 2 indicated that the seedling age, did not influence significantly the plant height at

Table 2 : Effect of seedling age, planting time and pinching on the plant height before pinching and at flowering stage of African marigold cv. Orange

Treatments	Plant height (cm)	
	Before pinching	At flowering
(A) Seedling age (S)		
S_1 (30 DAS)	11.16	72.90
S_2 (40 DAS)	11.09	68.71
S.Em. ±	0.11	1.65
C.D. at 5%	NS	NS
C.V. %	5.96	13.95
(B) Planting time (T)		
T_1 (25th January)	11.07	75.60
T_2 (5th February)	11.14	72.33
T_3 (15th February)	11.15	64.48
S.Em. ±	0.14	2.02
C.D. at 5%	NS	6.35
C.V. %	5.96	13.95
(C) Pinching (P)		
P_o (No pinching)	10.90	76.15
P_1 (20 DAT)	11.01	65.86
P_2 (30 DAT)	11.21	68.54
P_3 (40 DAT)	11.36	72.66
S.Em. ±	0.31	1.69
C.D. at 5%	NS	4.86
C.V. %	11.80	10.15
(D) Interactions		
SxT	NS	NS
SxP	NS	NS
TxP	NS	NS
SxTxP	NS	NS

flowering stage. The mean plant height of 72.90 and 68.71 cm were recorded under S_1 and S_2 treatments, respectively.

The planting time significantly influenced the plant height at flowering stage. Plants transplanted under T_1 (25th January) treatment recorded significantly higher plant height of 75.60 cm at flowering stage which remained statistically at par with the T_2 (5th February) treatment. While, the lowest plant height of 64.48 cm was recorded when crop was transplanted under T_3 (15th February) treatment.

Likewise, pinching also influenced the plant height at flowering stage significantly . The maximum plant height of 76.15 cm was recorded under P_0 (no pinching) treatment, followed by 72.66 cm recorded under P_3 (40 DAT) treatment. While, the minimum plant height of 65.86 cm was recorded under P_1 (20 DAT) treatment, which remained statistically at par with the treatment P_2 (30 DAT).

All the interactions, viz., SxT, SxP, TxP and SxTxP effect among different seedling ages, planting times and pinchings with respect to plant height recorded at flowering stage were found to be non-significant.

4.1.2 Number of branches per plant

The data regarding the number of branches per plant before pinching and at flowering stage as affected by different seedling ages, planting times and pinchings are highlighted in Table 3.

4.1.2.1 Number of branches before pinching

Data given in Table 3 revealed that the number of branches before pinching was not significantly influenced by the

Table 3 : Effect of seedling age, planting time and pinching on the number of branches before pinching and at flowering stage of African marigold cv. Orange

Treatments	Number of branches	
	Before pinching	At flowering
(A) Seedling age (S)		
S_1 (30 DAS)	7.65	26.26
S_2 (40 DAS)	7.65	24.26
S.Em. ±	0.10	0.88
C.D. at 5%	NS	NS
C.V. %	7.76	20.79
(B) Planting time (T)		
T_1 (25th January)	7.70	26.82
T_2 (5th February)	7.65	24.64
T_3 (15th February)	7.60	24.31
S.Em. ±	0.12	1.07
C.D. at 5%	NS	NS
C.V. %	7.76	20.79
(C) Pinching (P)		
P_o (No pinching)	7.37	26.14
P_1 (20 DAT)	7.56	20.33
P_2 (30 DAT)	7.75	22.46
P_3 (40 DAT)	7.94	32.10
S.Em. ±	0.19	1.28
C.D. at 5%	NS	3.68
C.V. %	10.40	21.51
(D) Interactions		
SxT	NS	NS
SxP	NS	NS
TxP	NS	NS
SxTxP	NS	NS

seedling age.

Likewise, the planting time also did not exert significant effect on the number of branches. On an average, the number of branches recorded were 7.70, 7.65 and 7.60 under T_1, T_2 and T_3 treatments, respectively.

Data also revealed that the pinching failed to influence the number of branches. The mean number of branches recorded at this stage were 7.37, 7.56, 7.75 and 7.94 under P_0, P_1, P_2 and P_3 treatments, respectively.

4.1.2.2 Number of branches at flowering

Data regarding the number of branches per plant revealed that there was no significant influence on number of branches per plant by the seedling age. However, the mean number of branches per plant was highest under S_1 (26.26).

Likewise, the planting time also did not influence the number of branches at flowering stage significantly. The average number of branches recorded under T_1, T_2 and T_3 treatments were 26.82, 24.64 and 24.31, respectively.

The number of branches per plant significantly differed due to various pinching times. The result revealed that delayed pinching increased the number of branches per plant. In fact, there was significant difference in the number when the plants were pinched after 40 DAT as compared to no pinching. Pinching at 20 or 30 DAT was not effective.

4.1.3 Spread of plant

The influence of different seedling ages, planting times and pinchings on the spread of plant recorded at two stages i.e. before pinching and at flowering stage are presented in

Table 4 : Effect of seedling age, planting time and pinching on the spread of plant before pinching and at the flowering stage of African marigold cv. Orange

Treatments	Spread of plant (sq.m)	
	Before pinching	At flowering
(A) Seedling age (S)		
S_1 (30 DAS)	0.01	0.30
S_2 (40 DAS)	0.01	0.29
S.Em. ±	0.0001	0.006
C.D. at 5%	NS	NS
C.V. %	7.76	11.54
(B) Planting time (T)		
T_1 (25th January)	0.01	0.30
T_2 (5th February)	0.01	0.29
T_3 (15th February)	0.01	0.29
S.Em. ±	0.0002	0.007
C.D. at 5%	NS	NS
C.V. %	7.76	11.54
(C) Pinching (P)		
P_o (No pinching)	0.008	0.22
P_1 (20 DAT)	0.01	0.35
P_2 (30 DAT)	0.01	0.31
P_3 (40 DAT)	0.01	0.28
S.Em. ±	0.0003	0.006
C.D. at 5%	NS	NS
C.V. %	13.43	9.30
(D) Interactions		
SxT	NS	NS
SxP	NS	NS
TxP	NS	NS
SxTxP	NS	NS

Table 4. .

4.1.3.1 Spread of plant before pinching

The results pertaining to different seedling ages, planting times and pinchings on the spread of plant showed that their differences were non-significant.

4.1.3.2 Spread of plant at flowering

The results of different seedling ages and planting times on the spread of plant at flowering were found non-significant.

However, the result pertaining to the spread of plant in marigold showed that their differences were significant to various times of pinching. The highest spread of plant (0.35 sq.m) was found with P_1 (20 DAT). Delayed pinching reduced the spread and the lowest spread of plant (0.22 sq.m) was found with P_0 (no pinching) treatment.

4.1.4 Stem diameter

The influence of different seedling ages, planting times and pinchings on the stem diameter presented in Table 5.

A perusal of the data presented in Table 5 revealed that the stem diameter was significantly influenced by the seedling age, planting time and pinching.

The data pertaining to the stem diameter of the marigold plant revealed that the seedling age singificantly affected the stem diameter. The diameter of the plant was significantly less with advancement of seedling age from 30 to 40 days.

The same trend was also observed in case of the planting time. Twenty fifth January was found to be the most

Table 5: Stem diameter and the number of nodes on main stem as influenced by seedling age, planting time and pinching

Treatments	Stem diameter (cm)	Number of nodes on main stem
(A) Seedling age (S)		
S_1 (30 DAS)	0.85	11.84
S_2 (40 DAS)	0.80	13.43
S.Em. ±	0.01	0.28
C.D. at 5%	0.04	0.89
C.V. %	8.56	13.42
(B) Planting time (T)		
T_1 (25th January)	0.92	13.38
T_2 (5th February)	0.84	13.29
T_3 (15th February)	0.72	11.23
S.Em. ±	0.01	0.35
C.D. at 5%	0.04	1.09
C.V. %	8.56	13.42
(C) Pinching (P)		
P_o (No pinching)	0.76	12.43
P_1 (20 DAT)	0.80	12.48
P_2 (30 DAT)	0.86	12.78
P_3 (40 DAT)	0.90	12.85
S.Em. ±	0.01	0.43
C.D. at 5%	0.04	NS
C.V. %	7.78	14.30
(D) Interactions		
SxT	Sig	NS
SxP	NS	NS
TxP	NS	NS
SxTxP	NS	NS

optimum planting time for maximum stem diameter (0.92 cm) and thereafter it significantly reduced as the planting was delayed (from 0.92 cm to 0.72 cm).

