

RESPONSE OF NITROGEN, PHOSPHOROUS AND COMMON  
PINCHING ON GROWTH, FLOWERING AND QUALITY  
OF AFRICAN MARIGOLD ( *Tagetes erecta* Linn. )

THESIS

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**THESIS**

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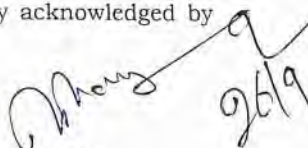
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## CERTIFICATE - I

This is to certify that the thesis entitled, "**RESPONSE OF NITROGEN, PHOSPHOROUS AND COMMON PINCHING ON GROWTH, FLOWERING AND QUALITY OF AFRICAN MARIGOLD (*Tagetes erecta* Linn.)**" submitted in partial fulfilment of the requirement for the degree of "**MASTER OF SCIENCE IN AGRICULTURE**" of the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a record of the bonafide research work carried out by **SHRI AMIT PANDEY** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (Certificate awarded etc.) or has been published/published part has been fully acknowledged. All the assistance and help received during the course of investigations have been duly acknowledged by him.

  
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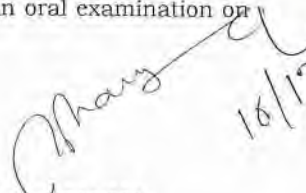
  
  
  
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This is to certify that the thesis entitled "**RESPONSE OF NITROGEN, PHOSPHOROUS AND COMMON PINCHING ON GROWTH, FLOWERING AND QUALITY OF AFRICAN MARIGOLD (*Tagetes erecta* Linn.)**" submitted by **SHRI AMIT PANDEY** to the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, in partial fulfilment of the requirements for the degree of "**MASTER OF SCIENCE IN AGRICULTURE**" in the Department of **HORTICULTURE** has been approved by the Student's Advisory Committee and the External Examiner(s) after an oral examination on the same.

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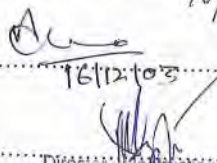
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*Place : Jabalpur*

*Date : 26.09.03*

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INTRODUCTION

## INTRODUCTION

Significance of floriculture in tropical country like India, in terms of crop diversification, value addition and export has achieved immense value especially in post GATT scenario. After having attained sufficiency in food through cereals, the economic country through Horticulture needs special emphasis by crop diversification and improvement in flower production with the introduction of hi-tech floriculture. The economic prosperity of the flower grower has been increased significantly. India has made fairly good progress in floriculture sector in recent years and ranks second place in production of flowers only after China. After acceptance of liberalization policy and WTO provisions the export potential of our flower has been increased, tremendously with the country also. The consumption pattern of flowers has changed and there is a better awareness among the consumers and also the flower growers for adopting the improved technology.

### 1.1 Multiples of Marigold

Marigold an important flower commonly grown to Indian government has multifaceted uses.

#### 1.1.1 Common uses

- used in religious and social functions
- used as house flowers and for display of gardens

- used for decoration and as landscape plants
- ideal for newly planted shrubberies to fill spaces with attractive colours.

#### 1.1.2 Medical uses

- Leaf paste is used externally against boils and caruncles.
- Leaf extracts are good remedy for earache, kidney troubles, muscular pain, piles, and ophthalmia
- Flower extract is considered as blood purifier and a cure for bleeding piles and is also good remedy for eye diseases and ulcers

#### 1.1.3 Perfumes

- Many *Tagetes species* oil used in the preparation of high-grade perfumes.
- *Tagetes signata* oil used in perfume industries.

#### 1.1.4 Other uses

- Marigold used as repellents and trap-crops in horticultural crops especially vegetables.
- included as a companion crop in nematode control.
- petal powder mixed in poultry feed to intensify the yellow colour of egg yolk. (Raghava, S.P.S. 1998a).
- Chinese uses marigold leaf for making tea.

In fact the flowers play a very important role in everyday life. Traditionally the flowers are used for puja, vrata, garlands, interior decoration, bouquets, wreaths, etc. The flowers due to their diversity in beauty, form, texture, colour and fragrance have always touched the heart of human beings. Rationally India has been great user of these beautiful creations for all purposes in happiness and sorrow.

The demand for cut flowers and other decorative plants has increased manifold during the recent years because of rapid urban planning. According to present estimate about 88,507 ha are grown under marigold, the production of flowers is estimated to be more than 5 lakh tonnes of loose flower and over 680 million cut flowers (Singh, 2002) and the trade of flowers is to the tune of Rs. 250 crore.

Marigold is one of the commercially exported flower crops in India, which is widely used in religious and social function. Marigold belongs to the family *Asteraceae* and is a native of Central and south America, especially Mexico.

It has gained popularity amongst gardeners and flower dealers in view of its easy cultivation, habit of free flowering, short duration to produce marketable flowers, wide spectrum of attractive color, shape, size and good keeping quality. Due to these favorable characteristics Marigold is considered as most important annual flower in India for commercial cultivation as well as for garden display.

In India, the total area and production under marigold cultivation is 1494 ha with a total

production of 11953 tonnes (Kolavalli *et.al.*, 1989). Marigold is mainly grown for production of loose flowers in state of Maharashtra, Madhya Pradesh, Haryana, Gujrat and Delhi. In M.P. the area under marigold cultivation is concentrated around Ujjain, Indore, Shajapur, Dewas, Hoshangabad, Khandwa, Chhindwara, Betul, Jabalpur, Mandla and Narsinghpur.

There are two groups of marigold namely, African marigold (*Tagetes erecta* L.) and French marigold (*T. patula* L.). African marigold represents vulgar minds whereas; French marigold is a symbol of jealousy (Anonymous). African marigold is a hardy annual plant about 75-90 cm tall; foliage is dark green with reddish to yellow stem. Leaves are pinnately compound, which are linear, lanceolate and serrated. Flowers are large to medium size, either single or double, borne on long peduncles. The flower colour varies from yellow to orange-red.

The plants of *Tagetes* species yield a strong aromatic and essential oil called *Tagetes* oil. It is used in compounding high-grade perfumes. Leaves and flower are equally important from medicinal point of view. Leaf paste extract is good remedy for earache. Flower extract is considered as a blood purifier, a cure for bleeding piles and is also a good remedy for eye diseases and ulcers. It is also used as nematicide.

In foreign countries, powder of orange coloured petal varieties is being fed to poultry birds through feed to obtain dark orange coloured yolk in eggs. (Raghava, 1998a). Few industries in India, particularly in Andhra Pradesh, Karnataka and Maharashtra are exporting powder of orange coloured marigold

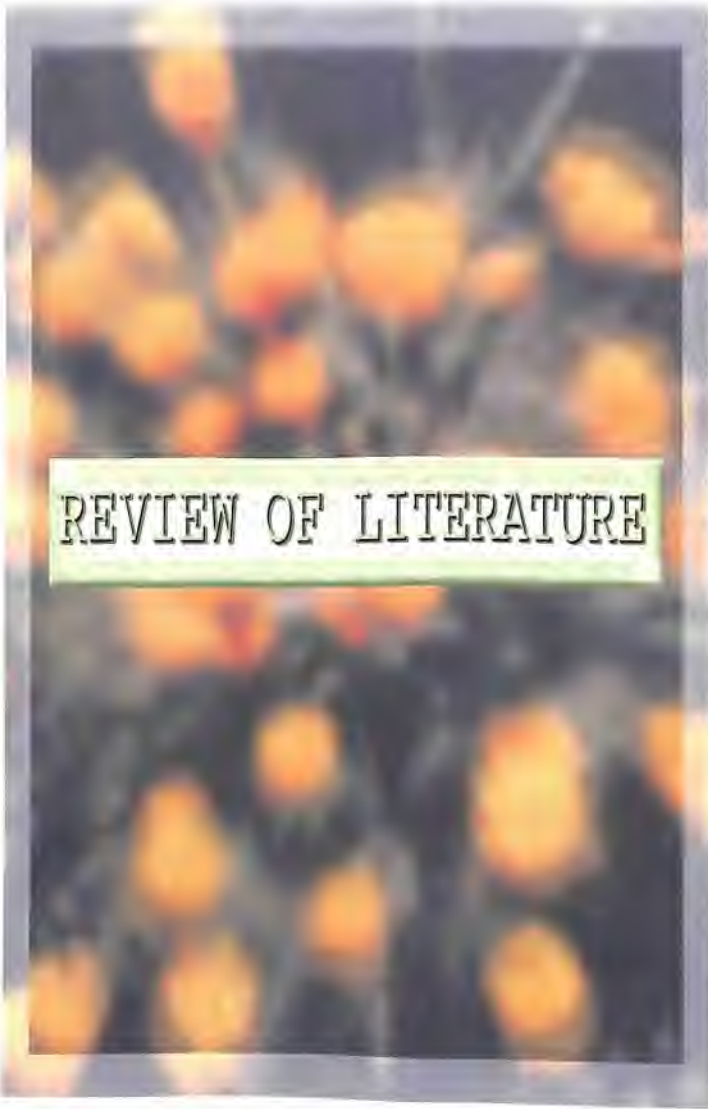
flowers. Therefore in these states, orange coloured marigold is being commercially cultivated. In South and Central Madhya Pradesh, the most cultivated varieties are 'Giant Double African Yellow', 'Cracker Jack', 'Climax', 'Charm', and 'Crown of Gold'. Pusa Narangi Gainda a double flowering of marigold recently released from IARI, New Delhi (Raghava, 1998b). The variety is a high yielder and produces larger size of bright orange colour flowers. It has immense scope for cultivation in the state for replacing the old cultivars. It is therefore necessary to test this new variety under the agro-climatic conditions of Jabalpur along with the new techniques of cultivation.

Like any other crop plants, improvement in yield and quality of flowers depends largely on nutrition. It is practically axiomatic established that nutrition plays an important role in the improvement of flowers and yield. Fertilizers being a costly affair, the growers would definitely be interested in the use of optimum dose of fertilizers for maximum return.

Keeping this in view the commercial importance of marigold and its requirement of nitrogen and phosphorus, a nutritional trial i.e. "Response of Nitrogen Phosphorus and common pinching on the growth flowering and quality African marigold" was carried out during the winters of year 2002-2003 at the Vegetable and Floriculture Nursery, Adhartal, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur with the following specific objectives: -

1. To find out the optimum dose of Nitrogen and Phosphorus for marigold flower production.

1. To find out the effect of Nitrogen and Phosphorus on growth, flowering and quality of marigold.
2. Interaction effect of Nitrogen and Phosphorus on yield of marigold.



REVIEW OF LITERATURE

## REVIEW OF LITERATURE

Several factors are responsible for growth and yield of crop. Out of these factors nutritional aspect is considered to be the most important one. Experimental results reveal that among a number of elements, which maintain the fertility of the soil and are needed by the plants. Nitrogen and phosphorus appear to be the most essential one for the nutrition of the crop.

The experimental evidences on manurial requirements of marigold (*Tagetes erecta* L.) and several herbaceous plants are very scanty in India. Investigations carried on the manurial requirements of the ornamental plants as a whole. The relevant literature on the effect of Nitrogen (N) and Phosphorus (P) on the growth and flowering of marigold is scanty. Therefore, an effort has been made to review on following heads:

2.1 Effect of Nitrogen and Phosphorus on growth parameters.

2.2 Effect of Nitrogen and Phosphorus on floral characters.

### 2.1 **Role of nitrogen and phosphorus on growth of flowering plants**

Nelson and Boodly (1964) reported that high level of nitrogen effects growth and flowering adversely in carnation. They reported that as the N level increased growth of plant decreased correspondingly.

Gammonssy *et al.* (1965) reported that vegetative growth in marigold continued for longer time with high nitrogen levels.

Cartner and Dermott (1966) reported that in chrysanthemum number of marketable blooms, height of plant, decreased with increasing level of nitrogen application.

Bose and Ray (1968) observed that characteristics effects of reduced growth in N deficient *Dianthus*, *Cosmos* and *Coreopsis*. The addition of 12 ml/litre of nitrogen in solution resulted in 6 and 11 per cent more growth in soil and perlite respectively of carnation plants as compared to 10 ml/litre of nitrogen.

Tsurushima and Date (1971) reported that extra application of nitrogen improved growth and increased the total plant and fresh weight of carnation.

Rahman and Mitra (1974) reported in *Dahlia* that nitrogen at 50lb/acre showed maximum shoot length, leaf and branch number and also the number of flowers as compared to Nitrogen at 0, 25 and 75 lb/acre. However, the highest dose of Nitrogen resulted in maximum number and weigh of root tubers.

Higher doses of Nitrogen and Phosphorus encouraged increase in number of leaves/plant and the effect was observed with the increased dose of Phosphorus in cv. Vink's Glory of *Gladiolus*. (Achal *et al.*, 1984).

Ravindra *et al.* (1986) noted significantly increased plant height in African marigold by higher dose (90 kg/ha) of Nitrogen than lower doses (30 and 60 kg/ha) and control.

Mukhopadhyay and Banker (1987) conducted a trial where plant received 20gNitrogen/m<sup>2</sup> in one dose or in 2-4 split doses. The greatest plant height, number of spike per plant were obtained by applying one third of the nitrogen before planting and one third at 30 days after planting in tuberose.

Arulmozhiyan (1989) studied that Nitrogen at 120kg/ha significantly increased the number of shoots in Marigold cv. MDU-I.

Anamika and Lavania (1990) reported in Rose that plant spread was improved with the application of 25g N, 20g P, and 15g K per plant.

Sidhu and Yamdagni (1992) observed that combination of N, P, and K @ 60, 30 and 60 gm/m<sup>2</sup> respectively increased plant height in hybrid tea rose cv. Super star.

Lodhi and Tiwari (1993) recorded maximum plant height (47.43 cm) with 45g N and 40g P m<sup>-2</sup> in Chrysanthemum.

Barman and Pal (1994) observed higher plant height of *Calendula officinalis* L. with increasing doses of Nitrogen along with 5 kg F.Y.M/m<sup>2</sup>.

Jana *et al.* (1997) suggested that in a single tuberose high Phosphorus (20g/m<sup>2</sup>) increased the number of leaves.

Yadav and Singh (1997) in a pot experiment using sandy loam soil the effect of 0, 60, 120, 180, 240 and 300 ppm Nitrogen and different levels of F.Y.M were studied on growth and fresh flower yield of marigold. The number of branches increased with up to 180 ppm.

Yadav and Singh (1997) found in a pot experiment using sandy soil the effect of 0, 60, 120, 180, 240 and 300 ppm nitrogen and different levels of F.Y.M were studied on growth of marigold and the plant height increased consistently with up to 120 ppm Nitrogen.

De and Barman (1997) studied the effects of 0, 5, 10, 15 and 20 g N/m<sup>2</sup> on chrysanthemum at Tripura and found that plant height, leaves/plant, flower/plant and flower yield were improved significantly under 15-20 g N/m<sup>2</sup>.

Dahiya *et al.* (1998) recorded in green house studies were conducted during 1996-97 to asses the effect of Nitrogen ( 0, 80, 160, and 240 ppm) and Phosphorus ( 0, 40, 80, 120 ppm) on plant height was increased up to 240 ppm Nitrogen and increasing Phosphorus rates significantly improved the growth parameters of potted African marigold.

Khattak *et al.* (1999) found in greenhouse experiment were carried out to investigate interactions between the effect of nitrogen applied at 0.136, 1.0, 3.16, or 10 mm (via nutrient solution) and 4 different spectral filters on the growth and development of Chrysanthemum. Increasing the nitrogen dose to a near 2-fold increase in plant height.

## 2.2 Role of nitrogen and phosphorus on floral characters

Chan *et al.* (1958) indicated that the increasing levels of Nitrogen from 20-60 ppm increased the flower production and yield through increased number of flowers. Later doubling of Nitrogen level also induced further increase in flower number indicating the need for higher level of nitrogen application of low level of Nitrogen produced slow growth of the leaves and delayed the flowering in carnation.