Likewise, the effect of pinching on stem diameter was also found significant. The maximum stem diameter (0.90 cm) was recorded under the P_3 (40 DAT) treatment which remained statistically at par with the P_2 (30 DAT). The minimum stem diameter (0.76 cm)was recorded under the P_o (no pinching) treatment which remained statistically at par with the P_1 (20 DAT) treatment.

Among all the interactions viz., SxT, SxP, TxP and SxTxP, only the SxT interaction was found significant (Table 6). Data mentioned in Table 6 revealed that by combining appropriate seedling age and optimum planting time (S_1T_1) significantly the maximum stem diameter (0.96 cm) was attained.

Table 6 : Interaction effect of seedling age and planting time on the stem diameter of African marigold cv. Orange

Seedling age	Planting time		
	T_1	T_2	T_3
S_1	0.96	0.81	0.79
S_2	0.89	0.87	0.64
S.Em. ±	0.02		
C.D. at 5%	0.06		

4.1.5 Number of nodes on main stem

The results pertaining to the number of nodes on main stem as affected by the different seedling ages, planting times and pinching treatments are presented in Table 5.

Significant differences in the number of nodes were observed between the two ages of seedling. The maximum number of nodes (13.43) on main stem was observed in the S_2 (40 DAS) treatment, while the minimum number of nodes (11.84) on main stem was recorded in S_1 (30 DAS) treatment.

The effect of different planting times on the number of nodes on main stem of marigold plant was also found significant. The maximum number of nodes on main stem (13.38) was recorded under the T_1 (25th January) treatment which was at par with the T_2 (5th February) treatment. Minimum number of nodes on main stem (11.23) was found under the T_3 (15th February) treatment.

The influence of the various times of pinching on the number of nodes on the main stem of marigold was found to be non-significant.

4.2 Flowering behaviour

The results concerning to the flowering behaviour of African marigold cv. Orange by the various treatments are given in the following paragraphs.

4.2.1 Number of days required for the appearance of flower bud (from transplanting)

The data relating to the number of days required for flower bud appearance (from transplanting) as affected by different seedling ages, planting times and pinching treatments are presented in Table 7 and also graphically depicted in Fig.1.

The results summarized in Table 7 focussed that the effect of various seedling ages, planting times and pinchings on the number of days required for flower bud appearance were found significant.

The minimum number of days (54.74) was required for the appearance of flower bud when the seedling age was 30 days (S_1) and this was significantly differed (58.29) for the flower bud appearance when it is 40 days (S_2).

It is seen from the Table 7 that the planting time treatments on differed significantly in respect to the number of days required for the appearance of flower bud. The number of days required for the appearance of flower bud did not change when the planting time was either T_1 or T_2 (55.18) but significantly delay was seen when the planting time was dalayed to 15th February (58.59).

Likewise, the influence of pinching on the number of days required for flower bud appearance was also found significant. The minimum number of days (54.24) was required for flower bud appearance in the P_o (no pinching) treatment and the maximum number of days (58.53) required under the P_3 (40 DAT) treatment (Fig.1).

Among all the interactions viz., SxT, SxP, TxP and SxTxP, only SxT and SxP interactions were found significant. While, TxP and SxTxP interactions were found to be non-significant (Table 7).

The interaction effect between the seedling age and the planting time was found significant. The data recorded in Table 8 showed that the minimum number of days (54.11) required for appearance of flower bud was recorded under the S_1T_1 interaction.

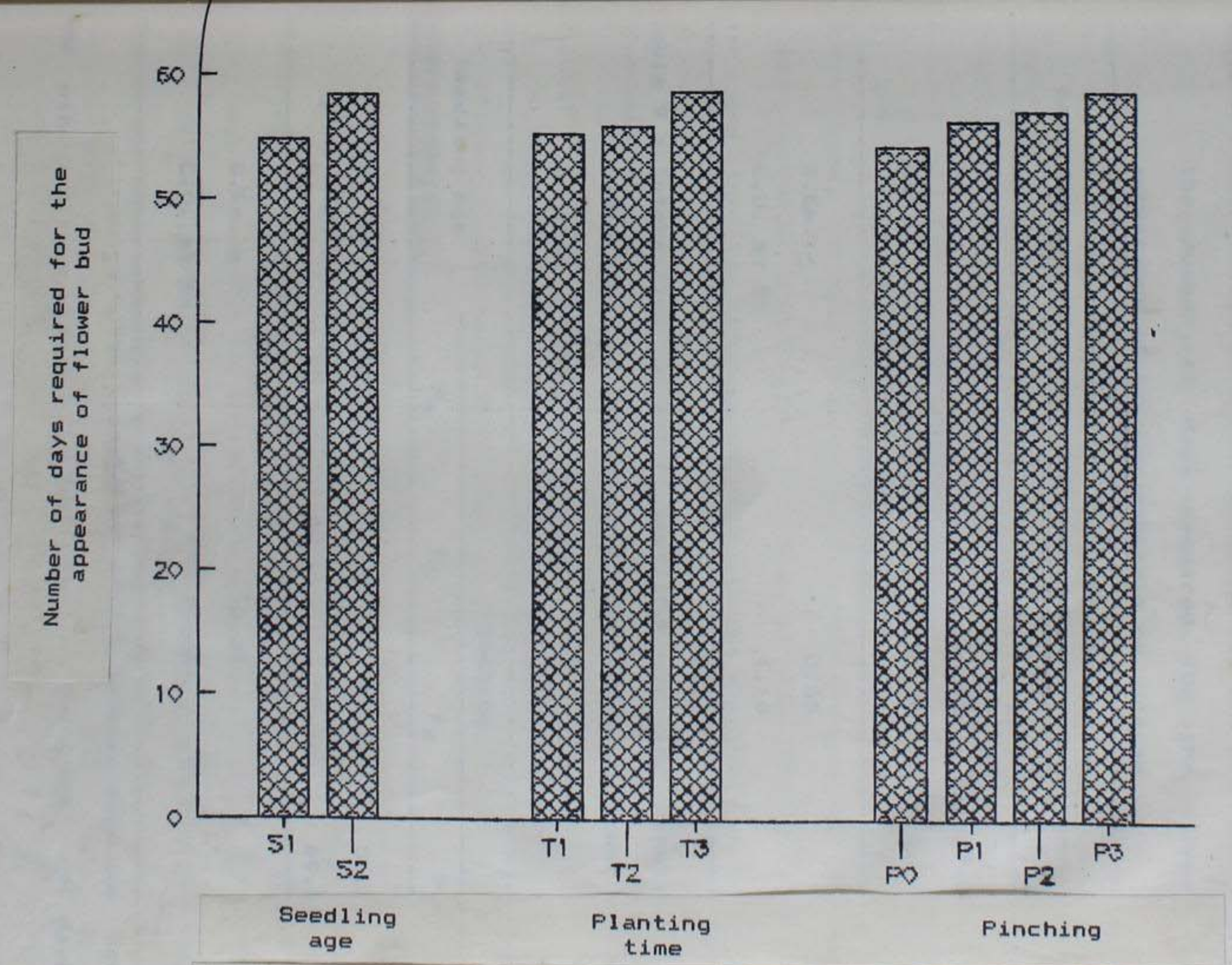

Fig. 1: Effect of seedling age, planting time and pinching on number of days required for the appearance of flower bud in African marigold cv. Orange

While, the maximum number of days (61.88) required for flower bud appearance was observed under the S_2T_1 interaction. Interactions S_1T_1 and S_1T_2 were statistically at par.

Table 8 : Interaction effect of seedling age and planting time on the number of days required for the flower bud appearance of African marigold cv. Orange

Seedling age	Planting time		
	T_1	T_2	T_3
S_1	54.11	54.82	55.30
S_2	61.88	56.74	56.24
S.Em. ±		0.35	
C.D. at 5%		1.10	

Table 9 : Interaction effect of seedling age and pinching on number of days required for appearence of flower bud of African marigold cv. Orange

Seedling age	Pinching			
	P_o	P_1	P_2	P_3
S_1	52.98	54.61	55.20	56.19
S_2	55.50	57.86	58.92	60.88
S.Em. ±		0.38		
C.D. at 5%		1.08		

Likewise, the interaction effect between seedling age and pinching was also found significant on the number of days

required -for flower bud appearance (Table 9). The interaction S_1P_0 recorded the minimum number of days (52.98), while the S_2P_3 interaction recorded significantly the maximum number of days (60.88) for the flower bud appearance.

4.2.2 Number of days required for opening of flower (from flower bud appearance)

Data of different seedling ages, planting times and pinchings on the number of days required for the opening of flower are presented in Table 7 and also graphically depicted in Fig.2. The influence of seedling age, planting time and pinching on the number of days required for flower opening were found significant. The data concerning the number of days required for flower opening highlighted that the S_1 (30 DAS) treatment recorded the minimum number (15.64) as compared to the S_2 treatment (40 DAS) and the difference was significant (16.67) only each other (Fig.2).

So far as the planting time was concerned, both T_1 and T_2 treatments were at par, while T_3 treatment (15th February) significantly increased the number of days (16.75) required for flower opening.

The data regarding the various times of pinching on the number of days required for the opening of flower showed that the minimum number of days (15.53) was observed under P_0 (no pinching) treatment and the maximum number of days (16.73) was required for opening of flower in the P_3 (40 DAT) treatment which was at par with P_2 and P_1 (Fig.2).

Among the SxT, SxP, TxP and SxTxP interactions, only the SxT interaction was found significant (Table 10). Data

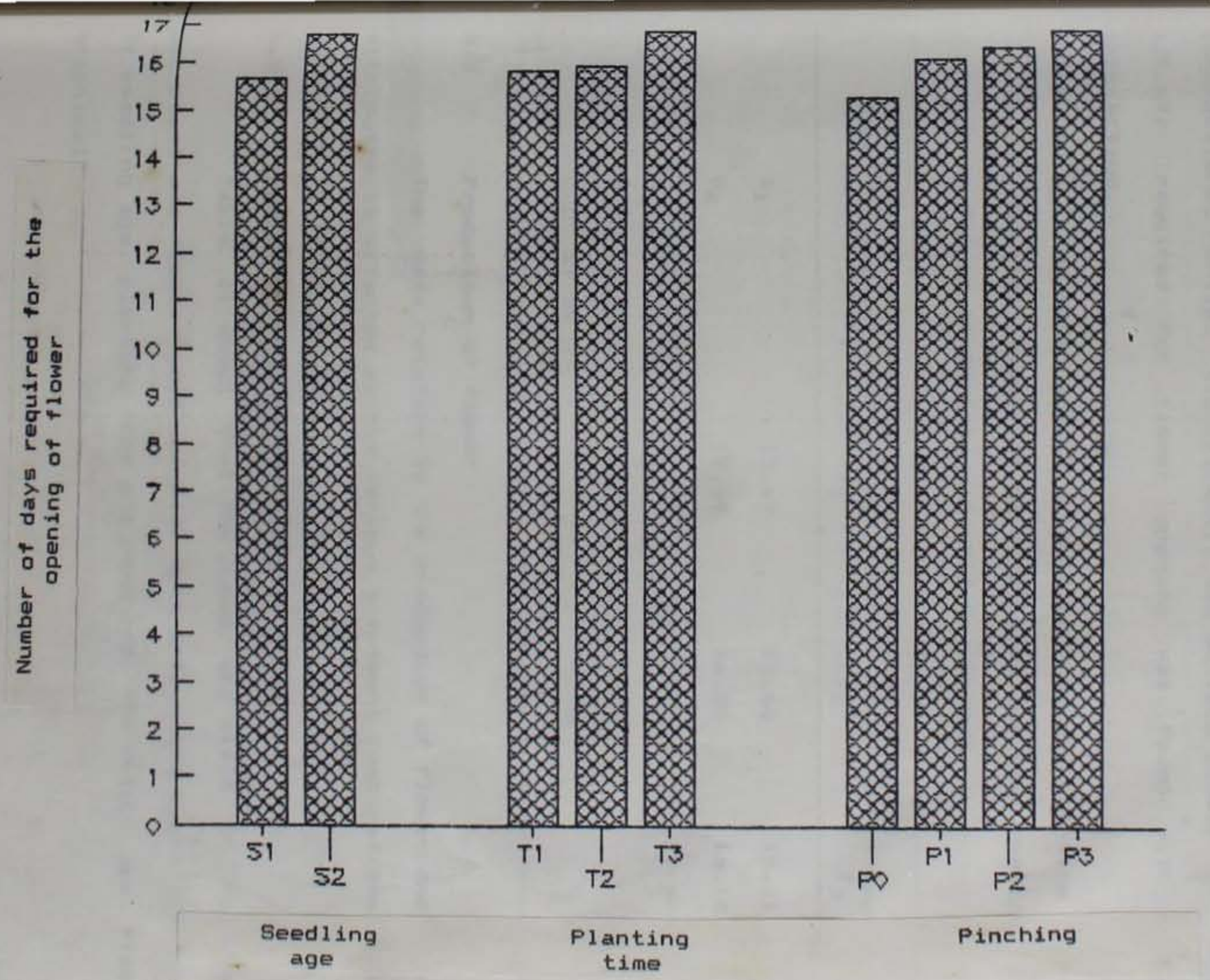

Fig. 2: Effect of seedling age, planting time and pinching on number of days required for the opening of flower in African marigold cv. Orange

presented . in Table 10 indicated that significantly the minimum number of days (15.47) required for flower opening was recorded under S_1T_1 interaction which was at par with S_1T_2, S_1T_3 and S_2T_3 interactions. While, significantly the maximum number of days (17.69) required for flower opening was found with S_2T_1 interaction.

Table 10 : Interaction effect of seedling age and planting time on the number of days required for the opening of flower of African marigold cv. Orange

Seedling age	Planting time		
	T_1	T_2	T_3
S_1	15.47	15.66	15.81
S_2	17.69	16.20	16.12
S.Em. ±		0.22	
C.D. at 5%		0.70	

4.3 Production of flower

The data relating to the production of flower and its attributes as affected by the various treatment combinations are presented in Table 11.

4.3.1 Number of flowers per plant

Table 11 shows that the number and yield of flowers per plant and flower yield per plot were influenced significantly by seedling age, planting time and pinching. The effect was also graphically depicted in Fig.3.

Table 11 : Effect of seedling age, planting time and pinching on the production of flowers of African marigold cv. Orange

Treatments	Production of flowers per plant		Flower yield per plot (kg)
	Number	Yield (g)	
(A) Seedling age (S)			
S_1 (30 DAS)	34.81	192.20	3.43
S_2 (40 DAS)	21.55	123.86	2.65
S.Em. ±	0.45	2.29	0.02
C.D. at 5%	1.40	7.72	0.06
C.V. %	9.49	8.70	4.11
(B) Planting time (T)			
T_1 (25th January)	32.44	184.83	3.54
T_2 (5th February)	28.02	156.17	2.90
T_3 (15th February)	24.07	133.09	2.69
S.Em. ±	0.54	2.81	0.02
C.D. at 5%	1.72	8.85	0.08
C.V. %	9.49	8.70	4.11
(C) Pinching (P)			
P_o (No pinching)	28.95	167.24	3.18
P_1 (20 DAT)	25.36	142.96	2.56
P_2 (30 DAT)	27.52	153.96	2.87
P_3 (40 DAT)	30.88	167.97	3.55
S.Em. ±	0.9	3.99	0.06
C.D. at 5%	2.58	11.44	0.17
C.V. %	13.53	10.70	8.09
(D) Interactions			
SxT	Sig.	Sig.	Sig.
SxP	NS	NS	NS
TxP	NS	NS	NS
SxTxP	NS	NS	NS

-It is seen from the Table 11 that the seedling age differed significantly in respect of the production of number of flowers per plant. The maximum number of flowers per plant (34.81) was noticed in treatment S_1 i.e. 30 days seedlings, while the minimum number of flowers per plant (21.55) was recorded in treatment S_2 i.e. 40 days old seedlings (Fig.3).

So far as planting time has concerned, the T_1 (25th January) treatment produced significantly higher number of flowers per plant (32.44) as compared to both the T_2 and T_3 treatments.

In case of pinching on the number of flowers per plant, the P_3 (40 DAT) treatment produced significantly more number of flowers (30.88) which was at par with the P_o (no pinching) treatment.While, P_1 and P_2 were at par.