Allen (1959) noted that phosphorus is an active ingredient of cell nucleous and encourages root growth and stimulates flowering.

Ailincai (1960) found that granular superphosphate at the rate of 60 g/m<sup>2</sup> combines with phospho-bacterin was useful to increase the number of flowers per inflorescence and also the life of flower in tuberose.

Kasagi and Kondo (1961) observed favorable response of Gladiolus to Nitrogen fertilization. The number of its flowers was significantly promoted by using higher doses of Nitrogen.

Joiner and Greuis (1962-63) observed in Marigold that lowest amount of Nitrogen supplied, i.e. 1 lb/100 sq. ft of 8-0-8 fertilizer sufficient for satisfactory flowering.

According to Jungk (1962) size and number of flowers in Chrysanthemum were increased with the increased levels of Nitrogen.

Nitrogen fertilization resulted in as 20% increase in flower number of Carnation also (Winsor, 1962)

Experiments conducted on nutrition of some ornamental crops such as Tulip (Nishii and Tsutsui, 1963; Cheal and Winsor, 1968) and Gladiolus (Garibaldi, 1964) in sand culture have also beneficial effects of nitrogen treatments on their growth and flowering behavior.

Bik (1964) reported that with increased amounts of Nitrogen supplied to yellow Delaware- Chrysanthemum, that was increase in flower bud number per plant and in final plant diameter.

Pawlowiski (1966) found that flower development in Petunia and Chrysanthemum was delayed with higher level of Nitrogen and the effect was enhanced with a lower Potassium level and greater N:K ratio.

Roelants (1973), found the beneficial effect of phosphorus in carnation. He recorded increased flower diameter, fresh weight of flowers, greater number of petals per flower, increased pigmentation and more intense colour of flower.

Jana *et al.* (1974) observed that the number and size of flowers improved appreciably under high Nitrogen treatments.

Zaltsfas and Chemarin (1974) indicated that when phosphorus was increased from 60 to 180 Kg/ha, the yield of flowers increased by 11% and oil yield by 12% in rose.

Cherneva (1976) observed that Nitrogen was the next most effective nutrition, increasing flower number, inflorescence diameter and seed yield in annual aster.

Singh *et al.* (1976) conducted experiments on fertilization of tuberose and reported that a dressing of 120kg N/ha gave the maximum number of flower.

Mishra and Negi (1977) observed that with every increase in the dose of nitrogen there was a progressive increase in the weight of corms and cormels and gladiotus. The best results regarding the length of spikes and number of florets per spike were obtained with the application of 20 g N/ m<sup>2</sup>

Highest weight of flower was recorded in Marigold cv. African Giant Double Orange with Nitrogen and Phosphorus each at 40g m<sup>-2</sup>. (Arora and Singh, 1980).

Arora and Jaswinder Singh (1980) obtained highest yield of Marigold in treatments receiving the highest Nitrogen and Phosphorus i.e. 40g N and 40g P<sub>2</sub>O<sub>5</sub> m<sup>-2</sup>.

Haidar *et al.* (1981) studied the effect of N on growth and development of gladiolus Cv. Psittacinus hybrid at NBRI, Lucknow concluding 200 Kg/ha N as the most effective dose for growth and flowering parameters and corm and Cormel production.

Natrajan *et al.* (1984) also found that an annual dressing of 10kg F.Y.M. per plant and bimonthly application of 40 g of nitrogen per plant gave the highest flower yield of *Jasminum sambac* L.

Kumar and Gill (1984) in case of *Jasminum sambac* L. found that plant receiving Nitrogen at 30g/plant gave the highest yield of flower buds.

Rathore *et al.* (1985) recorded in African Marigold that 4 replications of 1% Urea as foliar spray at weekly interval after transplantation increased flower weight significantly.

Arora and Khanna (1986) experimented with Marigold (*Tagetes erecta*) at PAU, Ludhiana and concluded that the application of 20g N/sq.m. was optimum for flower production.

Ravindran *et al.* (1986) obtained highest flower yield of African Marigold (142.48g/ha) with highest Nitrogen (90kg/ha) plus F.Y.M. as basal dressing.

Yassin (1988) found significantly increased number of flower, flower size in Chrysanthemum by 25 and 75 kg N/ha, than 100 kg N/ha.

Rathore *et al.* (1988) obtained maximum number of flowers with 200 kg N/ha in Marigold.

Anuradha *et al.* (1988b) reported that size of flowers were significantly less in Marigold plant receiving N and P @ 90 and 60 kg/ha respectively compared to plants supplied with 60 kg N and 30 kg P/ha.

Anuradha *et al.* (1988c) reported that, Nitrogen Phosphorus contents and uptake of N,P and K increased significantly with the increasing and N and P application rates.

Arulmozhiyan and Pappaiah (1989) reported increase in flower yield of Marigold with increasing both, Nitrogen and Phosphorus levels.

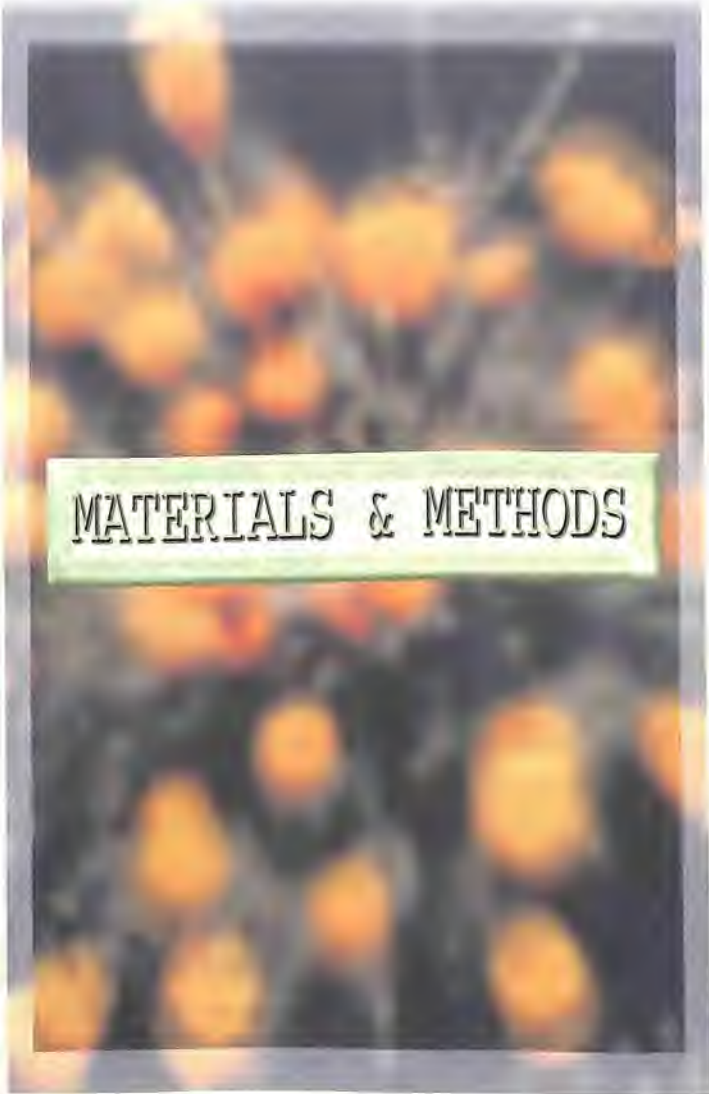
Belorkar *et al.* (1992) while comparing 4 rates of Nitrogen i.e. 60, 90, 120 and 150 kg/ha observed reduction in flower yields at higher rates of Nitrogen in African Marigold.

Lodhi and Tiwari (1993) studied Chrysanthemum plants grown with Nitrogen 0, 15, 30, 45, 60 gm<sup>-2</sup> and Phosphorus 0, 15, 30, 45 gm<sup>-2</sup> and recorded maximum number of flowers i.e. 49.83 per plant at 45g N + 45g P m<sup>-2</sup>.

Lodhi and Tiwari (1993) obtained maximum number of Chrysanthemum flower with 30g Nm<sup>-2</sup> when compared with 0, 15, 30, 45, and 60g Nm<sup>-2</sup>.

Dahiya *et al.* (1998) recorded in green house studies were conducted during 1996-97 to asses the effect of Nitrogen ( 0, 80, 160, and 240 ppm) and Phosphorus ( 0, 40, 80, 120 ppm) on the number of flowers per plant was increased up to 240 ppm Nitrogen and increasing Phosphorus rates significantly improved the yield of African marigold.

Yadav and Singh (1999) in a Sandy Loam soils in Hisar the effect of 0, 60, 180, 240 and 300 ppm Nitrogen and different level of F.Y.M. They found total leaf chlorophyll content increased with N application up to 180 ppm N and remained almost constant beyond this level. Leaf N content increased consistently with N rate but other nutrient concentrations (P,K) were highest at the 180 ppm N applicants.



MATERIALS & METHODS

## **MATERIALS AND METHODS**

The materials used and methods employed during tenure of investigation on the "Response of Nitrogen, Phosphorus and common pinching on the growth, flowering and quality of African Marigold" (*Tagetes erecta*) cv. "Pusa Narangi Gainda" are as follows:

### **3.1 Experimental Site**

The experiment was conducted at the New Nursery, Department of Vegetable Crops and Floriculture, Jawaharlal Nehru Krishi Vishwa Vidyalyaya, Jabalpur (M.P.) during September 2002 to March 2003.

### **3.2 Climate**

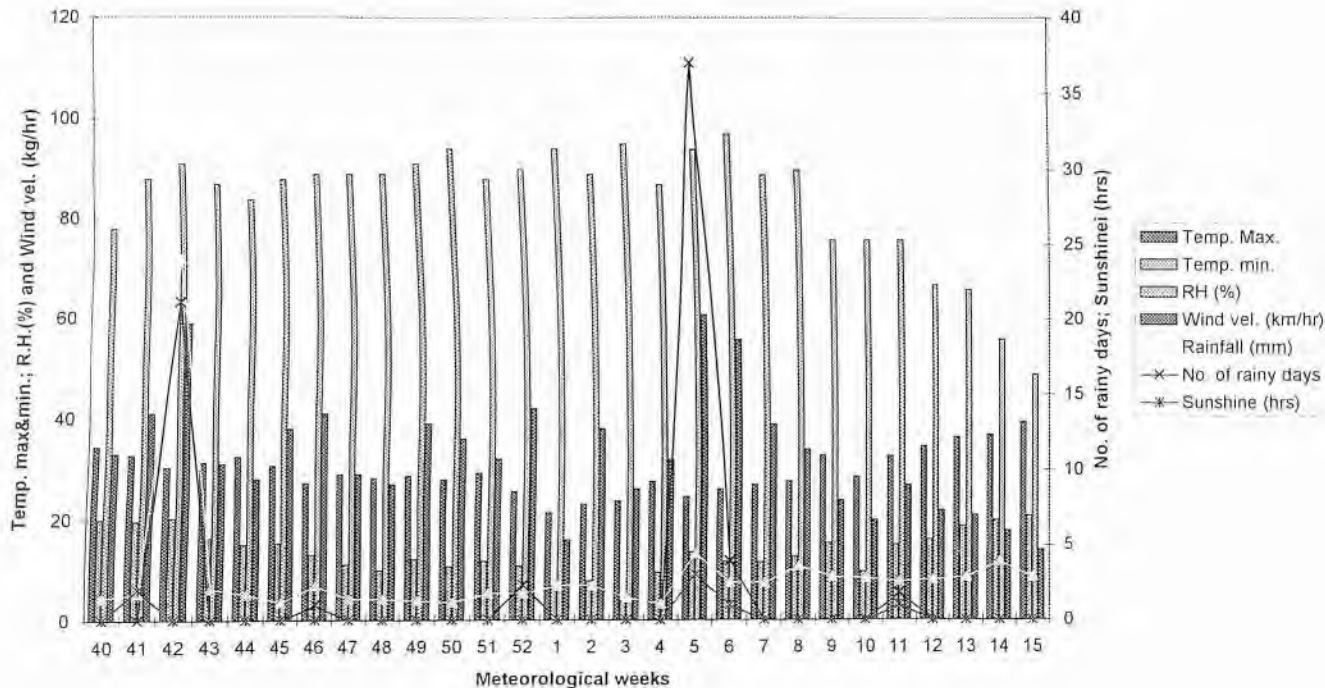
Jabalpur is situated in Kymore plateau agro climatic region of Madhya Pradesh at 23.91°North latitudes, 79.5°East longitude and on altitude of 411.78metres above the mean sea level. The climate is semi arid and subtropical with hot summer and moderately cool winter. The annual rainfall varies from 1200-1500 mm with an average of 1491 mm. The kharif season starts from June to September and receives 90 percent of the total rainfall. The average maximum and minimum temperatures are 46°C and 3.4°C respectively. Winter occurs during November to February with occasional frost.

Table 3.1. Meteorological information (week wise) during entire crop season of the year (2002-2003) at Jabalpur

Months	Weeks	Temperature		Mean relative humidity	Rainfall (mm)	No. of Rainy days	Sun-shine hours
		Max.	Min.				
1	2	3	4	5	6	7	8
Oct.	40	34.4	20.0	55.5	0	0	8.7
	41	32.7	19.7	64.5	0	2	9.2
	42	30.3	20.3	75	21.1	0	6.3
	43	31.3	16.3	59	0	0	8.8
Mean		32.1	19.1	63.5	(21.1)	(2)	8.3
Nov.	44	32.5	15.0	56	0	0	8.7
	45	30.7	15.3	63	0	0	7.8
	46	27.2	13.0	65	1.0	0	7.1
	47	29.0	11.0	59	0	0	4.6
	48	28.2	9.8	57	0	0	8.2
Mean		29.5	12.8	61.3	(1.0)	(0)	7.3
Dec.	49	28.7	12.1	61	0	0	7.6
	50	27.9	10.6	65	0	0	7.8
	51	29.2	11.7	60	0	0	8.6
	52	25.6	10.7	66	2.3	0	7.2
Mean		27.8	11.3	64	(2.3)	(0)	7.8
Jan	1	21.4	6.6	55	0	0	6.5
	2	23.1	7.8	63.5	0	0	6.7
	3	23.7	3.8	60.5	0	0	9.0
	4	27.5	9.5	59.5	0	0	9.1
	5	24.6	13.5	77.5	37.0	3	5.4
Mean		24.1	8.2	63.5	(37.0)	(3)	7.3
Feb.	6	26.1	11.6	76.5	3.9	1	7.3
	7	27.0	11.5	64	0	0	7.9
	8	27.7	12.6	62	0	0	9.1
	9	32.8	15.5	50	0	0	9.7
Mean		28.7	12.8	63.2	(3.90)	(1)	8.5
Mar.	10	28.6	9.7	48	0	0	9.1
	11	32.7	15.1	51.5	1.8	1	7.1
	12	34.7	16.2	44.5	0	0	8.5
	13	36.5	18.9	43.5	0	0	8.1
Mean		33.1	14.9	46.9	(1.8)	(1)	8.2
April	14	36.9	20.0	37	0	0	7.6
	15	39.4	20.9	31.5	0	0	8.8
Mean		39.2	20.4	34.3	(0.0)	(0)	8.2

Figures in the parenthesis are total values

Fig. 3.1: Meteorological information (week wise) during entire crop season of the year (2002-2003) at Jabalpur



### 3.3 Soil

The soils of the experimental field are light sandy loam with normal organic matter, uniform topography and good drainage. The soil samples were collected randomly with the help of auger at the depth of 15 cm before starting the experiment. The chemical analysis was done in the Department of Soil Science and Agriculture Chemistry, J.N.K.V.V., Jabalpur. The physiochemical characteristics of the soil is given in the table 3.2.