Only SxT interaction was found significant, while SxP, TxP and SxTxP interactions were found to be non-significant.

Table 12 : Interaction effect of seedling age and planting time on the number of flowers per plant of African marigold cv. Orange

Seedling age	Planting time		
	T_1	T_2	T_3
S_1	42.75	32.37	29.31
S_2	18.82	23.68	22.13
S.Em. ±		0.77	
C.D. at 5%		2.43	

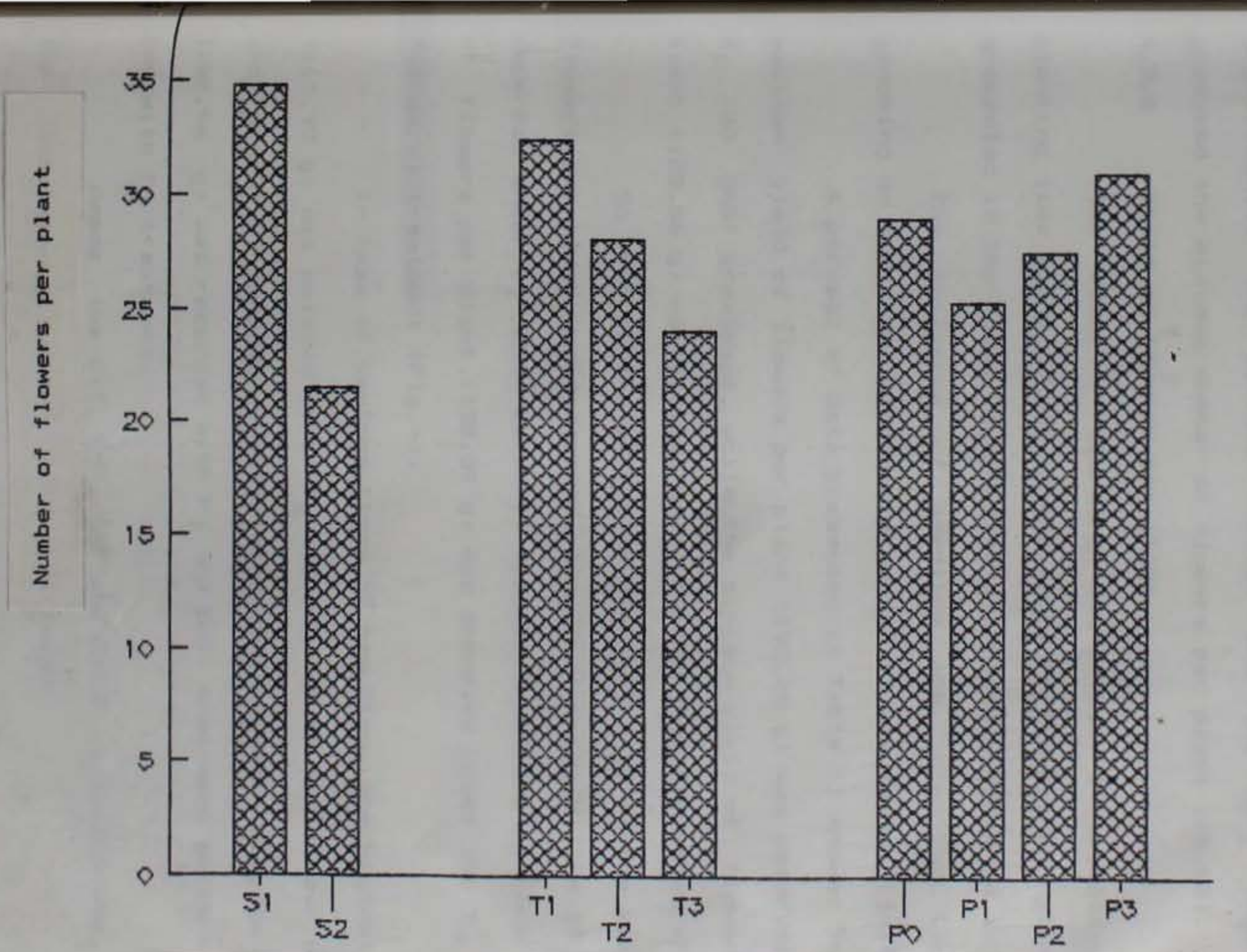

Fig. 3: Effect of seedling age, planting time and pinching on number of flowers per plant in African marigold cv. Orange

The interaction effect between seedling age and planting time was found significant (Table 12). Data tabulated in Table 12 reflected that the S_1T_1 interaction produced significantly the maximum (42.75) and the S_2T_1 interaction produced the minimum number of flowers per plant (18.82).

4.3.2 Yield of flowers per plant

The results regarding the effect of seedling age, planting time and pinching on the yield of flowers per plant are presented in the Table 11 and also graphically depicted in Fig.4.

The influence of seedling age, planting time and pinching on the yield of flowers per plant was found significant.

A perusal of data presented in Table 11 showed that the maximum yield of flowers per plant (192.20 g) was observed with S_1 (30 DAS) treatment, while the minimum yield of flowers per plant (123.86 g) was noticed under S_2 (40 DAS) treatment (Fig.4).

So far as the effect of planting time on the yield of flowers per plant was concerned, the maximum yield (184.83 g) was recorded under T_1 (25th January) treatment and the minimum yield of flowers per plant (133.09 g) was observed under the T_3 (15th February) treatment (Fig.4).

In case of various times of pinching, the highest yield (167.97 g) was noticed under P_3 (40 DAT) which was at par with P_o (no pinching) treatment, while significantly the minimum yield (142.96 g) was recorded with P_1 (20 DAT) treatment which was at par with P_2 treatment.

Among the SxT, SxP, TxP and SxTxP interactions, only the SxT interaction was found significant.

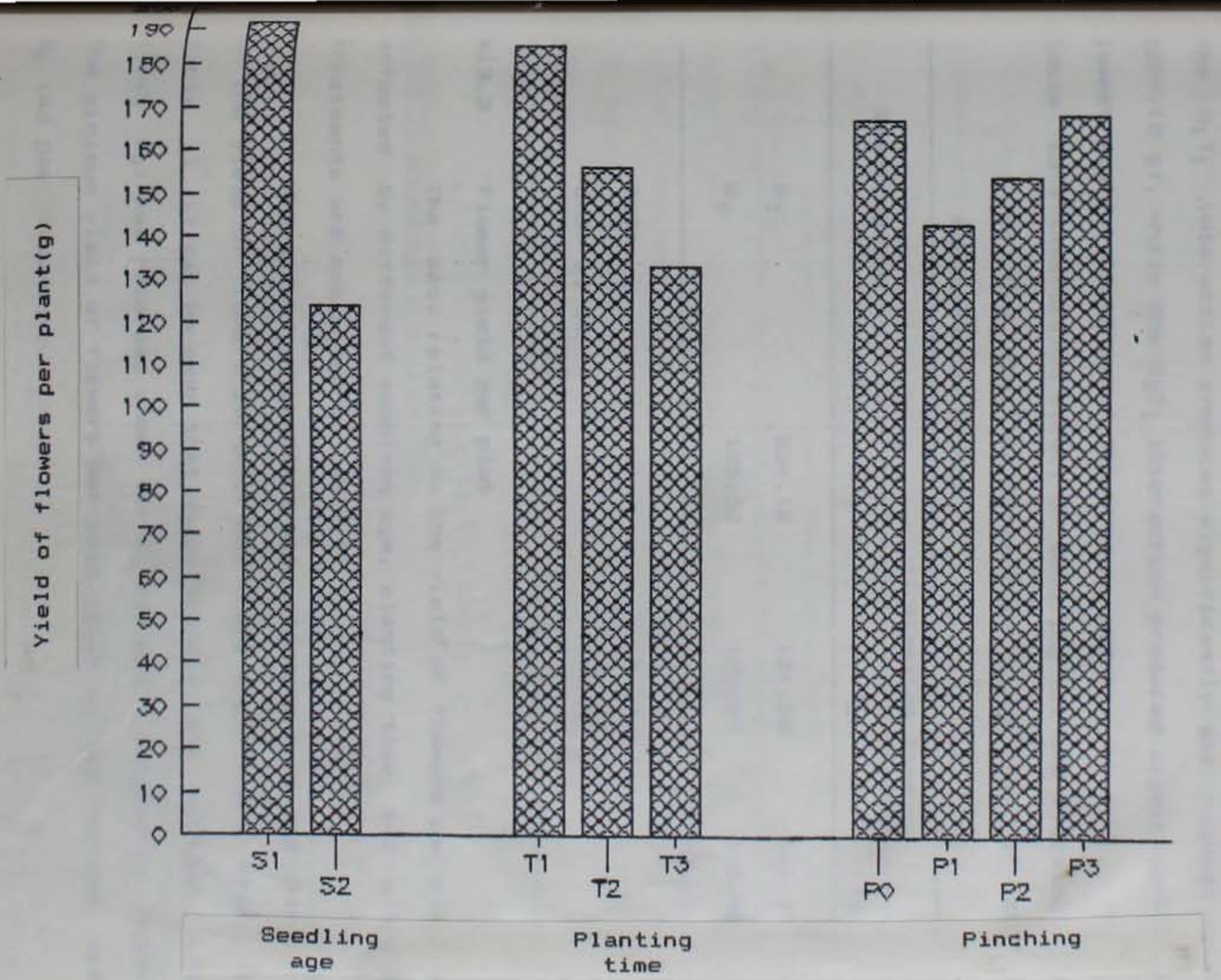

Fig. 4: Effect of seedling age, planting time and pinching on yield of flowers per plant(g) in African marigold cv. Orange

The interaction effect between seedling age and planting time on the yield of flowers per plant was found to be significant (Table 13). Data given in the Table 13 focussed that the S_1T_1 interaction produced significantly the highest yield (234.18 g), while the S_2T_1 interaction produced significantly the lowest yield (105.03 g) of flowers per plant.

Table 13 : Interaction effect of seedling age and planting time on the yield of flowers per plant (g) of African marigold cv. Orange

Seedling age	Planting time		
	T_1	T_2	T_3
S_1	234.18	181.28	161.15
S_2	105.03	131.07	135.48
S.Em. ±		3.97	
C.D. at 5%		12.51	

4.3.3 Flower yield per plot

The data relating to the yield of flowers per plot as affected by different seedling age, planting time and pinching treatments are exhibited in Table 11.

The effect of seedling age, planting time and pinching on the yield of flowers per plot was found significant. From the Table 11 it can be seen that significantly the maximum yield (3.43 kg) was recorded under the S_1 (30 DAS) treatment, while, the minimum yield of flowers per plot (2.65 kg) was noticed with S_2 (40 DAS) treatment.

In case of planting time, the T_1 (25th January) treatment produced significantly more flower yield per plot (3.54 kg) which remained at par with the T_2 treatment whereas, the T_3 (15th February) treatment produced significantly the minimum yield of flowers per plot (2.69 kg).

So far as the different timing of pinchings was concerned, significaptly the maximum yield (3.55 kg) was recorded in the P_3 (40 DAT). Whereas, the P_1 (20 DAT) produced significantly the minimum flower yield per plot (2.56 kg).

The yield of marigold flowers per hectare was recorded in Appendix II.

Interaction SxT was found significant. The interaction effect between seedling age and planting time on the yield of flowers per plot was found significant (Table 14). From the table it can be seen that S_1T_1 interaction produced significantly the maximum yield (4.15 kg), while the S_2T_1 interaction produced significantly the minimum yield of flowers per plot (2.33 kg).

Table 14 : Interaction effect between seedling age and planting time on the yield of flowers per plot of African marigold cv. Orange

Seedling age	Planting time		
	T_1	T_2	T_3
S_1	4.15	3.10	3.04
S_2	2.33	2.69	2.93
S.Em. ±		0.04	
C.D. at 5%		0.11	

4.4 Flower characters

The data pertaining to the flower characters of marigold as affected by the seedling age, planting time and pinching treatments have been presented in Table 13.

4.4.1 Flower diameter

Data regarding the flower diameter as affected by various treatments are presented in Table 15.

An appraisal of data showed that the effect of seedling age and planting time on flower diameter were found to be non-significant.

The effect of different times of pinching on the flower diameter was found significant . The maximum flower diameter (6.15 cm) was recorded in the P_0 (no pinching) treatment. On the other hand, treatment P_3 (40 DAT) produced the minimum flower diameter (5.42 cm) which remained statistically at par with the P_2 treatment.

4.4.2 Thickness of flower

The data regarding the thickness of flower as affected by various treatments are persented in Table 15.

It is apparent from the Table 15 that the influence of different treatments of seedling age, planting time and all the interactions viz., SxT, SxP, TxP and SxTxP on the thickness of flower were found to be non-significant.

The effect of various times of pinching on thickness of marigold flower was found significant. Significantly more thickness of flower (4.15 cm) was recorded with P_0 (no pinching) treatment, which was at par with the P_1 (3.96 cm) treatment. Treatment P_3 (40 DAT) produced minimum thickness of flower (3.42

Table 15 : Effect of seedling age, planting time and pinching on flower characters of African marigold cv. Orange

Treatments	Flower diameter (cm)	Thickness of flower (cm)	Peduncle length (cm)	Peduncle girth (cm)	Fresh weight of flower (g)	Dry weight of flower (g)	Longevity of flower (days)
(A) Seedling age (S)							
S_1 (30 DAS)	5.73	3.73	4.12	0.23	8.45	1.12	18.56
S_2 (40 DAS)	5.87	3.87	4.12	0.23	8.68	1.12	18.55
S.Em. ±	0.09	0.09	0.003	0.001	0.40	0.08	0.14
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS
C.V. %	9.42	14.39	0.46	1.61	28.12	40.72	4.69
(B) Planting time (T)							
T_1 (25th January)	5.88	3.88	4.12	0.23	9.31	1.21	18.54
T_2 (5th February)	5.65	3.66	4.12	0.23	7.80	1.02	18.55
T_3 (15th February)	5.86	3.86	4.12	0.24	8.58	1.14	18.56
S.Em. ±	0.11	0.11	0.003	0.001	0.49	0.09	0.18
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS
C.V. %	9.42	14.39	0.46	1.61	28.12	40.72	4.69
(C) Pinching (P)							
P_o (No pinching)	6.15	4.15	4.11	0.24	9.87	1.28	18.50
P_1 (20 DAT)	5.66	3.97	4.12	0.24	8.32	1.14	18.53
P_2 (30 DAT)	5.57	3.66	4.12	0.23	8.22	1.08	18.57
P_3 (40 DAT)	5.42	3.42	4.12	0.23	7.46	0.97	18.63
S.Em. ±	0.15	0.15	0.004	0.003	0.59	0.07	0.24
C.D. at 5%	0.42	0.42	NS	0.009	1.70	0.20	NS
C.V. %	10.69	16.30	0.38	5.53	29.42	28.85	5.44
(D) Interactions							
SxT	NS	NS	NS	NS	NS	NS	NS
SxP	NS	NS	NS	NS	NS	NS	NS
TxP	NS	NS	NS	NS	NS	NS	NS
SxTxP	NS	NS	NS	NS	NS	NS	NS

cm), which remained statistically at par with the P_2 treatment.

4.4.3 Peduncle length

Data pertaining the peduncle length of marigold flower as affected by various treatments are presented in Table 15.

The data furnished in the Table 15 indicated that the effect of different treatments of seedling age, planting time, pinching and all the interactions on peduncle length were found to be non-significant.

4.4.4 Peduncle girth

Data (Table 15) showed that the effect of seedling age, planting time and interactions viz., SxT, SxP, TxP and SxTxP on peduncle girth was found to be non-significant.

The influence of pinching on peduncle girth was found significant. The maximum peduncle girth of flower (0.24 cm) was recorded the in P_0 (no pinching) which remained statistically at par with the P_1 treatment. On the other hand, treatment P_3 (40 DAT), produced the minimum peduncle girth (0.23 cm) which was at par with the P_2 treatment.

4.4.5 Fresh weight of flower

Data presented in Table 15 indicated that the influence of different seedling ages, planting times and all the interactions were found to be non-significant.

The results revealed that the effect of pinching on the fresh weight of flower was found significant. Significantly more fresh weight of flower (9.87 g) was recorded under the P_0 (no pinching) treatment, which remained statistically at par with the P_1 and P_2 treatments. While, significntly the minimum fresh weight of flower (7.45 g) was observed under the P_3 (40 DAT)

treatment.

4.4.6 Dry weight of flower

It is apparent from the Table 15 that the effect of seedling age, planting time and all the interactions on the dry weight of marigold flower was found to be non-significant.