**Table 3.2. Physico-chemical characteristics of soil under experimental field**

Constituents	Value	Interpretation	Method
A. Physical properties		Sandy clay loam soil	International pipette method (Piper, 1967)
1. Sand %	54.91		
2. Silt %	18.98		
3. Clay %	26.61		
B. Chemical properties			
1. Organic carbon %	0.68	Medium	Walkly and Black method (Black, 1965)
2. Available N (kg/ha)	254.68	Low	Alkaline permanganate method (Subbiah and Asija, 1956)
3. Available P (kg/ha)	52.92	High	Colorimetric method (Olsen <i>et al.</i> , 1954)
4. Available K (kg/ha)	438.78	High	Flame photometer method (Black, 1955)
5. pH	7.2	Normal	pH meter (Piper, 1967)

### 3.4 Cropping History of the Field

The cropping programme of the experimental field adopted during past two years is given in the table:

**Table 3.3. Cropping history of the experimental field**

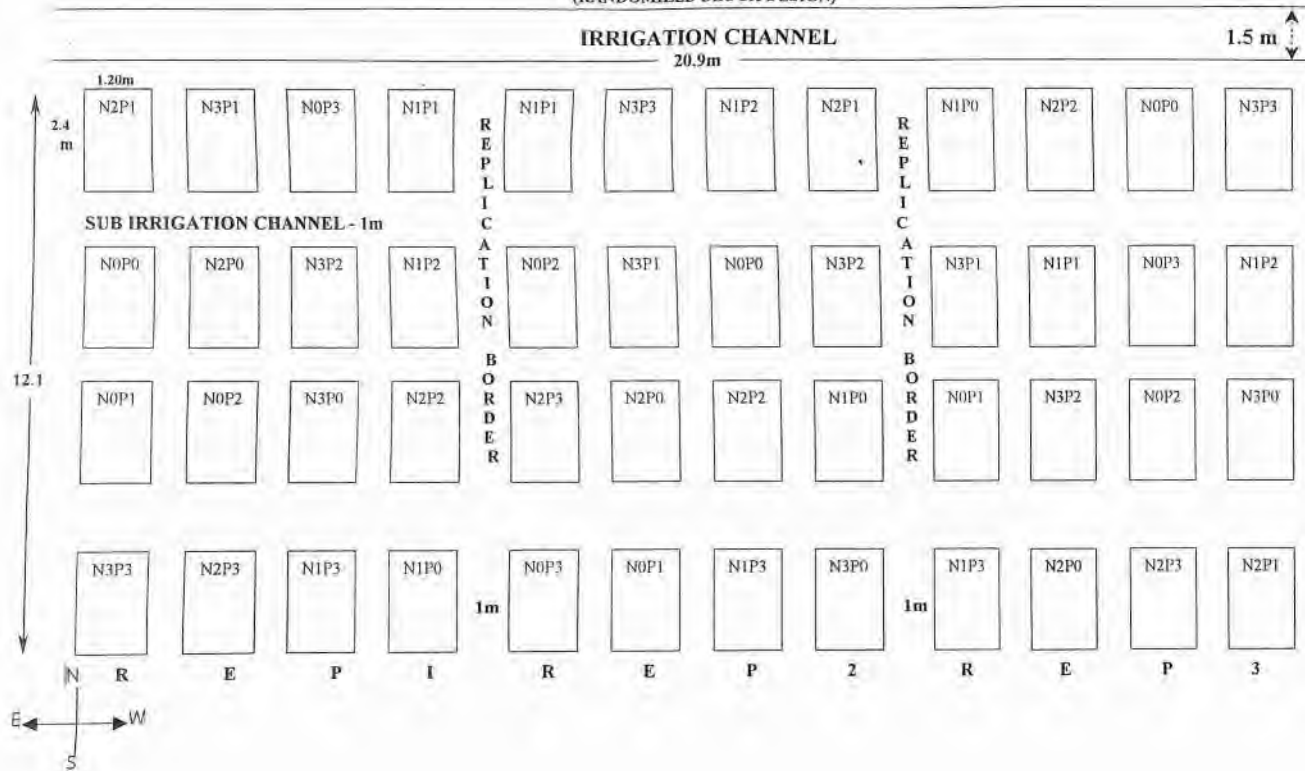
YEAR	KHARIF	RABI
2000	Fallow	Tomato
2001	Gaillardia	Fallow
2002	Fallow	Marigold

### 3.5 Planting Material

The African Marigold (*Tagetes erecta*) cv. "Pusa Narangi Gainda" was selected for the present study is a standard cultivar for commercial cultivation. This variety is a cross of "Cracker Jack" and "Golden Jubilee" and was released during 1998 by the division of Landscaping and Floriculture, Indian Agricultural Research Institute, New Delhi. The African marigold. "Pusa Narangi Gainda" possesses the following characteristics (Raghava, 1998c)

1. It takes 125-136 days for flowering.
2. Plants are tall and vigorous with a height of about 73 cms.
3. Plants have large sized dark green leaves and more numbers of branches.
4. Plants have large, carnation type, double, compact, flowers of 7.8 cms across.

FIG. 3.2: PLAN OF LAYOUT  
(RANDOMIZED BLOCK DESIGN)



5. The flower head is bright orange coloured with fully double blooms, disc florets present.
6. Flower has a mild fragrance.
7. The high yielding variety providing good flowers, suitable for garland making, decoration and religious purposes etc.

### 3.6 Experimental details

The experimental field was laid out in Factorial Randomized Block Design with three replications. Each replication consists of sixteen (16) treatments. All the treatments are randomized separately in each replication. The plan of layout is given in figure and other details are given below:

- 1) Name of variety : (African Marigold) Pusa Narangi
- 2) Levels of Nitrogen : 4 i.e. (60, 90, 120 and 150kg/ha)
- 3) Levels of Phosphorus : 4 i.e. (75, 100, 125 and 150 kg/ha)
- 4) Number of Treatments : 16
- 5) Total number of Plots : 48
- 6) Design adopted : R.B.D (Factorial)
- 7) Number of Replications : 3
- 8) Planting Distance:
  - (a) Row to Row : 40 cm
  - (b) Plant to Plant : 40 cm
- 9) Net Plot Size : 2.4 m x 1.20 m
- 10) Number of rows per plot/bed : 6
- 11) Number of plants per row : 4

- 12) Total number of plants/plot : 24
- 13) Distance between plots : 0.5 m
- 14) Distance between two replications : 1 m
- 15) Main irrigation channel : 1 m
- 16) Total length of experimental trial : 20.9 m
- 17) Total width of experimental trial : 12.1 m
- 18) Area of experimental field : 252.98 sq. m.

### 3.7 Details of Treatments

Details of Treatments and their notations are given below:

#### A. Levels of Nitrogen

S.No	LEVELS	NITROGEN
1	Nitrogen 60 kg/ha	N <sub>0</sub>
2	Nitrogen 90 kg/ha	N <sub>1</sub>
3	Nitrogen 120 kg/ha	N <sub>2</sub>
4	Nitrogen 150 kg/ha	N <sub>3</sub>

#### B. Levels of Phosphorus

S.No	LEVELS	PHOSPHORUS
1	Phosphorus 75 kg/ha	P <sub>0</sub>
2	Phosphorus <sup>100</sup> kg/ha	P <sub>1</sub>
3	Phosphorus <sup>125</sup> kg/ha	P <sub>2</sub>
4	Phosphorus 150 kg/ha	P <sub>3</sub>

In all the three replications sixteen treatments, combination were made which are as follows; -

- |                               |                               |                                 |                                 |
|-------------------------------|-------------------------------|---------------------------------|---------------------------------|
| 1. $N_0P_0$ (T <sub>1</sub> ) | 5. $N_1P_0$ (T <sub>5</sub> ) | 9. $N_2P_0$ (T <sub>9</sub> )   | 13. $N_3P_0$ (T <sub>13</sub> ) |
| 2. $N_0P_1$ (T <sub>2</sub> ) | 6. $N_1P_1$ (T <sub>6</sub> ) | 10. $N_2P_1$ (T <sub>10</sub> ) | 14. $N_3P_1$ (T <sub>14</sub> ) |
| 3. $N_0P_2$ (T <sub>3</sub> ) | 7. $N_1P_2$ (T <sub>7</sub> ) | 11. $N_2P_2$ (T <sub>11</sub> ) | 15. $N_3P_2$ (T <sub>15</sub> ) |
| 4. $N_0P_3$ (T <sub>4</sub> ) | 8. $N_1P_3$ (T <sub>8</sub> ) | 12. $N_2P_3$ (T <sub>12</sub> ) | 16. $N_3P_3$ (T <sub>16</sub> ) |

### **3.8 Details of Agronomical operations**

The details of cultural operations are given here under.

#### **3.8.1 Nursery Raising**

Raised nursery beds of 3m X 3m X 0.15m were prepared and levelled by mixing well rotten F.Y.M. properly. The healthy, true to type pure and good quality seeds were sown @ 750 gms/ha at a depth of 1.25cms after treating with Thiram @ 2.5 gm/kg of seeds. After sowing the seeds were covered with fine mixture of soil and F.Y.M. Just after sowing light irrigation was provided with the help of water can.

#### **3.8.2 Field Preparation**

The experimental area was ploughed twice with the help of tractor drawn implements in both directions and the harrowing was done to break the clods and finally levelling was done.

### **3.8.3 Layout**

The experimental area was finally levelled and divided into three replications, channels, block borders and bunds. The plan of layout as shown in figure 3.2 was executed.

### **3.8.4 Manures and Fertilizers**

Farmyard manure was applied at the rate of 30 tonnes/ha at the time of land preparation by using power tiller. After executing the plan of layout half dose of Nitrogen ( $N_0$ ,  $N_1$ ,  $N_2$ ,  $N_3$ ) through Urea (46% N) and full dose of Phosphorus ( $P_0$ ,  $P_1$ ,  $P_2$ ,  $P_3$ ) and 50 kg  $K_2O$ /ha through Single super phosphate (16%  $P_2O_5$ ) and Muriate of Potash (60%  $K_2O$ ) respectively were also applied in each plot before transplanting as basal dose. Urea, Single super phosphate and Muriate of Potash were broadcasted and mixed well with the soil. The remaining one-fourth dose of nitrogen was applied as top dressing in two installments after one month of transplanting.

### **3.8.5 Transplanting**

The 30 days old uniform healthy seedlings having 10-12cms height were lifted from the nursery beds and transplanted at a distance of 45 X 30 cms on 9<sup>th</sup> November 2002. The operation of transplanting was carried out in the evening and followed by light irrigation with a view to encourage the establishment of seedlings.

### **3.8.6 Gap Filling**

A week after transplanting, damaged and dead seedlings were replaced by healthy seedlings to maintain desired plant population in the plot.

### **3.8.7 Irrigation**

Irrigation was given twice a week in the initial stage of crop and later on the interval was increased to 8-10 days depending upon the soil moisture condition.

### **3.8.8 Weeding**

Weeding and hoeing were done manually with the help of kudali at 30 days interval to keep the plots clean and free from weeds.

### **3.8.9 Plant protection**

Necessary plant protection measures were adopted. Serious pest and diseases were not observed on this crop during the cropping period. Spraying of Malathion (0.04%) and Bavistin (0.3%) at 35 and 80 days after transplanting was done to protect the plant against insects like Red Spider mite (*Tetranychus sp*) and Leaf hopper (*Empoasca fabae*) etc.

**Table 3.4. Schedule of operations carried out in investigation**

<b>S. No.</b>	<b>Operation</b>	<b>Date</b>
1.	Nursery raising (Seed sowing)	October, 14 2002
2.	Field preparation	
	a. Ploughing	November 4, 2002
	b. Harrowing	November 4, 2002
3.	Layout	November 8, 2002
4.	Soil sample collection for physiochemical studies of soil before sowing	October 12, 2002
5.	F.Y.M. application	October 12, 2002
6.	Application of basal dose of Urea, S.S.P., & M.O.P	November 8, 2002
7.	Transplanting	November 9, 2002
8.	Top dressing of N <sub>2</sub> (50%)	
	a. First (25%)	December 10, 2002
	b. Second (25%)	December 30, 2002
9.	Irrigation	
	a. First	November 9, 2002
	b. Second	November 24, 2002
	c. Third	December 9, 2002
	d. Fourth	December 25, 2002
	e. Fifth	January 10, 2003
	f. Sixth	January 27, 2003
	g. Seventh	February 15, 2003
	h. Eighth	March 3, 2003
	j. Ninth	March 22, 2003
10.	Pinching	December 4, 2002
11.	a. Weeding and hoeing -I	November 30, 2002
	b. Weeding and hoeing -II	December 14, 2002
12.	Plant protection	
	a. Insecticide and fungicide spray- I	December 30, 2002
	b. Insecticide and fungicide spray- II	January 30, 2003
13.	Plucking of flowers	
	a. I <sup>st</sup>	February 10, 2003
	b. II <sup>nd</sup>	February 24, 2003
	c. III <sup>rd</sup>	March 12, 2003
	d. IV <sup>th</sup>	March 30, 2003

### 3.10 Observations recorded

To make critical analysis of crop performance as affected by different treatments five representative plants were selected at random from the plot of each treatment and they were tagged for recording different observations.

#### 3.10.1 Periodical Growth Studies

- i) Plant height (cms)
- ii) Girth of main stem of each plant (cms)
- iii) Spread of plants along the rows (cms)
- iv) Spread of plants across the rows (cms)
- v) Number of leaves on each plant
- vi) Number of branches on each plant
- vii) Leaf area

#### 3.10.2 Flower Studies

- i) Number of flowers on five plants
- ii) Weight per flower (gms)
- iii) Fresh weight of all the flowers of five plants (gms)
- iv) Size of flower
  - a. Circumference of the flower (cms)
  - b. Surface area of the flower (cms)
- v) Yield of flower

### 3.10.d Chemical analysis

- (i) Estimation of Nitrogen content
- (ii) Estimation of Phosphorus content
- (iii) Estimation of Chlorophyll content

### 3.10.f Vertical growth studies

#### i. Plant height:

The height of plant was measured from ground level to the top of the leaf and average height was determined. The height was measured with the help of meter scale in centimeters.

#### ii. Girth of main stem:

The diameter of plant was measured in centimeter with the help of vernier callipers at the base of plant.

#### iii. Spread (along and across the rows):

Spread of plant was measured in centimeters with the help of meter scale.

#### iv. Number of leaves per plant:

The numbers of leaves of the selected plants were counted and the average was determined.

#### v. Number of branches per plant:

Number of branches per plant was counted and the average was determined.

### 3.10.2: Flower indices

#### i. Number of flowers

The number of flowers of selected plants was counted and average was determined.

#### ii. Weight of flowers (g)

After plucking the flowers, flowers were weighed and mean weight was estimated.

#### iii. Size of flowers

Size of flowers was measured by Vernier Callipers and average was determined. The area of flower was essentially measured in the form of surface area of a flower and circumference of a flower.

#### iv. Yield of flowers

Weight of flowers per plot at early picking was recorded separately and then converted to G/ha.

### 3.10.3: Chemical analysis study

#### i. Estimation of Nitrogen and Phosphorus:

In order to assess the N and P uptake by marigold flowers, the samples were analyzed for N and P contents. Nitrogen was estimated by Kjeldahl method and P in wet digested samples by Ammonium molybdate vanadate method (Chapman and Peay, 1991).

## ii. Estimation of Carotenoids:

The carotenoids content of flower petals were estimated at flowering stage of marigold by acetone extraction method.

**Procedure:** 0.25 mg of fresh material was macerated in a crusher. Enough quantity of 80% acetone was added to allow the tissues to get thoroughly homogenized. The process continued with acetone till all the volumes was made up to 25 ml with acetone in a volumetric flask. The optical density was determined in Spectrophotometer (Spectronic -20 Baush and Lamp). The content of carotenoids were calculated by using the following formula-

$$\text{Carotenoids} = \frac{7.6 \times (A 480) - 1.49 \times (A 510)}{a \times 1000 \times w} \times V$$

where,

A = Optical density

a = length of light path in cell (1 cm)

w = weight of sample (0.25 mg)

V = Volume of solution (25 ml)

Unit = mg/g fresh leaf weight

### 3.11 Statistical analysis:

The data were analyzed statistically by the method of "Analysis of variance" as stated by Fisher (1967). The effects of

different treatments on various plant characters and yield have been reported under experimental findings.

**Table 3.5. The skeleton of analysis of variance**

S.No.	Source of variation	D.F.	S.S.	M.S.S.	'F' Cal
1.	Replication	2			
2.	Nitrogen	3			
3.	Phosphorus	3			
4.	Interaction	9			
5.	Error	30			
Total		47			

The 'F' test was applied for judging the significance of various treatments effect comparison of mean values corresponding to different significant effect was made by using critical difference at 5 percent level of significance which was calculated as given below:-

**1. Nitrogen application:**

$$S.E. (m) \pm = \sqrt{Ve/p \times r}$$

$$S.E. (d) = S.E. (m) \pm \times \sqrt{2}$$

$$C.D. (at 5\%) = S.E. (d) \times t_{5\% \text{ at error d.f.}}$$

## 2. Phosphorus application:

$$\text{S.E. (m)} \pm = \sqrt{\text{Ve/nxr}}$$

$$\text{S.E. (d)} \pm = \text{S.E. (m)} \pm \times \sqrt{2}$$

$$\text{C.D. at 5\%} = \text{S.E. (d)} \times t \text{ 5\% at error d.f.}$$

## 3. Interaction:

$$\text{S.E. (m)} \pm = \sqrt{\text{Ve/r}}$$

$$\text{S.E. (d)} = \text{S.E. (m)} \pm \times \sqrt{2}$$

$$\text{C.D. (at 5\%)} = \text{S.E. (d)} \times t \text{ 5\% at error d.f.}$$

Where,

- n = Nitrogen
- P = Phosphorus
- Ve = Error variance
- r = Replication
- N = Levels of nitrogen
- P = Levels of nitrogen

### 3.12 Economics of treatments

As per the existing market prices the input and output cost were computed treatment wise and different economical parameters viz , net returns and C:B ratio were estimated.

The image features a central rectangular area with a blurred background of orange flowers. A light green horizontal bar is superimposed over the center of this area, containing the text "EXPERIMENTAL FINDINGS" in a black, serif, all-caps font. The entire composition is framed by a thin, light green border.

EXPERIMENTAL FINDINGS

## EXPERIMENTAL FINDINGS

### 4.1 Plant height

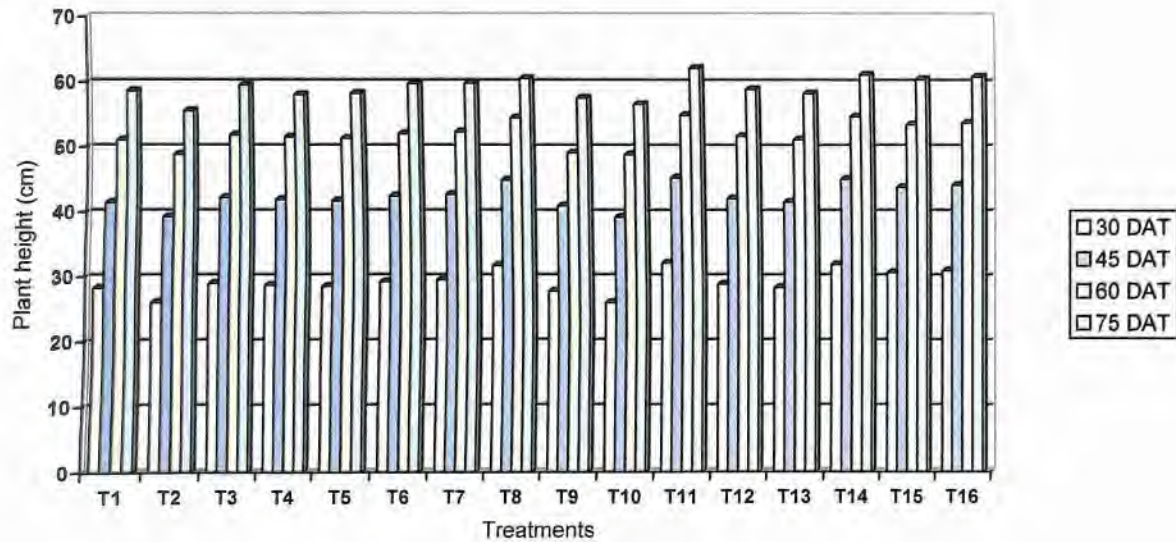
Height of plant is one of the important vegetative parameter. It exhibits vigor of plant and bears leaves at each node. Measurement of height was started 30 DAT and continued with an interval of 15 days. Data of the final observations were subjected to statistical analysis and displayed diagrammatically by figure 4.1. Analysis of variance is presented in appendix; mean height of plant as affected by different treatment is given below in table 4.1 and figure 4.1.

Table: 4.1 Mean plant height (cm) of plants affected due to fertilizer treatment

Treatment	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	Mean
N <sub>0</sub>	58.70	55.62	59.90	58.10	58.08
N <sub>1</sub>	58.30	59.83	59.90	60.60	59.65
N <sub>2</sub>	57.61	56.66	62.20	58.96	58.85
N <sub>3</sub>	58.30	61.20	60.50	60.90	60.22
Mean	58.22	58.32	60.62	59.64	
	Nitrogen (N)		Phosphorus (P)	Interaction (N x P)	
S.E (m) ±	0.388		0.388	0.776	
C.D. at 5%	1.12		1.12	2.24	

It is clearly evident from the table 4.1 that all the treatments of nitrogen, phosphorus and their interactions affected statistically the height of marigold plants.

Figure: 4.1 Plant height at successive growth stages as affected by different treatments



Maximum mean plant height (60.22 cm) was measured under  $N_3$ , which was found statistically similar to treatment  $N_2$ . Similarly treatment  $P_2$  produced maximum mean plant height (60.62 cm).

Treatment combinations between different levels of nitrogen and phosphorus were also found significant. However maximum height (62.20 cm) was noted in the combination  $N_2P_2$  that was found statistically similar to combination  $N_3P_1$ .

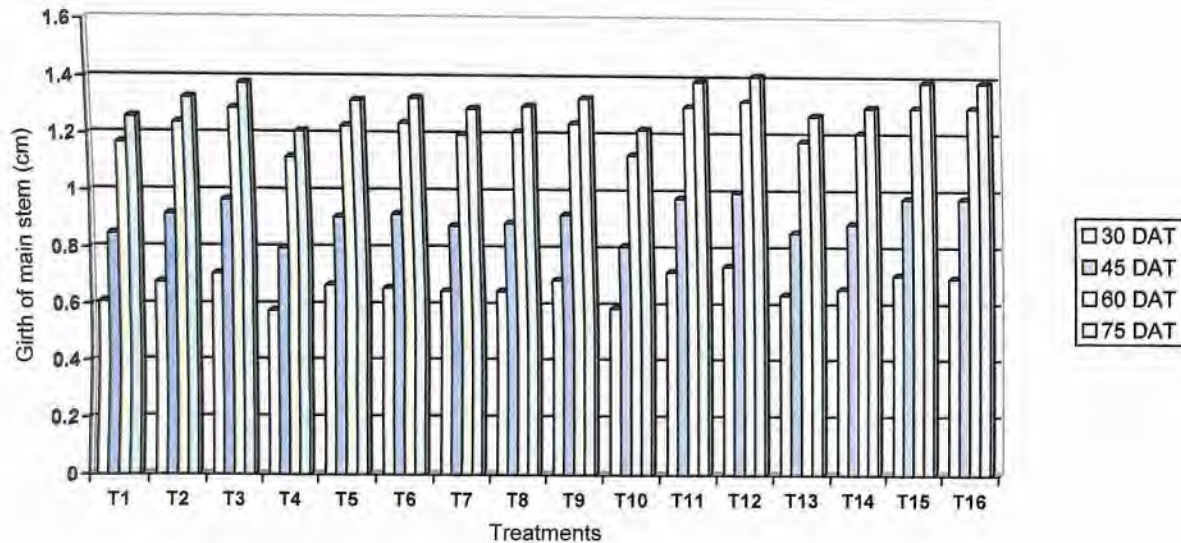
#### 4.2 Girth of stem

Besides height of the plant, the girth of stem is also of great importance. Therefore data on this aspect were recorded at fortnightly interval and final observations were taken at 75 DAT. Data were analyzed statistically and presented in table 4.2 and figure 4.2.

Table: 4.2 Mean girth of stem (cm) as affected due to fertilizer treatment

Treatment	$P_0$	$P_1$	$P_2$	$P_3$	Mean
$N_0$	1.26	1.33	1.38	1.21	1.29
$N_1$	1.32	1.33	1.29	1.30	1.31
$N_2$	1.33	1.22	1.39	1.41	1.33
$N_3$	1.27	1.30	1.39	1.39	1.33
Mean	1.29	1.29	1.36	1.32	
	Nitrogen (N)		Phosphorus (P)	Interaction (N x P)	
S.E (m) $\pm$	0.049		0.049	0.098	
C.D. at 5%	0.141		0.141	0.283	

Figure: 4.2 Girth of main stem at successive growth stages as affected by different treatments



A perusal of the table 4.2 clearly shows that different levels of nitrogen and phosphorus and their combinations did not show any significant effect on the girth of stem.

The treatment N<sub>3</sub> (150 kg/ha) produced maximum girth of stem (1.3375), which is similar to N<sub>2</sub> treatment. Similarly treatment P<sub>3</sub> produced maximum girth of stem (1.3625).

Interaction effect of nitrogen and phosphorus (N x P) did not show any significant effect on the girth of stem.

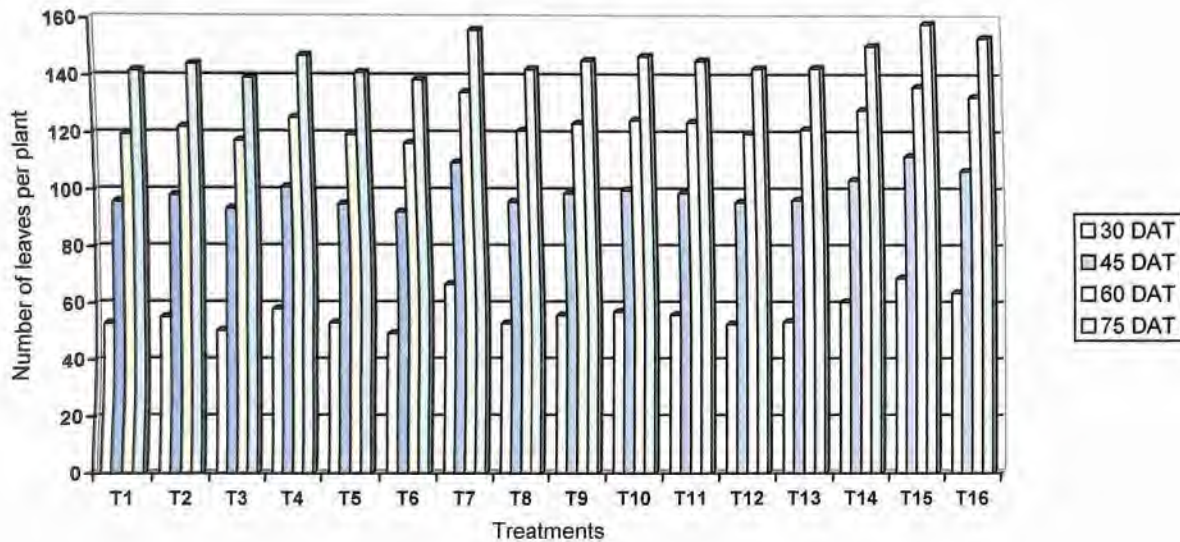
### 4.3 Number of leaves per plant

Number of leaves is one of the prime growth characters. The data on the final observation were statistically analyzed and have been depicted in table 4.3 and in the figure 4.3.

**Table: 4.3 Mean numbers of leaves per plant affected due to fertilizer treatment**

Treatment	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	Mean
N <sub>0</sub>	142.00	144.40	139.66	147.33	143.35
N <sub>1</sub>	141.40	138.93	156.26	142.53	144.78
N <sub>2</sub>	145.60	147.13	145.53	142.86	145.28
N <sub>3</sub>	143.00	150.73	158.40	153.60	146.58
Mean	143.00	145.30	149.96	146.58	
	Nitrogen		Phosphorus	Interaction	
	(N)		(P)	(N x P)	
S.E (m) ±	3.13		3.13	5.42	
C.D. at 5%	N.S		N.S	N.S	

Figure: 4.3 Number of leaves per plant at successive growth stages as affected by different treatments



It is evident that different levels of nitrogen, phosphorus and their interaction did not show any significant effect on the number of leaves per plant.

However, all the nitrogen levels produced more number of leaves per plant as compared to control, but the difference could not reach to the level of significance.

Phosphorus also showed the similar trend and all the fertilizer doses produced more number of leaves than control, but the effect was not significant

Treatment combinations of nitrogen and phosphorus also did not show any significance on the mean number of leaves per plant.

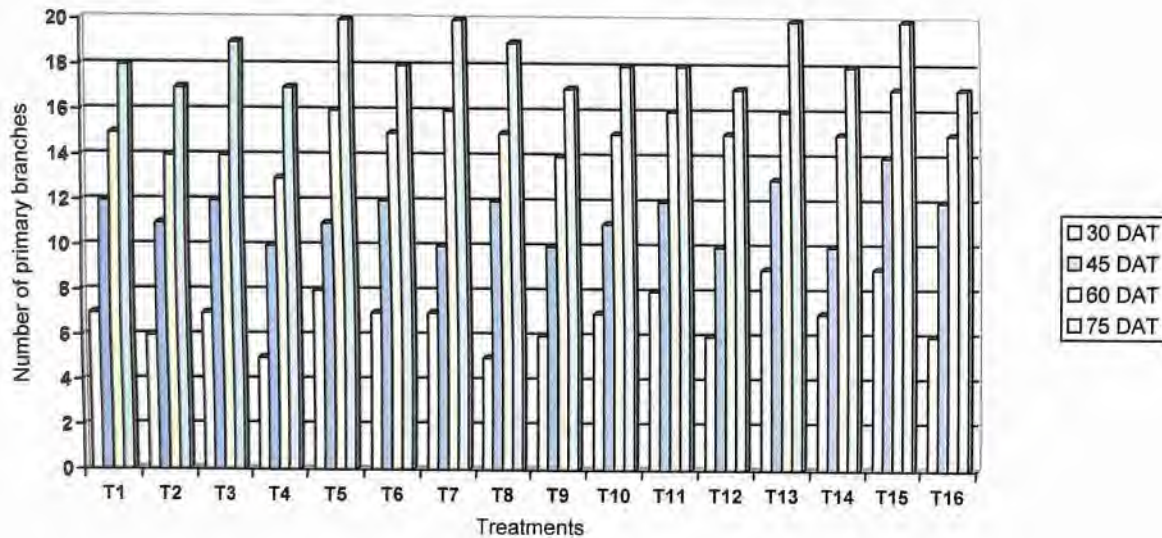
#### 4.4 Number of primary branches

Observations on the number of primary branches per plant were counted on 30 DAT and the subsequent observations were recorded at 15 days interval. The data of final observation were statistically analyzed presented in table 4.4 and depicted in figure 4.4.

**Table: 4.4 Mean number of primary branches per plant affected due to fertilizer treatment**

Treatment	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	Mean
N <sub>0</sub>	18	17	19	17	17.75
N <sub>1</sub>	20	18	20	19	19.25
N <sub>2</sub>	17	18	18	17	17.50
N <sub>3</sub>	20	18	20	17	18.75
Mean	18.75	17.75	19.25	17.75	

Figure: 4.4 Number of primary branches per plant at successive growth stages as affected by different treatments



	Nitrogen (N)	Phosphorus (P)	Interaction (N x P)
S.E (m) $\pm$	0.62	0.62	1.24
C.D. at 5%	N.S.	N.S.	N.S.