From the data (Table 15) it was seen that the influence of various times of pinching on the dry weight of flower was found significant. Significantly more dry weight (1.28 g) of single flower was recorded in the P_0 (no pinching) which was at par with the P_1 and P_2 treatments. While, significantly the minimum dry weight of flower (0.97 g) was recorded in the P_3 (40 DAT) treatment.

4.4.7 Longevity of flower

Data related to the longevity of marigold flower as affected by different treatments are presented in Table 15.

An appraisal of data presented in Table 15 showed that the influence of different seedling ages, planting times, pinchings and all the interactions viz., SxT, SxP, TxP and SxTxP on longevity of flower was found to be non-significant.

DISCUSSION

V. DISCUSSION

In this chapter an effort has been made to discuss critically the important findings from the present study titled "Response of African marigold (Tagetes erecta L.) cv. Orange to seedling age, planting time and pinching" assigning suitable reasons for the treatment behaviour. The discussion, for the sake of convenience, has been divided under the following sub-headings.

5.1 Effect of seedling age

5.2 Effect of planting time

5.3 Effect of pinching

5.4 Interaction effect

5.1 Effect of seedling age

5.1.1 Effect of seedling age on growth attributes

The response of different seedling age on various growth attributes of African marigold cv. Orange viz., plant height, number of branches per plant and spread of plant before pinching and at flowering stage (Table 2) did not change appreciably. However, the various seedling ages significantly affected the stem diameter and number of nodes on main stem (Table 3).

Flower production is governed by optimum vegetative growth. This can be achieved by varying seedling age which is an important criterion governing establishment of seedlings which is an imperative for proper plant growth and development. The results indicated that the younger age of seedlings S_1 (30 DAS) produced the maximum plant height i.e. 11.16 and 72.90 cm before

pinching and at flowering stage, respectively, but it could not reach upto the level of significance. In case of number of branches per plant and spread of plant before pinching stage, the values remained same at S_1 and S_2 treatments. While, at flowering stage, maximum number of branches per plant (26.26) and spread of plant (0.30 sq m) were found with S_1 (30 DAS) treatment eventhough the differences were not perceptible. The more vigorous vegetative growth of the crop might be due to the younger seedlings as compared to older ones. The roots of younger seedlings absorb more water and nutrients from the soil which results in the better vegetative growth of marigold plant.

The above findings are in agreement with the results of Lim and Wong (1975) and Norman (1977) in capsicum for vegetative growth. Likewise, Maurya and Singh (1986) also observed that maximum plant height and number of branches per plant in 25 days old seedlings were higher as compared to late planted chilli crop.

5.1.2 Effect of seedling age on flowering behaviour

The effect of seedling age on the number of days required for the appearance of flower bud and opening of flower were found to be significant (Table 5). The results indicated that minimum number of days was required for the appearance of flower bud (54.74) and for opening of flower (15.64) in the 30 days old seedlings as compared to 40 dyas old seedlings. These lesser number of days required for the appearance of flower bud and opening of flower might be owing to the fact that the 30 days old seedlings complete its vegetative growth earlier due to the better establishment of plant as compared to 40 days old

seedlings. These results are in conformity with those reported by Lim and Wong (1975) in chilli, Norman (1977) in hot-pepper and Adelana (1983) in tomato.

5.1.3 Effect of seedling age on flower production

A marked influence of different seedling age on the number and yield of flowers per plant and flower yield per plot were observed (Table 9). The number (34.81) and yield (192.20 g) of flowers per plant and flower yield (3.43 kg) per plot were remarkably higher in S_1 (30 days) as compared to those in S_2 (40 days) treatment. This might be due to the fact that the 30 days old seedlings got more time in the field for the growth and development of plant and thermo requirements for vegetative growth. Thus, the plants were able to manufacture more food materials i.e carbohydrate and translocation of these food materials towards reproductive phase, which might have resulted in higher flower yield. This trend was strongly supported by the findings of Lim and Wong (1975) in chilli, Adelana (1983) in tomato, Maurya and Singh (1986) in chilli and Mangal et al., (1987) in cabbage. Similarly, Islam et al., (1989) in cabbage also reported that the 28 days old seedlings of cabbage produced the highest marketable yield compared to those of 42 days old seedlings.

5.1.4 Effect of seedling age on flower characters

The effect of seedling age on flower characters like flower diameter, thickness of flower, peduncle length, peduncle girth, fresh and dry weight of flower and longevity of flower did not affect appreciably (Table 13). These results are in

conformity with those reported by Mangal et al., (1987) in cabbage.

5.2 Effect of planting time

5.2.1 Effect of planting time on growth attributes

Imperceptible influence of planting time was found on different growth attributes of African marigold cv. Orange viz., plant height before pinching and number of branches and spread of plant before pinching and at flowering stage but plant height at flowering stage was remarkable affected (Table 2). In general, however, relatively better growth was observed with T_1 (25th January) treatment. Different planting times significantly influenced the growth attributes viz., stem diameter and number of nodes on main stem. The T_1 (25th January) treatment recorded significantly the maximum stem diameter (0.92 cm) and number of nodes (13.38) on main stem as compared to those T_2 (5th February) and T_3 (15th February) treatments in African marigold cv. Orange. The better development of various growth attributes with T_1 (25th January) planting might be due to favourable climatic conditions prevailing at the time of growth phases.

These results are in close agreement with those reported by Kiyatkin (1975) in chrysanthemum, Mukhopadhyay and Bankar (1981) in tuberose, Saini et al., (1988) and Dod et al., (1989) in gladiolus and Singh (1990) in marigold for plant height. Likewise, for number of branches per plant, Yadav and Bose (1988) and Chanda and Roychoudhury (1991) in marigold found that the higher value observed in early planting. Plant spread was also found maximum in earlier planting by Singh (1990) in marigold.

5.2.2 Effect of planting time on flowering behaviour

Remarkable response of planting time on number of days required for the appearance of flower bud and opening of flower was observed and 25th January transplanting required appreciable minimum i.e., 55.18 and 15.80 number of days for the appearance of flower bud and opening of flower, respectively, as compared to those T_2 (5th February) and T_3 (15th February) planting. This earlier appearance of flower bud and opening of flower with T_1 (25th January) planting might be due to favourable environment enjoyed by the crop during growth period which ultimately enhancing flowering. This result is in close conformity with the findings of Arora and Sandhu (1987) and Dod et al., (1989) in gladiolus and Gowda (1990) in China aster for flowering time.

5.2.3 Effect of planting time on production of flower

The number and yield of flowers per plant and flower yield per plot were apparently influenced by different planting times (Table 11. The earlier planting T_1 (25th January) produced distincted maximum number of flowers (32.44) and yield (184.83 g) per plant and flower yield (3.54 kg) per plot as compared to later planting of T_2 (5th February) and T_3 (15th February) planting. This increase in yield was probably due to the favourable effect of earlier planting on yield attributes because of more congenial growth conditions received during crop growth period and got sufficient time to complete all physiological processes properly which resulted into more flower yield as compared to later planting.

These findings are in the report of Kiyatkin (1975) in chrysanthemum, Patil et al., (1987) in aster, Saini et al.,

(1988) in gladiolus, Yadav and Bose (1988) and Singh (1990) in marigold found that the maximum number of flowers was noticed in the early planting compared to later planting.

Likewise, Gowda and Jayanthi (1986), Yadav and Bose (1988) and Singh (1990) in marigold reported that the maximum flower yield was obtained under the early planting treatment.

5.2.4 Effect of planting time on flower characters

The effect of different planting times were not remarkable on flower characters like flower diameter, thickness of flower, peduncle length and girth, fresh and dry weight of flower and longevity of flower (Table 13). These results are in conformity with those reported by Gill et al., (1985) in chrysanthemum and Gowda (1993) in aster for flower characters.