It is revealed from the table 4.4 that different levels of nitrogen and phosphorus and their interaction (N x P) did not produced any significant effect with respect to mean number of primary branches per plant. It is evident from the table 4.4 that nitrogen did not impart any significant effect on the mean number of primary branches per plant. However, treatment N<sub>3</sub> gave maximum number of branches (18.75).

Different doses of phosphorus did not attribute any significant change to the mean number of primary branches per plant. However treatment P<sub>3</sub> gave maximum number (19.38) of branches. Treatment combination had failed to show any significant difference over the number of primary branches per plant.

#### 4.5 Plant spread along the row

Plant spread along the row is also a factor affecting successful plant growth characters. Therefore, data of the final observation were statistically analyzed and are given in table 4.5 and figure 4.5.

Figure: 4.5 Spread of plant along the row (cm) at successive growth stages as affected by different treatments

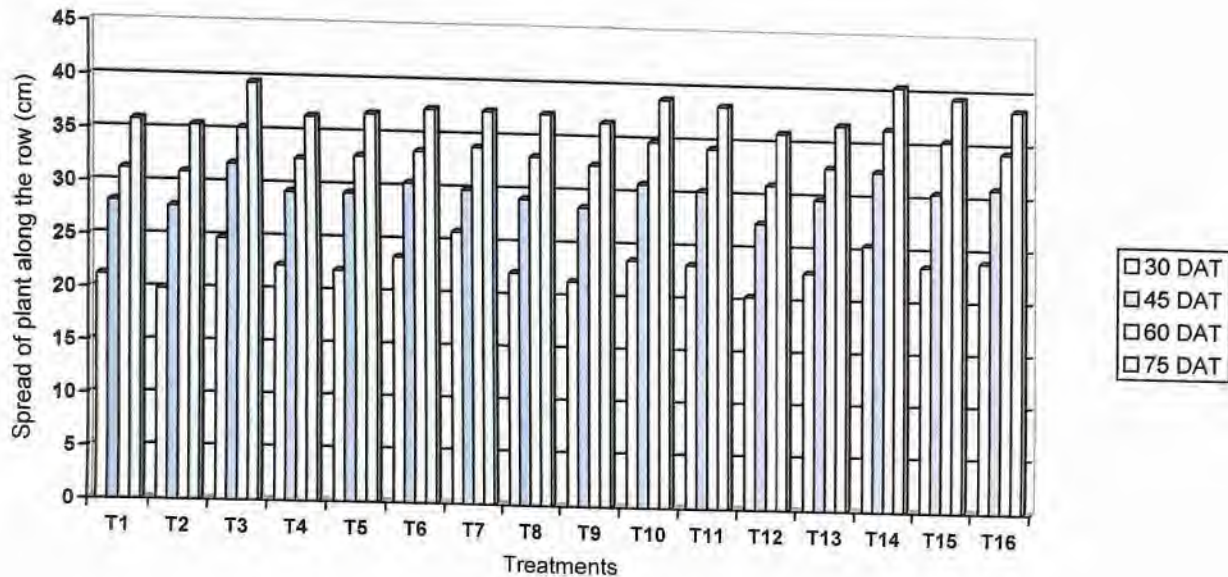


Table: 4.5 Mean plant spread along the row (cm) affected due to fertilizer treatment

Treatment	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	Mean
N <sub>0</sub>	35.92	35.48	39.52	36.46	36.84
N <sub>1</sub>	36.84	37.40	37.30	37.16	37.17
N <sub>2</sub>	36.48	38.80	38.26	35.88	37.35
N <sub>3</sub>	36.74	40.46	39.44	38.41	38.76
Mean	36.49	38.03	38.63	36.97	
	Nitrogen		Phosphorus	Interaction	
	(N)		(P)	(N x P)	
S.E (m) ±	0.35		0.35	0.695	
C.D. at 5%	1.00		1.00	2.00	

From the analysis of variance given in the appendix, it is clear that different levels of nitrogen, phosphorus and their interaction impart significant effect on the plant spread along the row.

It is clear from the table that different doses of nitrogen produced maximum plant spread along the row (38.76) were produced under the treatment N<sub>3</sub> (150 kg/ha) that was similar to N<sub>2</sub> treatment.

In case of Phosphorus maximum plant spread along the row (38.63) was recorded under the treatment P<sub>2</sub> (125 kg/ha) of Phosphorus application, which is similar to treatment N<sub>2</sub>.

Treatment combination of Nitrogen and Phosphorus were also found significant. However maximum plant spread along the rows (40.46) was produced under the treatment combination N<sub>3</sub>P<sub>1</sub>.

#### 4.6 Plant spread across the row (cm)

Plant spread across the row is also a factor affecting successful plant growth character. Therefore data of the final observations were statistically analyzed are given in table 4.6 and figure 4.6.

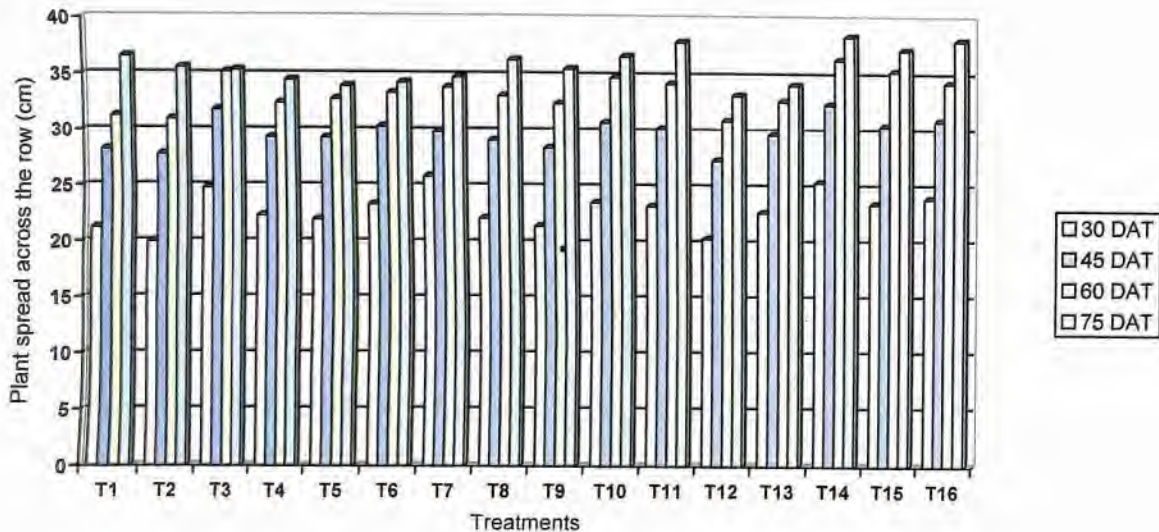
**Table: 4.6 Mean plant spread across the row (cm) affected due to fertilizer treatment**

Treatment	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	Mean
N <sub>0</sub>	36.62	35.63	35.46	34.53	35.56
N <sub>1</sub>	34.00	34.33	37.81	36.36	35.64
N <sub>2</sub>	35.56	36.69	38.0	33.26	35.88
N <sub>3</sub>	34.20	38.54	37.34	38.20	37.07
Mean	35.11	36.29	37.15	35.59	
	Nitrogen		Phosphorus		Interaction
	(N)		(P)		(N x P)
S.E (m) ±	0.989		0.989		1.97
C.D. at 5%	N.S.		N.S.		N.S.

It is clearly evident that different level of nitrogen, phosphorus and their interactions did not impart any significant difference on the plant spread across the row. It is obvious from the table that different doses of nitrogen did not influence the mean plant spread across the row significantly, however maximum plant spread across the row (37.07 cm) was measured under N<sub>3</sub>.

Different levels of phosphorus also have not significantly affected plant spread across the row. However maximum plant spread across the row (37.15 cm) was measured under P<sub>2</sub> treatment.

Figure: 4.6 Spread of plant across the row (cm) at successive growth stages as affected by different treatments



$N_3P_1$  interaction produced maximum plant spread across the row (38.54 cm), but it did not reached the level of significance as compared to other interactions.

#### 4.7 Leaf area per plant (cm<sup>2</sup>)

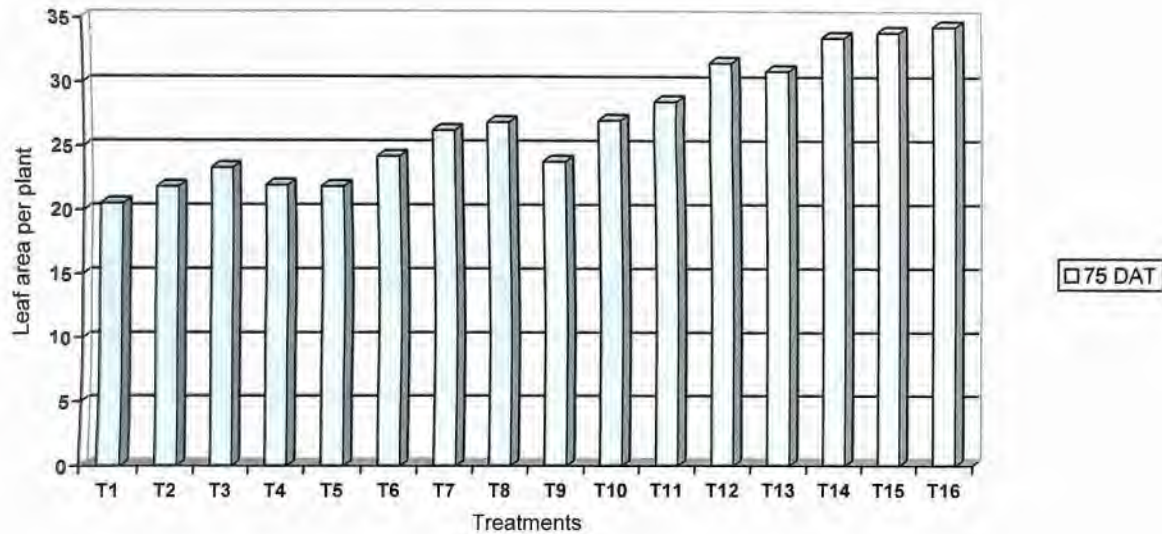
Leaf area characteristics the photosynthetic surface per plant, thus being an useful measure for estimating the differences between plant stand resulting from different treatments. Therefore, observation for leaf area per plant was recorded at 60 days after transplanting and data were analysed statistically and have been defined in table 4.7 and Fig. 4.7.

Table 4.7: Mean plant height (cm) of plants affected due to fertilizer treatment

Treatment	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	Mean
N <sub>0</sub>	20.54	21.87	23.34	21.99	21.68
N <sub>1</sub>	21.88	24.25	26.27	26.91	24.77
N <sub>2</sub>	23.82	27.04	28.51	31.52	27.72
N <sub>3</sub>	30.90	33.50	33.92	34.38	33.17
Mean	24.23	26.66	27.76	28.70	
	Nitrogen (N)		Phosphorus (P)		Interaction (N x P)
S.E (m) ±	0.45		0.45		0.90
C.D. at 5%	1.31		1.31		NS

Data presented in table 4.7 reveal the different levels of nitrogen and phosphorus had significant effect on the mean leaf area and their interaction did not impart any significant effect on the mean leaf area per plant.

Figure: 4.6 Leaf area per plant (cm<sup>2</sup>) as affected by different treatments



Maximum mean leaf area per plant (33.17) was recorded under N<sub>3</sub> level similarly level P produced maximum mean leaf area per plant (28.7).

Interaction of N x P did not show any significant effect on mean leaf area per plant. However maximum mean leaf area per plant (9.38) was recorded in the combination N<sub>3</sub> P<sub>3</sub> treatment.

#### 4.8 Number of flowers per plant

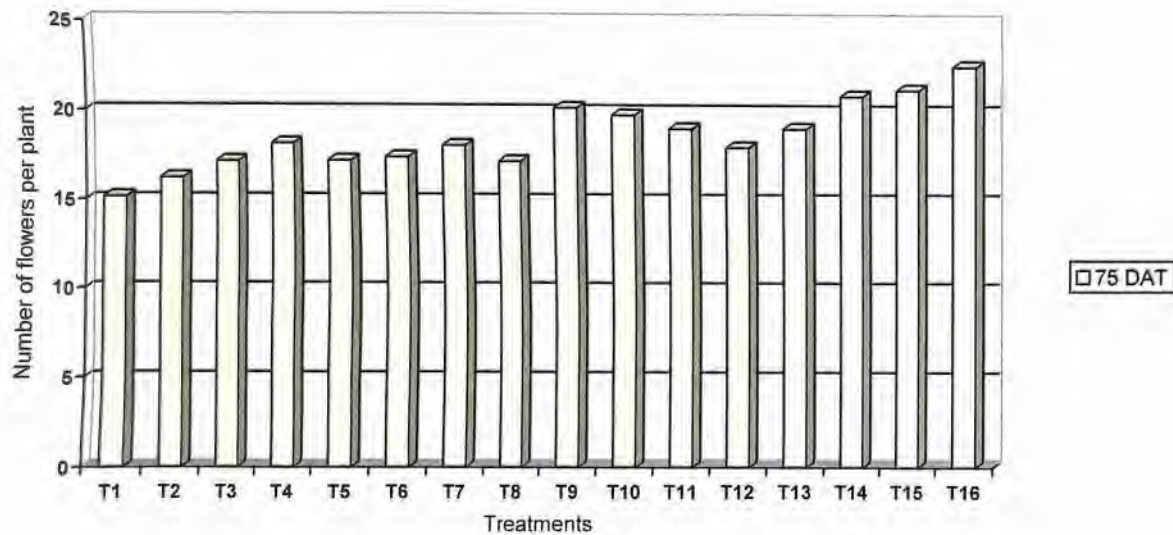
Number of flower is one of the important yield attributing characters, which ultimately affects the total yield per plant. Therefore, observations on number of flowers were recorded and data were analyzed statistically and have been depicted in table 4.8 and figure 4.8.

**Table: 4.8 Mean numbers of flowers per plant affected due to fertilizer treatment**

Treatment	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	Mean
N <sub>0</sub>	15.16	16.23	17.16	18.15	16.67
N <sub>1</sub>	17.20	17.40	18.05	17.16	17.45
N <sub>2</sub>	20.16	19.76	19.00	17.95	19.21
N <sub>3</sub>	19.00	20.83	21.18	22.50	20.87
Mean	17.88	18.55	18.84	18.94	
	Nitrogen		Phosphorus	Interaction	
	(N)		(P)	(N x P)	
S.E (m) ±	0.226		0.226	0.453	
C.D. at 5%	0.654		0.654	1.30	

The data presented in the table 4.8 reveal that different levels of nitrogen and phosphorus and their interaction

Figure: 4.8 Number of flowers per plant as affected by different treatments



had produced significant effect on the number of flower per plant.

Data indicate that the number of flowers increased with the increase with the increase in nitrogen levels and the highest dose of (150kg N/ha) i.e. N<sub>3</sub> produced the maximum significant number of flowers (20.87), which is significantly similar to N<sub>2</sub> treatment.

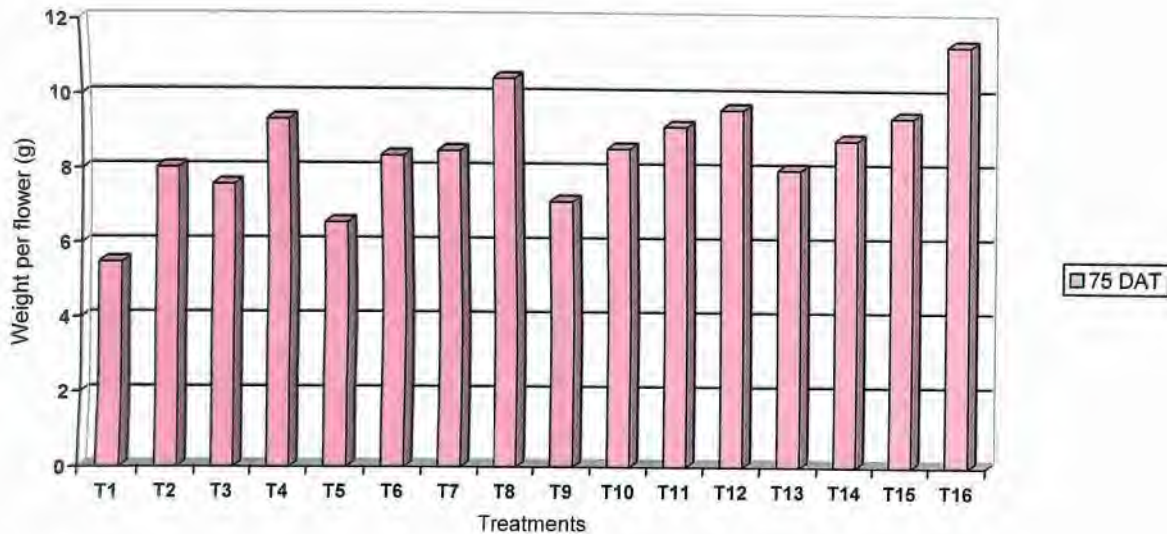
The number of flowers increased with the increase in phosphorus levels. Maximum number of flowers (18.94) was recorded under the treatment P<sub>3</sub> that was significantly superior to rest of the treatments.

Treatment combinations between different levels of N and P had shown significant difference in flower yield per plot. Treatment combination N<sub>3</sub>P<sub>3</sub> gave maximum number of flower (22.5) per plant that was found significantly higher then rest of the treatment combination.

#### **4.9 Weight per flower (g)**

Five flowers were plucked from each marked plant under each plot and weighed and average weight per flower was calculated. The resulting weight was analyzed statistically and data have been given in table 4.9 and figure 4.9.

Figure: 4.9 Weight per flower (g) as affected by different treatments



**Table 4.9: Mean weight per flowers (g) affected due to fertilizer treatment**

Treatment	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	Mean
N <sub>0</sub>	5.49	8.04	7.59	9.34	7.62
N <sub>1</sub>	6.57	8.37	8.50	10.44	8.47
N <sub>2</sub>	7.14	8.56	9.16	9.62	8.62
N <sub>3</sub>	8.01	8.81	9.42	11.35	9.40
Mean	6.80	8.44	8.67	10.19	
	Nitrogen		Phosphorus	Interaction	
	(N)		(P)	(N x P)	
S.E (m) ±	0.286		0.286	0.573	
C.D. at 5%	0.83		0.83	N.S.	

It is obvious from the data presented in the table 4.9 that levels of nitrogen and phosphorus had significant effect on the mean weight per flower and their interactions did not impart any significant effect on the mean weight per flower.

Maximum mean weight per flower (9.4 g) was recorded under N<sub>3</sub> treatment similarly treatment P<sub>3</sub> produced maximum mean weight per flower (10.19 g).

All the interactions did not show any significant effect on the mean weight per flower; however maximum weight per flower (11.35 g) was recorded in combination N<sub>3</sub>P<sub>3</sub>.

#### **4.10 Fresh weight of flowers per plant (g)**

It is obvious from the data given in the table 4.10 the fresh weight of flowers per plant significantly increased due to different level of nitrogen, different levels of phosphorus and their interaction combination as compared to control.

Figure: 4.10 Fresh weight of flowers (g) per plant as affected by different treatments

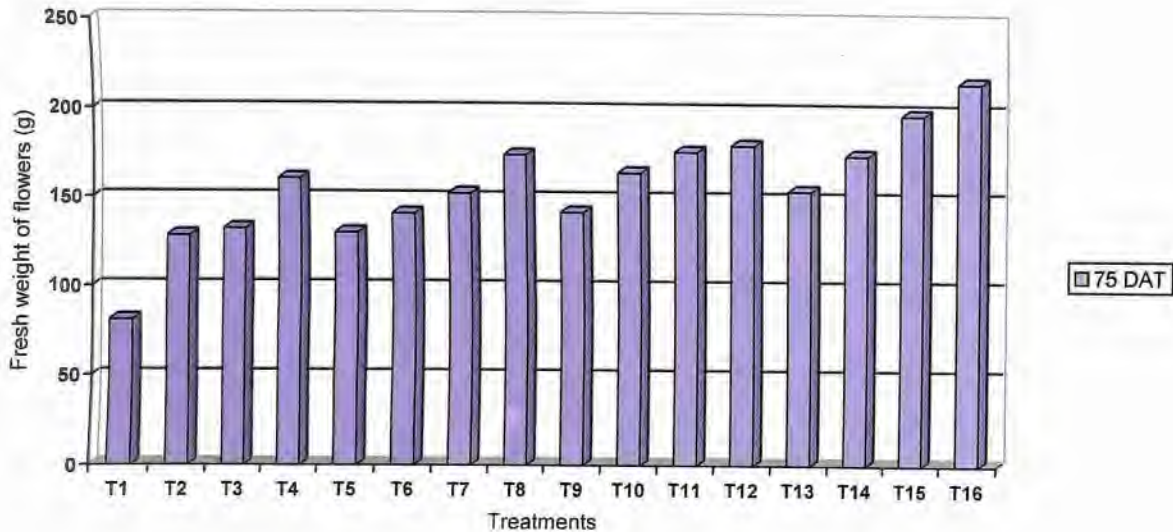


Table: 4.10 Mean fresh weight (g) of flowers per plant affected due to fertilizer treatment

Treatment	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	Mean
N <sub>0</sub>	81.22	128.53	132.34	160.64	125.68
N <sub>1</sub>	130.30	141.05	152.49	174.15	149.49
N <sub>2</sub>	141.94	164.14	176.04	179.71	165.45
N <sub>3</sub>	154.19	174.26	197.32	215.44	185.30
Mean	126.91	151.99	164.54	182.48	
	Nitrogen		Phosphorus	Interaction	
	(N)		(P)	(N x P)	
S.E (m) ±	2.54		2.54	5.08	
C.D. at 5%	7.3		7.3	14.6	



It is clear from the table that different doses of Nitrogen produced maximum flower weight plant as compared to control. Maximum weight of flower per plant (185.30) was produced under the treatment N<sub>3</sub> (150 kg/ha) that was statistically better than rest of the treatments.

In case of Phosphorus, maximum weight of flower per plant (182.49 g) was recorded under the treatment P<sub>3</sub> (150 kg/ha) of phosphorus application.

Treatment combination of nitrogen and phosphorus were also significant. However maximum weight of flower per plant (215.44 g) was produced the treatment combination N<sub>3</sub>P<sub>3</sub>.

#### 4.11 Mean circumference of flower

Flower size is an important aspect of a flower and that can be scientifically measured in the form of circumference of a flower

Table: 4.11 Mean circumference of flower(cm) affected due to fertilizer treatment

Treatment	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	Mean
N <sub>0</sub>	18.21	20.46	21.18	22.12	20.49
N <sub>1</sub>	19.42	22.2	22.46	23.57	21.89
N <sub>2</sub>	20.40	20.89	23.62	23.71	22.66
N <sub>3</sub>	21.94	22.96	24.57	23.97	23.36
Mean	20.00	22.10	22.95	23.34	
	Nitrogen		Phosphorus		Interaction
	(N)		(P)		(N x P)
S.E (m)±	0.45		0.45		0.90
C.D. at 5%	1.30		1.30		N.S.

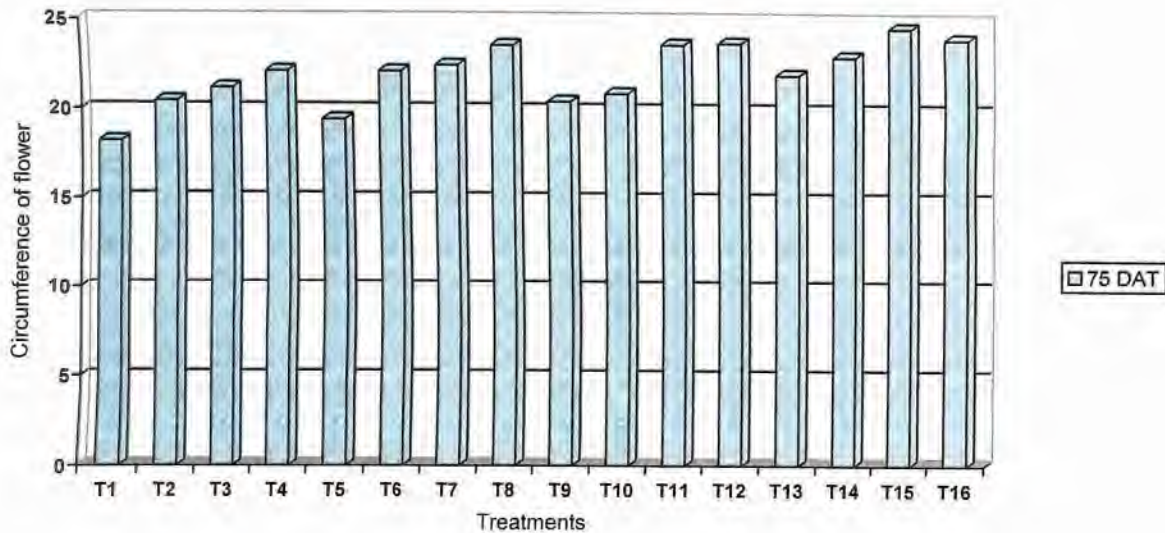
It is evident from table 4.11 that different levels of Nitrogen and Phosphorus had influenced significantly the circumference of the flower but interaction did not show any significant difference on the circumference of the flower.

Maximum circumference (23.36) was noted in the N<sub>3</sub> (150 kg/ha) treatment, which was similar to the treatment N<sub>2</sub>.

Phosphorus levels had responded significantly by increasing the circumference of a flower as compared to control (N<sub>0</sub>) but no significant difference was observed amongst the different levels of phosphorus

The interaction of N x P was observed to be non-significant.

Figure: 4.11 Circumference of flower as affected by different treatments



#### 4.12 Surface area of flower (cm<sup>2</sup>)

Surface area of a flower is most important aspect denoting the size of flower. Data were statistically analyzed and are given in table 4.12 and figure 14

Table: 4.12 Mean surface area of flower (cm<sup>2</sup>) affected due to fertilizer treatment

Treatment	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	Mean
N <sub>0</sub>	30.59	41.09	37.98	36.86	36.63
N <sub>1</sub>	34.22	37.99	43.98	36.35	38.13
N <sub>2</sub>	37.62	42.37	36.93	43.40	40.08
N <sub>3</sub>	35.37	46.08	47.48	54.76	45.92
Mean	34.45	41.88	41.59	42.84	
	Nitrogen (N)	Phosphorus (P)	Interaction (N x P)		
S.E (m)±	0.40	0.40	0.80		
C.D. at 5%	1.15	1.15	2.30		

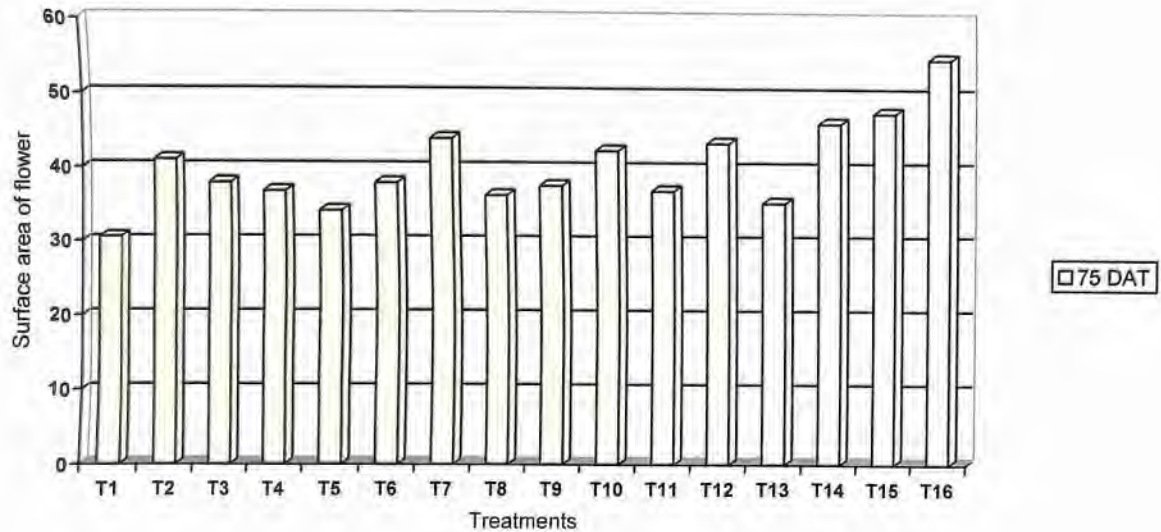
It is evident from the table 4.12 that different levels of Nitrogen and Phosphorus and their interactions had influenced significantly the surface area of the flower.

Table 4.12 clearly reveals that N<sub>3</sub> treatment is significantly superior to rest of its levels and control

N<sub>3</sub> and P<sub>3</sub> levels had responded significantly by increasing the surface area of the flower as compared to control and others.

Maximum surface area 45.92 and 42.84 was noted in the N<sub>3</sub> and P<sub>3</sub> treatments respectively.

Figure: 4.12 Surface area of flower( $\text{cm}^2$ ) as affected by different treatments



The interaction between different levels of nitrogen and phosphorus application had influenced the surface area of flower significantly. Maximum surface area of flower was measured in the treatment combination N<sub>3</sub>P<sub>3</sub> which was found statistically similar to treatment combination N<sub>3</sub>.

#### 4.13 Flower yield (q/ha)

The flower yield (kg/plot) were converted into quintal per ha to study the influence of nitrogen, phosphorus and their interaction on flower yield.

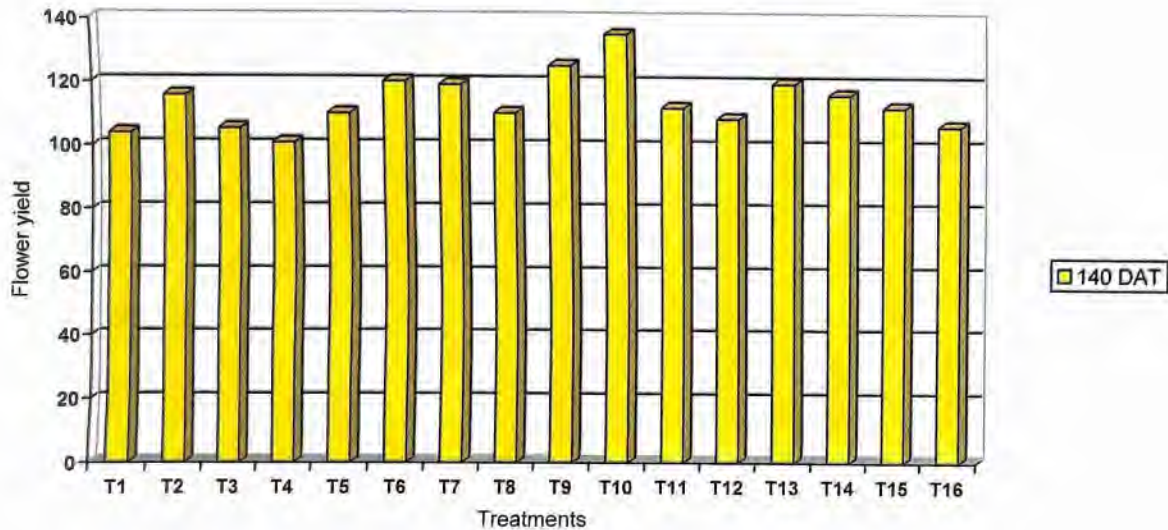
Table 4.13: Mean flower yield (q/ha.) affected due to fertilizer treatment

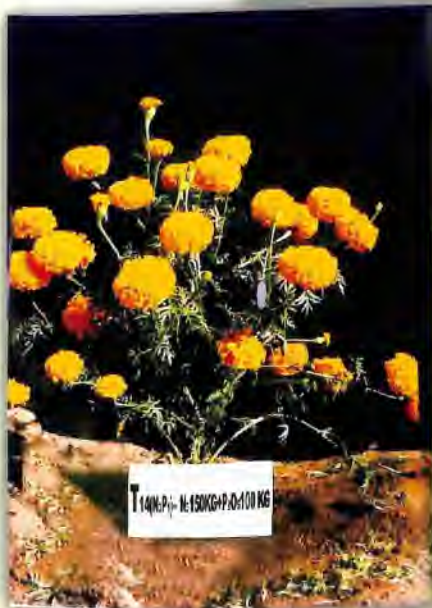
Treatment	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	Mean
N <sub>0</sub>	103.98	115.88	105.42	100.93	106.55
N <sub>1</sub>	110.23	120.27	119.27	110.32	115.02
N <sub>2</sub>	125.24	138.19	112.07	108.67	120.29
N <sub>3</sub>	119.76	116.16	112.19	106.38	113.62
Mean	114.86	121.87	112.23	106.57	
	Nitrogen		Phosphorus		Interaction
	(N)		(P)		(N x P)
S.E (m) ±	0.84		0.84		1.68
C.D. at 5%	2.43		2.43		4.87

Perusal of the data given in table shows that flower yield was significantly affected by the different levels of nitrogen phosphorous and their interactions.