5.3 Effect of pinching

5.3.1 Effect of pinching on growth attributes

The response of different time of pinching treatments to various growth attributes of African marigold cv. Orange viz., plant height, number of branches per plant and spread of plant at flowering was found appreciable. While all these characters before pinching stage did not change remarkably. Appreciably maximum plant height (76.15 cm) at flowering was recorded with P_o (no pinching) treatment followed by the P_1 (20 DAT) treatment. The maximum plant height was observed in no pinched plant. This might be due to the removal of apical portion which neutralised the effect of apical dominance and resulted into more side branches. Present findings are in close conformity with the findings of Chillida (1983) and Patel and Arora (1983) in carnation. A marked increase in values of number of branches per

plant and spread of plant viz., 32.10 and 0.35 sq m was noticed with P_3 (40 DAT) and P_1 (20 DAT), respectively. Likewise, stem diameter was also appreciably affected due to varying pinching time. Remarkably the thick stem (0.89 cm) was found with P_3 (40 DAT) followed by the P_2 (30 DAT) treatment. Number of nodes on main stem did not influence perceptibly due to different pinching treatments. The maximum number of branches per plant, spread of plant and stem diameter were recorded with P_3 (40 DAT) treatment reason being removal of apical buds results in more number of axillary buds compared to those of early pinchings. Also removal of apical buds stimulates the lateral growth because inhibitory influence of auxin which is present in the apical buds prevent lateral growth of the marigold. Thus, removal of apical buds results in the removal of auxin which produces better lateral growth. These results are in close conformity with those of Arora and Khanna (1986) and Bhati and Chitkara (1987) for plant height in marigold, Singh and Arora (1980) and Bhati and Chitkara (1987) for spread of plant and number of branches per plant in marigold and Arora and Khanna (1986) for number of branches in African marigold.

5.3.2 Effect of pinching on flowering behaviour

The number of days required for the appearance of flower bud and opening of flower were remarkably affected due to pinching (Table 7). A marked increase in (58.53) number of days required for the appearance of flower bud was observed with P_3 (40 DAT) treatment. Likewise, the highest (16.73) number of days required for opening of flower was recorded at P_3 (40 DAT) treatment but it showed similar response as P_2 (30 DAT) and P_1

(20 DAT) treatments. This delay in appearance of flower bud and opening of flower with P_3 (40 DAT) treatment was attributed to late physiological maturity of shoots emerged after pinching. Also, the phenomenon of apical dominance last for longer period at P_3 (40 DAT) treatment compared to those with earlier pinchings. These results corroborate the findings reported by Bunt (1980), Groskov and Angelov (1981), Chillida (1983) and Patel and Arora (1983) in carnation, Arora and Khanna (1986) in marigold and Khanna et al., (1986) in carnation.

5.3.3 Effect of pinching on production of flower

A marked variations of time of pinching on number and yield of flowers per plant and flower yield per plot were observed (Table ||). Remarkably the maximum number (30.88) and yield (167.97 g) of flowers per plant and flower yield (3.55 kg) per plot were observed with P_3 (40 DAT) as compared to earlier and no pinching treatment. These increase in yield in the P_3 (40 DAT) treatment was due to the fact that, by removal of the apical portion, more energy might have been diverted for the development of the side branches and flowers. Whereas, in control (no pinching) plants, the process of apical dominance was overcome by the appearance of flowers which utilized energy for its development. These results are substantiated the findings of Singh and Arora (1980) in African marigold, Patel and Arora (1983) and Chillida (1983) in carnation, Rajasekaran et al., (1983) in gomphrena, Khanna et al., (1986) in carnation and Bhati and Chitkara (1987) in marigold for number of flowers per plant. Whereas, Bing (1960), Hillard and Hanon (1976) in carnation, Singh and Arora (1980), Arora and Khanna (1986) and Bhati and

Chitkara (1987) in marigold and Yassin and Pappiah (1990) in chrysanthemum for yield of flowers.

5.3.4 Effect of pinching on flower characters

Various flower characters viz., flower diameter, thickness of flower, peduncle girth and fresh and dry weight of flower were remarkably affected by pinching but the peduncle length and longevity of flower did not reach upto the level of significance (Table 15). Apparently maximum flower diameter and thickness of flower was observed with P_0 (no pinching) treatment which showed similar behaviour as P_1 (20 DAT) treatment. Likewise, significantly the maximum values of fresh and dry weight of flower was also found with P_0 (no pinching) treatment. These better quality of flower in the P_0 (no pinching) treatment was due to the presence of apical dominance. Which gives less number of flowers per plant that ultimately results in better quality of flowers. These results are in close conformity with the findings of Singh and Arora (1980) for flower size in marigold, Singh and Arora (1980) and Arora and Khanna (1988) for keeping quality of marigold.

5.4 Interaction effect

5.4.1 Interaction effect between seedling age and planting time (SxT)

The interaction effect of seedling age and planting time on stem diameter (Table 5), number of days required for appearance of flower bud and opening of flower (Table 7), number and yield of flowers per plant and yield of flower per plot (Table 11) were found significant.

The data indicated profound and augmenting effect on stem diameter (Table 6), number of days required for the appearance of flower bud (Table 8), opening of flower (Table 10),number of flowers per plant (Table 12), yield of flowers per plant (Table 13) and yield of flowers per plot (Table 14) was seen by combining optimum seedling age and planting time (S_1T_1) involving early planting of 30 days old seedlings planted on 25th January. Better effect of 30 days old seedlings planted at 25th January may be owing to better vegetative growth of the seedlings and favourable climatic conditions.

5.4.2 Interaction effect between seedling age and pinching (SxP)

The data on interaction effect of seedling age and pinching (SxP) presented in Table 9 and of very clearly revealed that combining optimum seedling age i.e. 30 DAS in absence of pinching (S_1P_0) showed pronounced and enhancing effect to attain minimum number of days (52.48) required for appearance of flower bud.

SUMMARY
AND
CONCLUSION

VI. SUMMARY AND CONCLUSION

The present investigation on response of African marigold (Tagetes erecta L.) cv. Orange to seedling age, planting time and pinching was carried out during 1993-94 at the Regional Fruit Research Station, Gujarat Agricultural University, Navsari Campus, Navsari.

Twenty-four treatment combinations consisting of two seedling age viz., S_1 (30 DAS) and S_2 (40 DAS), three planting times viz., T_1 (25th January), T_2 (5th February) and T_3 (15th February) and four pinching treatments viz., P_0 (no pinching), P_1 (20 DAT), P_2 (30 DAT) and P_3 (40 DAT) were compared using split plot design with the seedling age and planting time as main plot treatment and pinching as sub-plot treatment replicated thrice.

During the investigation, treatment effects were studied on the plant height, number of branches and spread of plant before pinching and at flowering stage, stem diameter, number of nodes on the main stem, number of days required for (i) appearance of flower bud and (ii) opening of flower, number and yield of flowers per plant, flower yield per plot and flower characters. The results presented and discussed in preceding chapter was summarized as under.

6.1 Growth attributes

6.1.1 Plant height

The plant height was not appreciably affected due to seedling age before pinching and at flowering stage and the planting time and pinching treatment before pinching. Whereas,

the maximum plant height at flowering stage was attained by T_1 (25th January) planting and P_0 (no pinching) treatment produced remarkably tall plant of 75.60 cm and 76.15 cm, respectively.

6.1.2 Number of branches

The influence of seedling age and planting time before pinching and at flowering stage and pinching treatment before pinching on the number of branches was not perceptible. Appreciably the highest number of branches (32.10) per plant at flowering stage was observed with P_3 (40 DAT) treatment.

6.1.3 Spread of plant

Appreciable effect on plant spread was only seen due to pinching at flowering stage. A marked increase in spread of plant (0.35 m^2) at flowering was noticed at P_1 (20 DAT) treatment.

6.1.4 Stem diameter

The younger seedlings S_1 (30 DAS) and earliest planting time T_1 (25th January) recorded distinctly more stem diameter of 0.85 cm and 0.92 cm, respectively. Delayed pinching P_3 (40 DAT) produced remarkably the thick stem of 0.90 cm of marigold plant. The interaction S_1T_1 recorded the maximum stem diameter of plant (0.96 cm) while, S_2T_3 recorded the minimum stem diameter of plant (0.64 cm).

6.1.5 Number of nodes on main stem

Significantly the maximum number of nodes 13.43 on main stem was observed in S_2 (40 DAS) seedlings. The highest number of nodes (13.38) recorded in T_1 (25th January) planting, however, it was at par with T_2 recording 13.29 nodes on main stem. While, the effect of pinching on the number of nodes on main stem was found

to be non-significant.

6.2 Flowering behaviour

6.2.1 Appearance of flower bud

The younger seedlings S_1 (30 DAS) required lesser days (54.74) for the appearance of flower bud. The earlier planting T_1 (25th January) required the minimum number of days (55.18); except treatment T_2 requiring 55.78 days for appearance of flower bud. The pinching P_o (no pinching) treatment required the minimum number of days (54.24). On the other hand, the delayed pinching P_3 (40 DAT) required the maximum number of days (58.53) for the appearance of flower bud. The interaction S_1T_1 involving 30 days old seedlings planted at 25th January recorded the minimum number of days required for appearance of flower bud (54.11). The combination S_1P_o comprised of 30 days old seedlings planted at 25th January recorded the lesser days (52.98); while, S_2P_3 combination required the maximum number of days for the appearance of flower bud (60.88).

6.2.2 Opening of flower

The younger seedlings S_1 (30 DAS) required lesser days (15.64) for opening of flower. The early planting T_1 (25th January) required the minimum number of days (15.80) for opening of flower except treatment T_2 which took 15.93 days. The P_o (no pinching) treatment required the minimum number of days (15.53) for opening of flower. On the other hand P_3 (40 DAT) required appreciably more days for opening of flower in marigold (16.73 DAS); however except P_2 and P_1 treatments. The interaction S_1T_1 consisted 30 days old seedlings planted at 25th January recorded the minimum number of days required for opening of flower

(15.47).Treatment combination S_2T_1 involving 40 days old seedlings planted on 25th January recorded the maximum number of days required for opening of flower (17.69).

6.3 Production of flower

6.3.1 Number of flowers per plant

The younger seedlings S_1 (30 DAS) produced the maximum number of flowers per plant (34.81). The early planting T_1 (25th January) recorded 32.44 number of flowers per plant and delayed pinching P_3 (40 DAT) produced the maximum number of flowers (30.88) per plant. The interaction S_1T_1 comprised of 30 days old seedlings planted on 25th January recorded the maximum number of flowers per plant (42.75); while, S_2T_1 produced the minimum number of flowers (18.82) per plant.

6.3.2 Yield of flowers per plant

A marked increase in yield of flowers (192.20 g) per plant was recorded by S_1 (30 days the younger seedlings). The early planting T_1 (25th January) also recorded the maximum yield of flowers (184.83 g) per plant. The maximum yield of flowers (167.97 g) per plant was recorded with P_3 (40 DAT) treatment except treatment P_o (no pinching) which produced 167.24 g flower yield per plant. The combination S_1T_1 involving 30 days old seedlings planted on 25th January recorded the maximum yield of flowers per plant (234.18 g).

6.3.3 Flower yield per plot

The younger seedlings S_1 (30 DAS) produced the maximum flower yield per plot (3.43 kg). The earlier planting T_1 (25th January) recorded 3.54 kg flowers per plot and delayed pinching P_3 (40 DAT) produced the maximum flower yield of 3.55 kg per

plot. The interaction S_1T_1 recorded the maximum flower yield per plot (4.15 kg); while S_2T_1 produced the minimum flower yield per plot (2.33 kg).

6.4 Flower characters

6.4.1 Flower diameter

All the four treatments of pinching differed distinctly from each other in respect to the flower diameter. The P_o (no pinching) treatment recorded the maximum diameter of marigold flower which was 6.15 cm. The minimum diameter of flower (5.42 cm) was observed in the P_3 (40 DAT) treatment.

6.4.2 Thickness of flower

The effect of pinching treatment was only found perceptible. The maximum thickness of flower (4.15 cm) was recorded with P_o (no pinching) treatment except P_1 treatment.

6.4.3 Peduncle length

The influence of seedling age, planting time and pinching did not manifest remarkable change on peduncle length.

6.4.4 Peduncle girth

Time of pinching only expressed appreciable effect on peduncle girth and P_o (no pinching) treatment recorded the maximum peduncle girth (0.24 cm) of marigold flower except P_1 treatment.

6.4.5 Fresh weight of flower

The pinching effect was remarkable on fresh weight of flower and P_o (no pinching) treatment recorded maximum fresh weight of marigold flower (9.87 g) except P_1 treatment.

6.4.6 Dry weight of flower

The effect of pinching treatments perceptible and P_o

(no pinching) treatment produced maximum dry weight of marigold flower (1.28 g).

6.4.7 Longevity of flower

The influence of seedliing age, planting time and pinching on longevity of flower did not exert appreciable influence on longevity of flower.

CONCLUSION

Based on the resluts of one year investigation, it is indicated that the potential production from African marigold cv. Orange in summer under South Gujarat conditions can be achieved by using 30 days aged seedlings transplanted on 25th January and pinched at 40 days after transplanting.

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APPENDICES

APPENDIX - I : Meteorological data during the crop period of marigold (from December, 1993 to April, 1994)

Month	Std. Week	Dates	Temperature °C Maxi.	Temperature °C Mini.	Relative humidity(%) Maxi.	Relative humidity(%) Mini.	Sunshine hours
Dec. '93	49	03-09	30.5	17.2	75	35	08.4
	50	10-16	31.5	15.1	73	35	10.1
	51	17-23	30.3	13.2	74	35	10.0
	52	24-31	29.6	15.0	77	49	08.6
Jan. '94	01	01-07	31.8	15.0	89	52	08.8
	02	08-14	29.0	14.0	92	65	07.2
	03	15-21	26.9	10.3	87	57	10.0
	04	22-28	33.6	16.9	90	44	09.5
	05	29-04	30.0	11.9	71	33	10.0
Feb '94	06	05-11	30.2	12.7	81	37	09.8
	07	12-18	30.7	12.3	85	34	10.1
	08	19-25	29.0	14.4	82	48	10.1
	09	26-04	34.2	14.0	80	31	10.3
March '94	10	05-11	35.7	14.9	86	37	10.4
	11	12-18	37.8	18.0	85	46	10.0
	12	19-25	36.9	20.2	89	30	09.9
	13	26-01	37.3	19.9	88	55	10.3
April '94	14	02-08	33.7	21.5	90	62	10.6
	15	09-15	34.3	21.0	78	40	10.7
	16	16-22	35.9	22.7	86	55	10.7
	17	23-29	33.8	23.0	90	67	10.2
	18	30-06	34.0	24.1	88	54	10.3

Source : Meteorological observatory, N.M. College of Agriculture, Gujarat Agricultural University, Navsari.

APPENDIX - II : Hectarewise yield of African marigold flower under different treatments combination (kg/ha)

Treatment combination	Replication I	Replication II	Replication III	Mean kg/hectare
$S_1T_1P_0$	10505.29	9811.98	10517.04	10278.10
$S_1T_1P_1$	9471.21	7226.79	7461.81	8053.27
$S_1T_1P_2$	8495.89	9435.96	8965.92	8965.92
$S_1T_1P_3$	10998.82	12420.68	11715.63	11711.71
$S_1T_2P_0$	6745.00	8636.90	7226.79	7536.23
$S_1T_2P_1$	6310.22	5569.92	7050.53	6310.22
$S_1T_2P_2$	7309.05	6933.02	7203.29	7148.45
$S_1T_2P_3$	7732.08	9048.18	8660.40	8480.22
$S_1T_3P_0$	6603.99	7555.81	7121.03	7093.61
$S_1T_3P_1$	5757.93	6603.99	6803.76	6388.56
$S_1T_3P_2$	6756.76	7168.04	7602.82	7175.87
$S_1T_3P_3$	8813.16	7461.81	7638.07	7971.01
$S_2T_1P_0$	7485.31	7356.05	7614.57	7485.31
$S_2T_1P_1$	5334.90	5640.42	6227.97	5734.43
$S_2T_1P_2$	6404.23	6603.99	6380.73	6462.98
$S_2T_1P_3$	7790.83	7861.34	7826.09	7826.09
$S_2T_2P_0$	6639.25	6063.45	6980.02	6560.91
$S_2T_2P_1$	5287.90	4947.12	5064.63	5099.88
$S_2T_2P_2$	6227.97	5922.44	6368.98	6173.13
$S_2T_2P_3$	7356.05	7461.81	7638.07	7485.31
$S_2T_3P_0$	5522.91	5334.90	6603.99	5820.60
$S_2T_3P_1$	4806.11	4477.08	4453.58	4578.93
$S_2T_3P_2$	4641.60	4559.34	4606.34	4602.43
$S_3T_3P_3$	6462.98	7461.81	6874.26	6933.02

C E R T I F I C A T E

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Date : July 31 ,1995

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