It is obvious from the table that different doses of N produced significantly higher flower yield over control and the total yield increased significantly with every increase in the does

Figure: 4.13 Flower yield (Q/ha) as affected by different treatments





Photograph showing effect of different treatments on yield of African Marigold

of nitrogen maximum flower yield (120.29 q/ha) was recorded under the level of N<sub>2</sub> (120 kg/ha) which was observed statistically superior to rest of the treatment.

Similarly level P<sub>2</sub> produced maximum flower yield (121.87 q/ha). Treatment combinations b/w d/f levels of nitrogen and phosphorus had shown significant difference in flower yield per plot. Treatment combination N<sub>2</sub> P<sub>1</sub> gave maximum flower yield (138.19 q/ha) which was found significantly higher than rest of the treatment combination.

#### 4.14 Nitrogen content (%) in flower

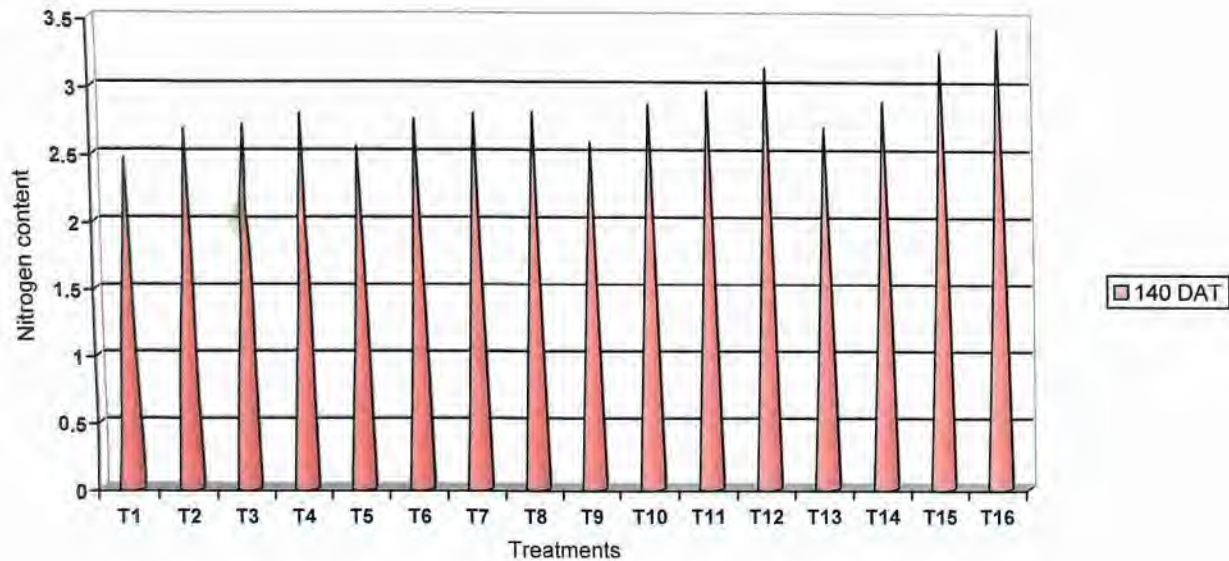
In order to find out the effect of different levels of N, P and their interactions nitrogen was determined in flower samples of individual treatments and is presented in table 4.14.

Table: 4.14 Mean nitrogen content (%) in flower affected due to fertilizer treatment

Treatment	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	Mean
N <sub>0</sub>	2.46	2.68	2.71	2.79	2.66
N <sub>1</sub>	2.55	2.75	2.79	2.8	2.72
N <sub>2</sub>	2.58	2.86	2.96	3.13	2.88
N <sub>3</sub>	2.69	2.88	3.25	3.42	3.06
Mean	2.57	2.79	2.93	3.03	
	Nitrogen (N)		Phosphorus (P)		Interaction (N x P)
S.E (m) ±	0.024		0.024		0.048
C.D. at 5%	0.07		0.07		0.14

Perusal of the data reveals that increasing levels of nitrogen significantly increased its concentration in flowers and

Figure: 4.14 Nitrogen content (%) as affected by different treatments



highest (3.06) was found in N<sub>3</sub> treatment, which was significantly higher over other levels of nitrogen. The lowest concentration was in control.

Application of phosphorus significantly increased nitrogen content over control, highest being (3.039) in P<sub>3</sub> treatment which was significantly higher over other treatments.

Interaction between nitrogen and phosphorus produced significant effect on percent nitrogen content. Treatment combination N<sub>3</sub>P<sub>3</sub> produced maximum nitrogen content (3.42) followed by N<sub>2</sub>P<sub>3</sub>.

#### 4.15 Phosphorus content (%) in flower

Phosphorus content in flower samples are presented in table 4.15.

Table: 4.15 Mean phosphorus content (%) in flower affected due to fertilizer treatment

Treatment	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	Mean
N <sub>0</sub>	0.44	0.49	0.55	0.59	0.51
N <sub>1</sub>	0.51	0.58	0.63	0.67	0.59
N <sub>2</sub>	0.62	0.69	0.69	0.75	0.68
N <sub>3</sub>	0.71	0.78	0.82	0.88	0.80
Mean	0.57	0.63	0.67	0.72	
	Nitrogen (N)		Phosphorus (P)		Interaction (N x P)
S.E (m)±	0.009		0.009		0.018
C.D. at 5%	0.028		0.028		N.S.

Figure: 4.15 Phosphorus content (%) as affected by different treatments

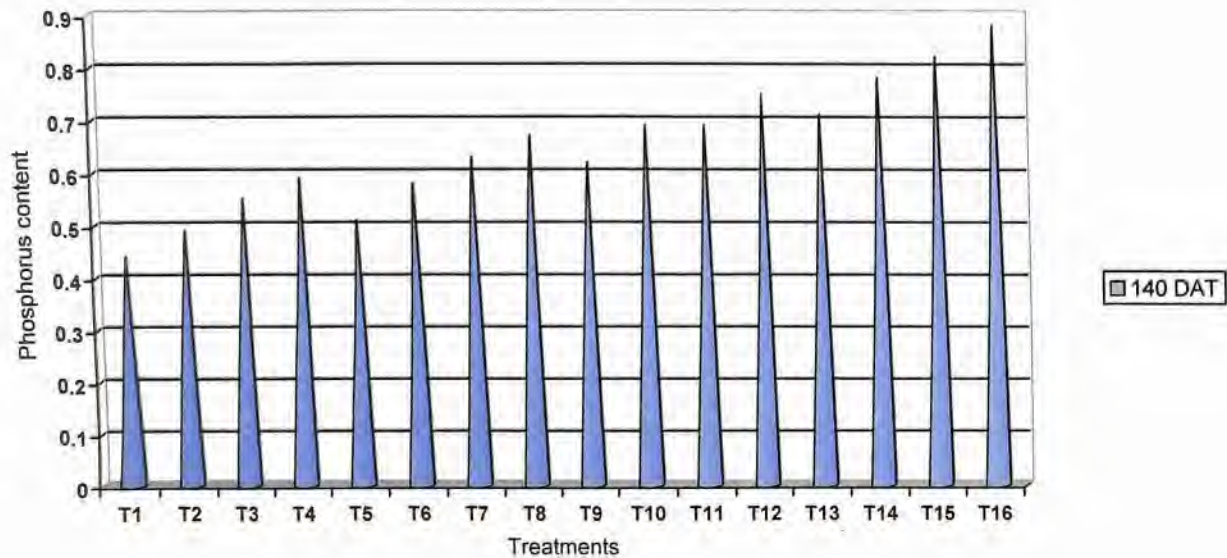


Table 4.13 reveals that increasing levels of nitrogen significantly increased chlorophyll content in flower and highest was recorded in  $N_3$  treatment, which was significantly higher over other levels of nitrogen. The lowest content was in control.

Data reveals that application of phosphorus significantly increased its content over control. Highest was in  $P_3$  which was significant over other treatments.

Interaction between nitrogen and phosphorus did not produce significant effect on percent phosphorus content.

#### 4.16 Total carotenoid content in flower

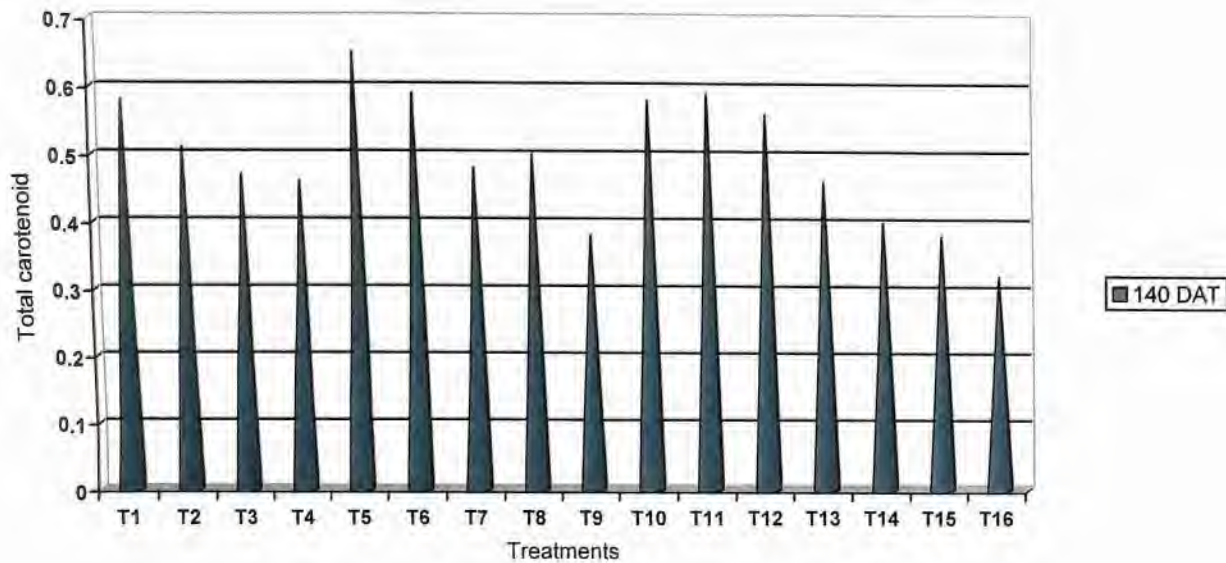
Total carotenoid content was determined in flower samples of individual treatments and is presented in table 4.16.

Table 4.16 Mean carotenoid content (%) in flower affected due to fertilizer treatment

Treatment	$P_0$	$P_1$	$P_2$	$P_3$	Mean
$M_0$	0.58	0.51	0.47	0.46	0.51
$N_1$	0.65	0.59	0.48	0.50	0.55
$N_2$	0.38	0.58	0.59	0.50	0.51
$N_3$	0.46	0.40	0.38	0.32	0.39
Mean	0.52	0.51	0.48	0.46	
	Nitrogen		Phosphorus	Interaction	
	(N)		(P)	(N x P)	
S.F (m.s.)	0.002		0.002	0.004	
C.D. at 5%	0.006		0.006	0.013	

From the analysis of variance given in the annexure it is clearly evident that different levels of nitrogen, phosphorus

Figure: 4.16 Total carotenoid content (mg/g) as affected by different treatments



and their interaction impart significant effect on the carotenoid content in the flower.

Maximum carotenoid content (0.559) was produced under the treatment  $N_1$  that was similar to  $N_2$  treatment. In case of phosphorus maximum carotenoid content (0.524) was recorded under treatment  $P_1$ .

Treatment combination of nitrogen and phosphorus were also found significant. Maximum carotenoid content (0.649) was produced under the treatment interaction  $N_1P_0$ .

## ECONOMICS

### NET PROFIT AND BENEFIT COST RATIO

The economics of different treatments is usually a deciding factor for its adoption by the farmers for commercial crop production. It is, therefore, of wide interest to calculate the effects of various treatments on the basis of yield and to work out the most remunerative combination of these factors to be applied in raising the flowering of African Marigold.

An account of net returns received from various treatment combinations is shown in table 4.17.

**Table 4.17: Economics of different treatments per hectare basis.**

S.No.	T/t	T/t cost (Rs)	Total cost (Rs)	Yield (Q/ha)	Gross income (Rs)	Net income (Rs)	Cost: Benefit Ratio
1.	N <sub>0</sub> P <sub>0</sub>	2209.2	18050.2	103.98	51990	33939.8	2.8
2.	N <sub>0</sub> P <sub>1</sub>	2771.7	18612.7	115.88	57940	39327.3	3.1
3.	N <sub>0</sub> P <sub>2</sub>	3334.2	19175.2	105.42	52710	33534.8	2.7
4.	N <sub>0</sub> P <sub>3</sub>	3896.7	19737.7	100.93	50465	30727.3	2.5
5.	N <sub>1</sub> P <sub>0</sub>	2470.1	18311.1	110.23	55115	36803.9	3.0
6.	N <sub>1</sub> P <sub>1</sub>	3032.6	18873.6	120.27	60135	41261.4	3.2
7.	N <sub>1</sub> P <sub>2</sub>	3595.1	19436.1	119.27	59635	40198.9	3.0
8.	N <sub>1</sub> P <sub>3</sub>	4157.6	19998.6	100.32	55160	35161.4	2.7
9.	N <sub>2</sub> P <sub>0</sub>	2730.9	18571.9	125.24	62620	44048.1	3.3
10.	N <sub>2</sub> P <sub>1</sub>	3293.4	19134.4	135.19	67595	48460.6	3.5
11.	N <sub>2</sub> P <sub>2</sub>	3855.9	19696.9	112.07	56035	36338.1	2.8
12.	N <sub>2</sub> P <sub>3</sub>	4418.4	20259.4	108.67	54335	32075.6	2.6
13.	N <sub>3</sub> P <sub>0</sub>	2991.8	18832.8	119.76	59880	41047.2	3.2
14.	N <sub>3</sub> P <sub>1</sub>	3554.3	19395.3	116.16	58080	38684.7	2.9
15.	N <sub>3</sub> P <sub>2</sub>	4116.8	19957.8	112.19	56095	36137.2	2.8
16.	N <sub>3</sub> P <sub>3</sub>	4679.3	20520.3	106.38	53190	32669.7	2.6

As per perusal of data presented in table 4.17 it is revealed that out of all combinations of N and P in the cultivation of Marigold, treatment  $N_2P_1$  recorded maximum net income accounting Rs. 48460.6 with a Benefit: Cost ratio of 3.5, followed by treatment  $N_2P_0$  and  $N_1P_1$ , where net income per hectare was in order of Rs. 44048.1 and Rs. 41261.4 whereas Benefit: Cost ratio being 3.3 and 3.2 respectively.



## DISCUSSION

## DISCUSSION

In this chapter an attempt has been made to evaluate the findings of the experiment "**Response of Nitrogen, Phosphorus, common pinching on growth, flowering and quality of African Marigold**". The experimental findings have been presented in the preceding chapter. This chapter consists of the possible reasons of the treatments, which are briefly discussed here in the light of research work done in the past.

### 5.1 Effect of nitrogen on growth characters:

In the present trial different doses of nitrogen could not show any significant effect on growth characters viz. girth of stem, number of leaves, number of branches and plant spread across the row. Except only the plant height, plant spread along the row and leaf area was significantly affected by different levels of Nitrogen.

Plant height, plant spread along the row and leaf area increased with increasing the nitrogen level. The maximum plant height was associated with 150 kg N/ha and minimum with control. Such effect may be ascribed to the fact as the nitrogen is the major nutrient for plant growth and is mainly responsible for increasing the growth of the plant. These observations in the agreement with the findings of Gammassay *et al.* (1965), De and Burman (1997).

It is now well established that nitrogen has quickest and more pronounced effect on growth and productivity of the

plants. However, in the present trial nitrogen could show only the marginal effect and not the significant on the growth characters viz. girth of stem, number of leaves, number of primary branches, plant spread etc. in the present trial half dose of nitrogen was applied as a basal dose before transplanting and setting of plant roots, which might have cause leaching of nitrogen. Some workers have opined that nitrogen particularly Urea loss quickly from the root zone by leaching, it is more likely to be the limiting factor for growing ornamental plants on the most of the soils.

Data recorded in the present trial indicates that the effect of nitrogen increased with the increase in nitrogen dose. (Bik, 1964, Gammassy *et al.* (1965), Bose and Roy (1968), Tsurushima and Date (1971), Rahman and Mitra 1974).

Mishra and Negi (1977) and Ravindran *et.al.* (1986) have reported increased plant growth with increase in nitrogen level which are in conformity with the present trial. However, Nelson and Boodly (1964), Cartner and Dermott (1966) and Yassin (1988) have noted adverse effect of higher doses of nitrogen in comparison to lower doses.

In the present studies 150 kg N/ha showed the marginally better result as compared to lower doses. Rathore *et.al* (1988) noted the best results with 200 kg N/ha in marigold.

## 5.2 Effect of Phosphorus on growth characters

Phosphorus is essential element; it occupies a key position in energy transformation in fat and protein metabolism.

The availability of phosphorus in the medium growth is related to the absorption of nitrogen, phosphorus has been associated with the development of roots and early maturity of crops. Allen (1959) opined that it is an active ingredient of cell nucleolus and encourages root growth and also stimulate flowering.

In the present trial phosphorus had shown a marginal increase in girth of stem, number of leaves per plant, plant spread across the row up to 100-125 kg phosphorus/ha and thereafter a decrease was recorded in all the characters with further increase in the dose i.e. 150 kg/ ha application. However, these differences (increase or decrease) was up to the level of statistical significance.

The plant height and plant spread along the row was significantly affected by different levels of phosphorus. The maximum plant height, plant spread along the row was associated with 125 kg P/ha and minimum with control. The maximum leaf area was obtained with 150 kg P/ha. This significant increase in plant height, plant spread along the row and leaf area due to application of phosphorus is probably a major nutrient for plant growth, which helps in root development and branching. It is widely accepted that phosphorus helps in cell division, cell elongation, and assists the development of meristematic tissues in growing points. Jana *et.al.* (1997), Arora (1980) in an experiment with African marigold concluded that 40 g of  $P_2O_5/m^2$  increased the height of plants.

### 5.3 Effect of Nitrogen on floral characters and yield:

Data presented in the preceding chapter clearly indicate that number of flowers per plant, circumference of flower, surface area of flower, fresh weight of flower per plant and ultimately yield of flowers per hectare increased significantly with the increase in nitrogen doses. It seems that marginally better plant growth produced more number of flower production and ultimately more number of flowers and heavier weight of flowers.

Chan *et al.* (1958), Kasagi and Kondo (1961), Jungk (1962), Winsor (1962), Bik (1964), Rahman and Mitra (1974), Cherneva (1974), Jana *et al.* (1974), Singh *et al.* (1976), and Pal *et al.* (1985) reported higher number of flowers, with the increase in nitrogen levels

In the present trial total yield of flowers increased significantly with the increase in nitrogen levels. Marginally better plant growth, higher number of flowers, weight of flowers, weight of flowers, better size of flower and higher fresh weight of flowers cumulatively resulted in significantly higher yields with highest dose of nitrogen. Chan *et al.* (1958), Jana *et al.* (1976), Cherneva (1976), Singh *et al.* (1976), and Rathore *et al.* (1988), Mukhopadhyay and Banker (1987), Arora and Singh (1980), Arora and Jaswinder observed higher yield of marigold in treatments of highest nitrogen i.e. 40 g N/m<sup>2</sup>. Natrajan *et al.* (1984), Kumar and Gill (1984), Arora and Khanna (1986), Lodhi and Tiwari (1993) and Dahiya *et al.* (1998) obtained significantly higher yields with higher nitrogen levels.

#### **5.4 Effect of Phosphorus on floral characters and yield**

In the present studies data reveal that circumference of flower, number of flower, weight of flower, surface area of flower, fresh weight of flower and total flower yield increase significantly with application of phosphorus at higher levels.

Ailincai (1960) found beneficial effect of phosphorus for increasing the number of flowers and vase life of flowers. Winsor (1962) recorded 20 percent increase in flower numbers with the application of phosphorus.

These studies further indicate a significant improvement in weight of flowers per plant and total yield per plot. Roelants (1973), Yadav (1983) and Yadav *et al.* (1985) Sidhu and Yamdagni (1992), Lodhi and Tiwari (1993), Jana *et al.* (1997), Arora and Jaswinder Singh (1980), Dahiya *et al.* (1998) obtained higher yields of flowers with the application of phosphorus. These results are in conformity with the findings of the present trial.

#### **5.5 Effect of Nitrogen and Phosphorus on growth, floral and yield attributing characters**

In the present studies Nitrogen and Phosphorus combined could affect significantly the total yield of flower, number of flower, surface area of flower, fresh weight of flower and growth characters like plant height and spread along the row, while all other growth characters like girth of stem, number of leaves, number of branches, plant spread across the row and

yield contributing characters like mean circumference and weight per flower were found non-significant. Arora and Singh (1988), Lathi and Prasad (1993), Dalvi *et al.* (1998) have also reported higher yields with the application of Nitrogen and Phosphorus. In the present studies significantly higher yields were obtained with the application of 120 kg P/ha and 100 kg P/ha.

Individuals nitrogen and phosphorus failed to show any effect on the growth characters and the same trend was noted on both of them when combined effect was studied.

In the present trial nitrogen up to 150 kg/ha and phosphorus up to 180 kg/ha were used. It seems that the these doses were optimum to show significant effect. Arora and Singh (1988) obtained the best results in marigold with the application of 40 g N/m<sup>2</sup> and 40 g P/m<sup>2</sup> (600kg N and 600 kg P/ha). Yadav and Boaz (1989) have also noted maximum plant growth and flower production in marigold with the application of 400kg N and 200 kg P/ha. Arora and Khanna (1985) also noted that 20 g N/m<sup>2</sup> (200 kg N/ha) was optimum for flower production in marigold. Dalvi *et al.* (1998) also recorded in greenhouse conditions 280 ppm Nitrogen and 120 ppm Phosphorus significantly increased the yield of African marigold. These studies confirm that higher doses of nitrogen and phosphorus are better for growth and yield in marigold production.

### 5.6 Effect of Nitrogen and Phosphorus on nutrient concentration

In order to test out the effect of different levels of N, P and their interaction nitrogen was determined to flower

samples. The results reveal that increasing levels of N and P increased the concentration of nitrogen significantly. The maximum concentration was found in N<sub>3</sub>P<sub>3</sub> treatment (150 kg N/ha). *It may be attributed to the fact that adequate supply of P helps in the development and growth of roots as well as in the formation of ATP, a energy supplier to the plant.*

Data recorded in the present studies indicate that increasing levels of N and P increased the P concentration in marigold flower. The increase in P concentration due to P application was high. It is well ascribed to the fact that N supply ensures healthy growth to the plants which helps in the uptake of P. It also indicates towards the synergism between two nutrients.

It seems from the results that nitrogen requirement of marigold is very high therefore higher level of N (150 kg N/ha) used in the present study responded well. Rathore *et al.* (1988), Arora and Singh (1980) recorded increase in yield of flowers with the application of nitrogen, however they could not report regarding N content of flowers.

### 5.7 **Effect of nitrogen and phosphorus on total carotenoid content**

Results reveal that maximum carotenoid content under the N<sub>1</sub> level which was similar to N<sub>2</sub> level. Total carotenoid content is significantly decreased from N<sub>1</sub> to N<sub>2</sub> level. The enhancement of the carotenoid content by nitrogen application might be due to the fact that N<sub>2</sub> being a major nutrient and important constituent of several molecular

structures of vital importance namely protein, amino acids, enzymes, photosynthetic pigments, chlorophyll and carotenoid.

In case of phosphorus maximum carotenoid content was recorded under level P1 which was at par to P0 level. It was found that 75 kg P/ha is the optimum dose for total carotenoid content. It seems from the results that 100 kg P/ha had shown a marginal increase in total carotenoid content and thereafter a decrease was recorded in the carotenoid content.

The beneficial effects of phosphorus on carotenoid content might be due to availability of high energy in the form of ATP which favored the cell multiplication and enhanced the carotenoid content in leaf tissues.



SUMMARY; CONCLUSION  
& SUGGESTIONS

## SUMMARY, CONCLUSION AND SUGGESTIONS

### 6.1 Summary

A field experiment entitled "Response of nitrogen, phosphorous and common pinching on growth, flowering and quality of African marigold (*Tagetes erecta* Linn.)" was carried out at the New Nursery, Department of Vegetable Crops and Floriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during September 2002 to March 2003. The 16 treatment combinations of aforesaid treatments were laid out in factorial arrangement in randomized block design (RBD) with 3 replications.

#### 6.1.1 Effect of nitrogen application on growth and flowering of African Marigold

The significant effect of the nitrogen levels was observed for plant height, plant spread along the row, leaf area, no of flowers, weight per flower, fresh weight of flower, mean circumference of flower surface area of flower and yield of the flower.

The 150 kg nitrogen application per hectare gave significantly higher values for all above traits except in case of flower yield 120 kg N/ha gave maximum yield.

Marginal increase in growth characters viz; girth of stem, no. of leaves per plant, no. of primary branches, plant spread across the row was noted due to increase levels of

nitrogen but did not touch the level of significance. Maximum content of nitrogen and phosphorus in marigold flower was found in level  $N_3$ . Maximum carotenoid content in marigold was found in level  $N_1$  i.e. 90 kg N/ha.

### 6.1.2 Effect of phosphorus application on growth and flowering of African Marigold

Among the levels of phosphorus, application of 125 kg  $P_2O_5$ /ha treatment proved to be better in all the growth characters. The 125 kg  $P_2O_5$ /ha gave significantly higher values for plant height, plant spread along the row and leaf area. Application of 150 kg  $P_2O_5$ /ha had shown significant effect on number of flower per plant, weight per flower, fresh weight of flowers per plant, circumference of flower, surface area of flower.

The 125 kg  $P_2O_5$ /ha gave significantly higher value for flower yield. Maximum content of N, P in marigold flower was found in level  $P_3$ . Maximum carotenoid content in marigold was found in level  $P_1$  i.e. 100 kg  $P_2O_5$ /ha.

### 6.1.3 Interaction effect of nitrogen and phosphorus<sup>on</sup> growth and yield of African Marigold

The significant effect of interaction of N and P was observed for plant height, plant spread along the row and maximum plant height was noted under  $N_2P_2$  treatment and maximum plant spread along the row was noted under  $N_3P_1$  treatment. In other growth characters viz; girth of stem, no. of leaves per plant, no. of primary branches, plant spread across

was for interaction of N and P did not show any significant effect.

Among the interactions, highest value for no. of flowers per plant, weight of per flower, fresh weight of flower per plant, surface area of flower, nitrogen content and phosphorus content were recorded with the treatment  $120N_2$ .

The significant flower yield was achieved by the treatment combination  $120N_2P_2$  i.e.  $120 \text{ kg } N_2 + 100 \text{ kg } P_2O_5$  per ha. in marigold.

## 6.2 Conclusion

From the overall performance it can be concluded that application of  $120 \text{ kg } N_2$  and  $100 \text{ kg } P_2O_5$  ha<sup>-1</sup> greatly increased the yield of flower in marigold crop under laboratory condition.

## 6.3 Suggestion for further work

1. Since it was the first year of the trial, it is suggested that this experiment should be repeated for the confirmation of the results of the present investigation.
2. Effect of pinching should be tested on the growth and yield of marigold.
3. Present experiment was on seedling plants, but in future it should be repeated on vegetatively propagated (cuttings) plants of marigold to have the uniformity in growth and floral characteristics.



Author is taking the observation



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APPENDICES

## APPENDICES

**APPENDIX - I: Analysis of variance of the morphological observations under different treatments**

Source of variation	D.F.	TREAT						
		Plant height	Stem girth	Number of leaves	Number of branches	Plant spread along the row	Plant spread across the row	Leaf area
Replication	2	3.450082	0.001415	218.26	1.187500	0.804524	4.891592	2.807563
Nitrogen	5	16.521537*	0.005285	163.81	8.187500	8.579415*	5.982519	286.887138*
Phosphorus	3	13.725908*	0.012285	101.52	8.187500	11.365716*	9.507668	44.502882*
Interaction	9	6.514033*	0.010035	83.58	1.687500	4.079753	8.665723	4.15293
Error	30	5.890056	0.029001	117.82	4.654167	1.453164	1.748818	2.475030

**APPENDIX - II: Analysis of variance of quality of yield characters under different treatments**

Source of variation	D.F.	No. of flower per plant	Weight of flower	Weight of flower/plant	Circumference of flower	Surface area of flower	Yield
Replication	2	1.760106*	0.678064	132.498114	4.407476	0.276092	17.008471
Nitrogen	3	42.366643*	6.386200*	7634.339843*	18.144039*	198.08135*	384.336200*
Phosphorus	3	2.757013*	0.052507*	6342.313539*	26.722869*	179.269620*	481.452007*
Interaction	9	1.916098*	0.570691	259.247905*	0.644152	51.943116*	93.841626*
Error	30	0.617031	0.985287	77.872732	2.440449	1.922620	8.560704

**APPENDIX - III: Analysis of variance of per cent nitrogen, phosphorus and carotenoid in flowers**

Source of variation	d.f	Mean sum of squares		
		Mean per cent nitrogen in flowers	Mean per cent phosphorus in flowers	Mean per cent carotenoids in flowers
Replication	2	0.012065	0.000858	0.000538
Waring	3	0.380724*	0.117861*	0.065816*
Phosphorus	3	0.482919*	0.50094*	0.009877*
Interaction	9	0.038363**	0.000513	0.018669*
Error	60	0.007202	0.001143	0.000062

\* significant at 5% probability level

## VITA

Amit Pandey, the author of this thesis was born on 11<sup>th</sup> April 1979 at Jabalpur District (M.P.). He passed his Higher Secondary School Certificate examination from Model High School, Jabalpur in the year 1996 and secured second division.

He obtained Bachelors Degree in Agriculture in the year 2001 from college of Agriculture Jabalpur with an OGPA 6.98 out of 10 point scale.

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His achievement in the field of sports and HSS aver prave worthy. He actively participated in many social and cultural activities during college time. Now he is going to complete his master degree programme requirement by submission of this thesis.